ORIGINAL SCIENTIFIC PAPER

Nutritional and sensory properties of wild lettuce (*Lactuca taraxacifolia*) leaves as affected by sun drying alone or in combination with blanching

Kikelomo Rukayat Busari[1]*, Samson Adeoye Oyeyinka[2], Raman Akinoso[1], Ogugua Charles Aworh[1]

[1]*University of Ibadan, Department of Food Technology, Ibadan, Nigeria*
[2]*University of Ilorin, Department of Home Economics and Food Science, Ilorin, Nigeria*

Abstract

This study investigated the effect of pre-treatments and storage on the physical, chemical and sensory attributes of wild lettuce (Lactuca taraxacifolia). The pre-treatments included blanching with 0.125% (w/v) Na_2CO_3 at 95°C for 1 min and without Na_2CO_3 with subsequent drying. All vegetable samples were analyzed for colour (Hunter L, a, b), vitamin C, β-carotene, minerals (Ca, Mg, K, Na, Fe), rehydration ratio (fresh vegetable excluded) and moisture content before and after storage at intervals of two weeks for a period of three months. The vitamin C, β-carotene, rehydration ratio and mineral contents of all the vegetables (pre-treated and untreated) decreased with increasing storage period. Sensory evaluation showed vegetable soup prepared from unblanched-sundried wild lettuce showed comparable quality to the soup prepared from fresh leaves. Wild lettuce leaves could be preserved by sun drying with prior blanching in 0.125% (w/v) Na_2CO_3 for minimal loss of quality.

Key words: *Wild lettuce, Blanching, Sun drying, Colour, Vitamin C*

**Corresponding author*
Email: busarikikelomo@gmail.com; sartf2001@yahoo.com
Phonenumber: +2348138631780

Introduction

Increased consumers' awareness of the relationship between health and diseases, and the knowledge of the role of leafy vegetables in human diet has influenced the consumption of leafy vegetables in recent times. Leafy vegetables are valuable sources of natural antioxidants such as vitamins, carotenoids, flavonoids and other phenolic compounds (Turkmen et al., 2005; Zhang and Hamauzu, 2004). These array of nutrient are known to reduce the risk of several age-related diseases such as cancer and cardiovascular diseases (Cheung et al., 2003; Turkmen et al., 2005; Zhang and Hamauzu, 2004). Besides the nutritional and health value, leafy vegetables also serve culinary purposes. Fresh vegetables have better health promoting properties than dehydrated or frozen types. According to Danesi and Bordoni, (2008), most people do not have the time to prepare fresh vegetables daily. Consequently, vegetables are frozen since they can be rapidly prepared. However, most developing or underdeveloped nations usually have access to erratic supply of electricity, making freezing practically impossible. Hence, excess vegetables are either sun dried or loss due to wilting or spoilage.

In Nigeria, green leafy vegetables are usually subjected to various methods of processing such as blanching to improve the taste (Akindahunsi and Oboh, 1999; Oboh, 2005). Blanching, which aim is to destroy or inactivate enzyme may be used as a pretreatment to subsequent processing methods such as drying. These pretreatments and processing methods have been found to affect yield and nutrients retention in leafy vegetables (Maeda and Salunkhe, 1981; Onayemi and Badifu, 1987). The effect of pretreatments such as blanching on nutrient retention may however vary with blanching type (water or steam) and drying method. For instance, water blanching and sun drying was reported to substantially reduce ascorbic acid and beta carotene content of *Amaranthus hybridus*, *Celosia argentia* and *Solanum nudiflorum* compared to steam blanching and cabinet drying (Onayemi and Badifu, 1987). Further, irrespective of drying method, ammonium or sodium bicarbonate steam blanched vegetables reportedly showed comparable ascorbic acid, beta carotene and ash contents to the fresh vegetables (Onayemi and Badifu, 1987).

Wild Lettuce (*Lactuca taraxacifolia*) also known as bitter, opium or African Lettuce is a neglected indigenous leafy vegetable in Nigeria. It is commonly called *efo yanrin* and mostly consumed among the Yoruba tribe of Nigeria (Sakpere et al., 2011). The leaves of wild lettuce can be eaten fresh as salad or cooked in soups and sauces (Sakpere et al., 2011). The protein ash and iron contents of wild lettuce leaves were reportedly higher than other common vegetables like *Solanum aethiopicum* and *Talinum triangulare* (Yekeen et al., 2011). Similarly, the leaves of wild lettuce has been found to contain higher (almost double) beta carotene than *Telfairia occidentalis* (Adewale et al., 2013). So far studies on wild lettuce leaves have focused on its composition (Adewale et al., 2013; Yekeen et al., 2011) and antioxidant properties of its extract in food application (Arawande et al., 2012a; Arawande and Ogunyemi, 2012; Arawande et al., 2012b). The high moisture content of leafy vegetables predisposes them to wilting and rapid spoilage. Blanching in combination with freezing or drying has been successfully employed in preserving these vegetables for con-

sumption in best possible form. There is limited information on the quality of dried wild lettuce pretreated by water or chemical blanching. In this study we investigated the effect of sun drying alone or in combination with water or sodium carbonate blanching on selected quality of stored wild lettuce leaves.

Materials and Methods

Plant materials

Freshly harvested wild lettuce was purchased from a local farm in Ibadan, Nigeria. The vegetables were transferred into the laboratory, destalked and immediately used for the study. All other reagents used in this study were laboratory grade.

Blanching and sun drying of vegetables

Wild lettuce leaves were divided into four parts. One part was washed with distilled water and cut into thin slices (2 mm) and spread on tray and sun dried (Relative humidity 78-80%, ambient temperature 30±2°C) until crisp. Another portion of the vegetable was rinsed with distilled water, drained and blanched in water at 95±1°C for 1 min. The vegetables were drained and sun-dried until crisp. The final treatment involved rinsing with distilled water, and blanching in 0.125% (w/v) Na_2CO_3 at 95°C for 1 min. The blanched sample was also sundried until crisp. Untreated wild lettuce served as the control. The minimum blanching time which is a function of enzyme inactivation was determined by negative peroxidase test (Masure and Campbell, 1944). Sundried vegetables were poured inside clean airtight plastic containers.

Analyses

All samples were analyzed for vitamin C, beta carotene, colour, mineral contents and rehydration capacity at intervals of two weeks for a period of 12 weeks. Processed vegetables were stored at ambient temperature of 25±2°C. Sensory evaluation of both the fresh and sundried samples was carried out after the 12 weeks storage period.

Beta carotene, vitamin C and moisture contents

The beta carotene contents of the fresh and processed wild lettuce leaves was determined using the modified method of Jaworska et al., (2014). Briefly, the extract was injected into a HPLC equipped with a C18 column (Dimension 215mm; Particle size 5µm). Isocratic elution was done using a mixture of n-hexane and 2-propanol (95:5) at a flow rate of 2 mL/min. Quantification was based on the peak areas, against a calibration curve obtained using β-carotene standard. Vitamin C content was determined using the quantitative discolouration of 2,6-dichlorophenol indophenol (Merck KgaA, Darmstadt, Germany) titrimetric method as described in AOAC methodology No. 967.21 (AOAC, 2000). Moisture content of the vegetables was determined using a hot air oven at 105°C until the samples had constant weight for three consecutive measurements.

Colour measurement

The colour of fresh and processed wild lettuce leaves were assessed using a Hunter L-a-b colorimeter (Konica Minolta, Japan). Tristimulus L, a and b parameters of the leaves were determined after standardization. The instrument was standardized with a Business Xerox 80 g white paper (L = 93.24, a = 00.96, b = 02.75) by making contact between the colorimeter sensor and the paper.

Mineral contents

Fresh and processed vegetables were digested as described in Karim et al., (2015) and the mineral content analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP)-Mass spectrometer (Perkin-Elmer). Samples (0.5 g) were acid digested using 65% nitric acid. Digested samples solutions were then quantified against standard solutions of known concentrations.

Rehydration ratio

Rehydration ratio of processed wild lettuce leaves were done according to the methods of Wang et al., (2013) except that the temperature used was 80±2°C and the vegetable to water ratio 1 to 100 for 2 min. The samples were immediately drained on a metal sieve for 5 min and weighed. The rehydration capacity was calculated as shown in equation 1.

$$\text{Rehydration ratio} = \frac{\text{Weight after rehydrated sample (g)}}{\text{Initial weight of dried sample (g)}} \quad (1)$$

Sensory evaluation

A fifty member panel consisting of semi-trained male and female students in the Department of Food Technology, University of Ibadan, Nigeria, who are regular consumers of vegetable soups and familiar with the attributes, were used to assess the sensory qualities of the prepared soups. Panelists were comfortably seated in booths and served with separate plates of soup and "Semo" (a common starchy staple). The soup samples were coded before the assessment. Most panelists were between the ages: 18–30. A 9 point hedonic scale (1- extremely dislike; 9- extremely like) was used.

Statistical analysis

All experiments were conducted in triplicate. Data were analyzed using analysis of variance (ANOVA) and means were compared using Fischer's Least Significant Difference Test ($p<0.05$).

Results and discussion

Moisture

Expectedly, the moisture content of fresh wild lettuce leaves was high approximately 85% (Data not shown). The moisture content of fresh wild lettuce is in the range (approx. 80-89%) reported for other lesser known vegetables (Oduse et al., 2012). Wild lettuce leaves sundried alone had moisture content of 5.9%, which was higher than wild lettuce leaves water blanched prior to sun drying (3%) and sodium carbonate blanched-sun dried samples (3%).

Generally, the moisture content of all samples increased and varied significantly ($p<0.05$) throughout the storage period of 12 weeks (Data not shown). Oladele and Aborisade, (2009) similarly reported an increase in moisture content of dried Indian spinach (*Basella rubra*) stored for 12 weeks. The increase in moisture content during storage may be attributed

to moisture uptake through the packaging material. Most packaging material possesses minute pores which may enhance gas exchange including water vapour during storage.

Vitamin C

As expected, freshly harvested wild lettuce leaves had significantly higher vitamin C content (24.26 mg/100 g) compared to sundried (21.03 mg/100 g), blanched-sundried (20.17 mg/100 g) and sodium carbonate blanched-sundried (20.97 mg/100 g) wild lettuce leaves (Table 1). The vitamin C content of fresh wild lettuce leaves in this study is much higher (approx. 4 times) than values previously reported for wild lettuce leaves (Adewale et al., 2013). In comparison with other commonly consumed vegetables in Nigeria, the vitamin C content of the studied wild lettuce appear lower than values reported for *Telfairia occidentalis* (148.0 mg/100 g), *Amaranthus cruentus* (70.0 mg/100 g) and *Basella alba* (64.6 mg/100 g) (Oboh, 2005), but higher than those reported for *Talinum triangulare* (9.30 mg/100g), *Crassephalum crepidioees* (13.79 mg/100 g), *Amaranthus hybridus* (24.00 mg/ 100 g), *Celosia argentea* (15.66 mg/100 g) (Babalola et al., 2010). The differences in vitamin C content among vegetables may be attributed to varietal difference, pre-harvest climatic conditions, stage of maturity and postharvest handling procedures (Mkandawire and Masamba, 2014).

Among the processed samples, water blanched wild lettuce leaves in combination with sun drying showed higher reduction (approx. 17%) in vitamin C content compared to sundried samples or sodium carbonate blanched in combination with sun drying which both showed approximately 13% reduction (Table 1). Several authors similarly reported higher reductions in vitamin C content of blanched vegetables which was subsequently dried compared to those sundried alone (Jaworska et al., 2014; Mepba et al., 2007). The higher reduction in vitamin C content of the water blanched-sundried samples compared to samples sundried alone may be associated with the high solubility of ascorbic acid in water. According to Mepba et al., (2007) the pH, temperature of the heating medium, enzyme activity and the presence oxygen may also influence the vitamin C content of vegetables during blanching (Mepba et al., 2007).

With increasing storage period from 0 to 12 weeks, the vitamin C content progressively decreased by 74.79%, 76.35% and 74.58% for wild lettuce leaves sundried alone, water-blanched-sundried and sodium carbonate blanched-sundried respectively (Table 1). Some authors also observed reduction in vitamin C content of stored processed vegetables (Jaggi et al., 2015; Mkandawire and Masamba, 2014; Oladele and Aborisade, 2009). As previously indicated, the moisture content of the dried wild lettuce leaves increased with storage period. The increase in moisture content may have spurred interactions between different components of the vegetables leading to the reduction in vitamin C content during storage (Fellows, 1997). Wild lettuce leaves pretreated with sodium carbonate prior to sun drying showed higher vitamin C retention (25.42%) compared to sun drying alone and water blanched-sundried leaves. This may be attributed to the preservative effect of sodium carbonate.

Table 1. *Effect of pre-treatments and storage on the vitamin C content (mg/100 g) of wild lettuce leaves*

	Week 0	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12
Fresh	24.26^{a}	-	-	-	-	-	-
Sundried	21.03^{b}	17.53^{a}	11.81^{a}	10.81^{a}	10.53^{a}	8.05^{a}	5.30^{a}
Blanched and sundried	20.17^{b}	16.69^{a}	10.97^{b}	10.27^{b}	9.98^{b}	7.51^{a}	4.77^{b}
Na_2CO_3 blanched and sundried	20.97^{b}	17.50^{a}	11.78^{a}	10.80^{a}	10.51^{a}	8.05^{a}	5.33^{a}

Mean with different superscript letters along the same column are significantly different $p<0.05$).

Beta carotene

The beta (β) carotene content of fresh wild lettuce leaves was 1696 µg/100 g (Table 2). All pre-treatment methods significantly reduced the β-carotene content of wild lettuce leaves. Water blanched-sundried wild lettuce leaves showed higher reduction (approx. 46%) in β-carotene content compared to wild lettuce leaves sun dried alone and sodium carbonate blanched-sun dried wild lettuce leaves which both showed approximately 26% reduction. The reduction in β-carotene content of green leafy vegetables after processing is well known. Several mechanisms may account for the varied effect of the processing methods on the β-carotene content of vegetables. Excessive activity of lipoxygenase enzyme in the initial warming stages of blanching may lead to the reduction of β-carotene (Mosha et al., 1997; Speek et al., 1988). Changes in the structural stability of carotenoids during thermal processing may also contribute to reduction in β-carotene. For instance Nguyen et al., (2001) observed that all-trans lycopene did not isomerize from *trans*- to *cis*-form during typical processing conditions. However, trans- β-carotene and trans-lutein isomerized. The cis-form of β-carotene is generally unstable compared to the *trans* form (Mosha et al., 1997; Speek et al., 1988). Presumably the formation of the less stable cis form of β-carotene during water blanching of wild lettuce leaves may have accounted for the lower β-carotene content recorded for water blanched-sun dried wild lettuce leaves. In the wild lettuce leaves blanched with sodium carbonate, the basic condition created by sodium carbonate may have reduced the effect of heat on the cis form of β-carotene. This may explain why sodium carbonate-sun dried samples (1252 µg/100 g) showed higher β-carotene content than the water blanched-sun dried samples (924 µg/100 g). Previous studies reported that β-carotene degradation was slow at low pH (Qian et al., 2012).

With increase in storage period, the β-carotene content of wild lettuce leaves decreased (Table 2). At the end of 12 weeks storage, the β-carotene content of the leaves varied between 107 to 448 µg/100 g for water blanched-sun dried wild lettu-

ce and wild lettuce sun dried alone respectively. The retention of β-carotene content in the stored leaves were 35.20%, 11.58% and 35.38 % for wild lettuce leaves sun dried alone, blanched-sun dried wild lettuce leaves and sodium carbonate blanched-sun dried wild lettuce leaves respectively. Blanching in combination with air or freeze drying reportedly reduced the β-carotene content of *Boletus edulis* mushrooms stored for 24 months at ambient temperature (20°C) (Jaworska et al., 2014). The decrease in β-carotene content of wild lettuce leaves during storage may be attributed to the activity of lipoxygenase which may degrade carotenoids (Booth et al., 1992; Dietz et al., 1988). Further the heat, light and moisture prevailing during water blanching and sun drying conditions may have contributed to the destruction of β-carotene by oxidation, isomerization and free radical formation (Chandler and Schwartz, 1988; Mosha et al., 1997; Speek et al., 1988).

Table 2. *Effect of pre-treatments and storage on the β –carotene content (µg/100 g) of wild lettuce leaves*

	Week 0	Week 2	Week 4	Week 6	Week 8	Week 10	Week12
Fresh	1696.00^{a}	-	-	-	-	-	-
Sundried	1272.70^{b}	1073.00^{a}	900.00^{a}	700.00^{a}	500.00^{a}	450.00^{a}	448.00^{a}
Blanched and sundried	924.00^{d}	725.00^{c}	555.33^{c}	354.00^{b}	155.00^{b}	109.33^{c}	107.00^{c}
Na_2CO_3 blanched and sundried	1252.00^{c}	1054.00^{b}	884.00^{b}	687.00^{a}	489.33^{a}	444.33^{b}	443.00^{b}

Mean with different superscript letters along the same column are significantly different $p<0.05$).

Colour

Changes in the colour of pretreated wild lettuce leaves was assessed using L, a, b parameters. As expected the colour of fresh wild lettuce leaves as physically observed was very green. This was confirmed by its high negative a-value of -9.76 (Table 3). Most leafy vegetables are known to be green when freshly harvested. Therefore a high negative a-value is expected for the fresh wild lettuce. However, blanching in combination with sun drying significantly affected the colour of wild lettuce leaves. All processed wild lettuce leaves, showed a reduction in their green colour as shown by lower negative a-values of -4.26, -0.37 and -0.60 for sun dried wild lettuce leaves, water blanched-sun dried and sodium carbonate blanched-sun dried wild lettuce leaves respectively. The reduction in the negative a values suggests the loss of chlorophyll pigment responsible for the greenness in green leafy vegetables. The a-value of the processed wild lettuce decreased with increase in storage period and was accompanied with corresponding increase in L and b-values.

Table 3. *Effect of pre-treatments and storage on the colour value of wild lettuce leaves*

		L	a	b
Week 0	Fresh	40.52^{a}	-9.76^{c}	12.88^{a}
	Sundried	30.01^{b}	-4.26^{b}	7.58^{b}
	Blanched and sundried	17.38^{d}	-0.37^{a}	2.68 ^{c}
	Na_2CO_3 blanched and sundried	20.42^{c}	-0.60^{a}	2.14^{c}
Week 2	Sundried	30.77^{a}	-0.81^{c}	8.08^{a}
	Blanched and sundried	17.94^{c}	1.13^{a}	2.72^{b}
	Na_2CO_3 blanched and sundried	20.66^{b}	0.74^{b}	2.41^{b}
Week 4	Sundried	31.63^{a}	-0.72^{c}	8.78^{a}
	Blanched and sundried	19.27^{b}	1.40^{a}	2.97^{b}
	Na_2CO_3 blanched and sundried	20.83^{b}	0.85^{b}	2.65^{b}
Week 6	Sundried	34.63^{a}	-0.69^{c}	9.40^{a}
	Blanched and sundried	23.42^{c}	1.77^{a}	3.70^{b}
	Na_2CO_3 blanched and sundried	24.64^{b}	1.07^{b}	2.70^{c}
Week 8	Sundried	38.24^{a}	-0.69^{a}	9.98^{a}
	Blanched and sundried	24.50^{b}	2.07^{a}	4.18^{b}
	Na_2CO_3 blanched and sundried	24.89^{b}	1.33^{b}	2.75^{c}

Week 10	Sundried	39.66[a]	-0.46[c]	10.06[a]
	Blanched and sundried	24.71[c]	2.63[a]	4.33[b]
	Na_2CO_3 blanched and sundried	25.55[b]	1.37[b]	2.83[c]
Week 12	Sundried	39.84[a]	-0.45[c]	10.04[a]
	Blanched and sundried	25.02[c]	2.88[a]	4.72[b]
	Na_2CO_3 blanched and sundried	25.56[b]	1.38[b]	2.84[c]

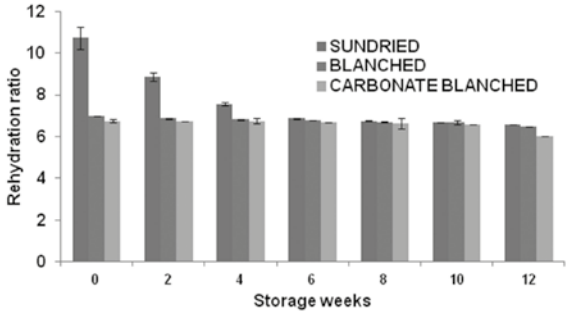
Mean with different superscript letters along the same column are significantly different $p<0.05$).

Rehydration ratio

Rehydration ratio (RR) is one way to analyze dried products. A high RR means the dried product has a good quality. The RR of dried wild lettuce leaves varied from 6.76 to 10.73 at the beginning of the storage period (Fig. 1). Unblanched-sun dried wild lettuce leaves showed the highest RR compared to water blanched and sodium carbonate blanched-sundried samples. The lower RR of the blanched-sun dried wild lettuce compared to the unblanched sun dried samples could possibly be linked with damage to wild lettuce leaf tissues as a result of irreversible cellular rupture and dislocation that occurs during blanching and subsequent drying. This may result in loss of tissue integrity producing a dense structure of collapsed, shrunken capillaries with reduced hydrophilic properties. Blanching is known to soften vegetables tissues. This softening process together with sun drying may have increased the extent of tissue damage and integrity as previously stated. Some authors also reported higher RR for unblanched vegetables compared to blanched vegetables (Okpala and Ekechi, 2014; Rajeswari et al., 2011).

The RR of stored sun dried wild lettuce leaves was higher than water blanched and sodium carbonate blanched-sundried samples up till week 4 (Fig. 1). Beyond this storage period, the differences in RR among the samples were not very different.

Figure 1. *Effect of pre-treatments and storage on the rehydration capacity of wild lettuce leaves*



Error bars indicate standard deviation (n=3)

Mineral

Calcium (430.00 mg/100 g) and sodium (488.33 mg/100 g) are the major minerals in freshly harvested wild lettuce leaves (Table 4). Magnesium (100 mg/100 g), potassium (51.67 mg/100 g) and iron (13.30 mg/100 g) are present in relatively small quantities. There was reduction in the Na, Ca, Mg, K and Fe contents of sundried and blanched-sundried wild lettuce leaves immediately after processing as compared with the fresh wild lettuce leaves. Similarly, the mineral content of dried wild lettuce leaves decreased with increase in storage period. Although, the mineral contents of the pretreated vegetables decreased with increasing period of storage, the decrease was very marginal. This suggests that fresh and stored dried wild lettuce leaves are relatively good sources of Na, Ca, Mg, K and Fe. These minerals are known to facilitate various bio-chemical processes in humans and minimizing micronutrient deficiencies. Calcium functions in the body by sustaining strong bones and plays important role in muscle contraction and relaxation, blood clotting, synaptic transmission and absorption of vitamin B12 (Mensah et al., 2008; Oduse et al., 2012). Studies have also reported that magnesium can participate in blood pressure reduction (Fasuyi, 2006; Latunde-Dada, 1990).

Table 4. *Effect of pre-treatments and storage on the mineral content (mg/100 g) of wild lettuce leaves*

		Ca	Mg	K	Na	Fe
Week 0	Fresh	430.00[b]	100.00[a]	51.67[a]	488.33[a]	13.30[a]
	Sundried	429.33[b]	100.00 [a]	43.33[b]	428.33[b]	13.13[a]
	Blanched and sundried	421.67[c]	95.00[a]	45.00[b]	420.00[c]	12.70[b]
	Na_2CO_3 blanched and sundried	450.00[a]	97.33[a]	49.33[a]	490.00[a]	13.23[a]

Week 2	Sundried	428.33^{b}	99.33^{a}	43.33^{b}	426.00^{b}	12.90^{a}
	Blanched and sundried	416.67^{c}	90.67^{b}	41.67^{b}	418.67^{b}	11.93^{b}
	Na_2CO_3 blanched and sundried	441.67^{a}	94.00^{ab}	49.00^{a}	446.67^{a}	13.13^{a}
Week 4	Sundried	427.33^{b}	98.33^{a}	42.67^{b}	425.00^{b}	12.77^{a}
	Blanched and sundried	415.00^{c}	90.00^{b}	41.33^{b}	416.67^{b}	11.73^{b}
	Na_2CO_3 blanched and sundried	438.33^{a}	91.67^{ab}	49.00^{a}	443.33^{a}	13.03^{a}
Week 6	Sundried	425.00^{ab}	95.67^{a}	41.00^{b}	423.33^{b}	12.60^{a}
	Blanched and sundried	410.00^{b}	87.00 ^{b}	40.33^{b}	415.67^{c}	11.37^{b}
	Na_2CO_3 blanched and sundried	436.00^{a}	90.67^{ab}	48.33^{a}	442.33^{a}	12.90^{a}
Week 8	Sundried	420.00^{b}	94.67^{a}	40.00^{b}	418.67^{b}	12.53^{b}
	Blanched and sundried	409.00^{c}	85.33^{b}	37.00^{b}	415.00^{c}	11.30^{c}
	Na_2CO_3 blanched and sundried	430.00^{a}	90.00^{b}	47.00 ^{a}	440.00^{a}	12.87^{a}
Week 10	Sundried	415.00^{b}	93.67^{a}	38.00^{b}	417.33^{b}	12.30^{b}
	Blanched and sundried	407.00^{c}	84.00 ^{c}	34.00^{c}	411.67^{c}	11.00^{c}
	Na_2CO_3 blanched and sundried	428.67^{a}	88.67^{b}	46.00^{a}	437.33^{a}	12.81^{a}
Week 12	Sundried	412.00^{b}	93.00^{a}	36.00^{b}	415.00^{b}	11.97^{b}
	Blanched and sundried	405.33^{c}	81.00^{c}	31.00^{c}	409.00^{c}	10.80^{c}
	Na_2CO_3 blanched and sundried	427.00^{a}	87.33^{b}	44.00^{a}	435.33^{a}	12.79^{a}

Mean with different superscript letters along the same column are significantly different $p<0.05$).

Sensory properties

Mean sensory score of soups prepared with fresh and dried wild lettuce are shown in Table 5. Fresh wild lettuce leaves had higher ratings in taste, colour, aroma, texture and overall acceptability, while sodium carbonate-sun dried wild lettuce had the lowest rating in these parameters. Among the processed vegetables, unblanched sundried wild lettuce had comparable ratings with the fresh wild lettuce leave. The green colour of leafy vegetable is a desirable quality parameter by consumers. Therefore, the lower colour ratings for the pretreated vegetables may be associated with the lower negative a-value compared to the fresh wild lettuce leaves (Table 3).

Table 5. *Mean sensory scores for soups prepared with fresh and dried wild lettuce after 12 weeks storage*

Soups	Taste	Colour	Flavour	Texture	Overall Acceptability
Fresh	7.56^{a}	7.04^{a}	7.44^{a}	7.30^{a}	7.64^{a}
Sundried	7.56^{a}	7.00^{a}	6.88^{b}	6.90^{ab}	7.48^{ab}
Blanched and sundried	7.12^{ab}	7.00^{a}	7.08^{ab}	6.32^{b}	7.04^{bc}
Na_2CO_3 blanched and sundried	6.74^{b}	6.72^{a}	7.00^{ab}	6.28^{b}	6.78^{c}

Mean with different superscript letters along the same column are significantly different $p<0.05$).
Hedonic scale: 1- extremely dislike; 9- extremely like

Conclusions

Wild lettuce leaves are relatively good sources of vitamin C, β-carotene, calcium and sodium. The leaves are fairly good sources of iron, magnesium and potassium. In general, the vitamin C, β-carotene, calcium, sodium iron, magnesium and potassium contents of the pretreated vegetable decreased with increasing storage period. However sun drying alone or in combination with sodium carbonate blanching had similar effect on colour, vitamin C and β-carotene content of wild lettuce leaves during storage. The greenness of the dried stored product as measured by the a-value also decreased with increase in storage period. This study demonstrated the varying effect of pretreatments and drying on the quality of wild lettuce leaves which until now is underutilized. Sun drying alone or in combination with sodium carbonate blanching is recommended for the processing of wild lettuce leaves, since these method showed minimal losses of nutrients compared to water blanched-sun dried wild lettuce leaves.

References

Adewale A., Ayoade A. A., Alani E. A. (2013). Determination of vitamins in five selected West African green leafy vegetables. *Journal of American Science,* 9, 40-43.

Akindahunsi A., Oboh G. (1999). Effect of some post-harvest treatments on the bioavailability of zinc from some selected tropical vegetables. *La Rivista Italiana Delle Sostanze Grasse,* 76, 285-287.

AOAC. (2000). Official methods of analysis (17th ed.). *Washington DC: Association of official Analytical Chemists*.

Arawande J., Amoo I., Lajide L. (2012a). Phytochemical and antioxidant characterization of fireweed (*Crassocephalum crepidioides*) and african lettuce (L*actuca taraxacifolia*). *Journal of Applied Technology in Environmental Sanitation,* 2.

Arawande J., Ogunyemi O. (2012). Effect of Methanol and Water Extract of African Lettuce (Lactuca taraxacifolia) on Stability of Refined Palm Kernel Oil. *Nigerian Food Journal,* 30, 1-7.

Arawande J. O., Komolafe E. A., Ijitona O. O. (2012b). Antioxidative effect of wild lettuce (Launaea taraxaciafolia) on stability of refined soybean oil. *Journal of Agricultural Technology,* 8, 2283-2295.

Babalola O., Tugbobo O., Daramola A. (2010). Effect of processing on the vitamin C content of seven Nigerian green leafy vegetables. *Advance Journal of Food Science and Technology*.

Booth S., Bressani R., Johns T. (1992). Nutrient content of selected indigenous leafy vegetables consumed by the Kekchi people of Alta Verapaz, Guatemala. *Journal of Food Composition and Analysis,* 5, 25-34.

Chandler L. A., Schwartz S. J. (1988). Isomerization and losses of trans-. beta.-carotene in sweet potatoes as affected by processing treatments. *Journal of Agricultural and Food Chemistry,* 36, 129-133.

Cheung L., Cheung P. C., Ooi V. E. (2003). Antioxidant activity and total phenolics of edible mushroom extracts. *Food Chemistry,* 81, 249-255.

Danesi F., Bordoni A. (2008). Effect of home freezing and Italian style of cooking on antioxidant activity of edible vegetables. *Journal of food science,* 73, H109-H112.

Dietz J. M., Kantha S. S., Erdman Jr J. W. (1988). Reversed phase HPLC analysis of α-and β-carotene from selected raw and cooked vegetables. *Plant Foods for Human Nutrition,* 38, 333-341.

Fasuyi A. (2006). Nutritional potentials of some tropical vegetable leaf meals: chemical characterization and functional properties. *African Journal of Biotechnology,* 5, 49.

Fellows P. J. (1997). *Food processing technology: Principles and practice*. New York: Wood Head Rebleing Limited.

Jaggi M. P., Sharma R., Vali S. (2015). Effect of packaging and storage conditions on retention of ascorbic acid in fenugreek leaves (Trigonella Foenum-Graecum). *Ukrainian Food Journal,* 4.

Jaworska G., Pogoń K., Bernaś E., Skrzypczak A. (2014). Effect of different drying methods and 24-month storage on water activity, rehydration capacity, and antioxidants in boletus edulis mushrooms. *Drying Technology,* 32, 291-300.

Karim O., Kayode R., Oyeyinka S., Oyeyinka A. (2015). Physicochemical properties of stiff dough 'amala' prepared from plantain (*Musa Paradisca*) flour and Moringa (*Moringa oleifera*) leaf powder. *Food in Health and Disease,* 4, 48-58.

Latunde-Dada G. O. (1990). Effect of processing on iron levels in and availability from some Nigerian vegetables. *Journal of the Science of Food and Agriculture,* 53, 355-361.

Maeda E., Salunkhe D. (1981). Retention of ascorbic acid and total carotene in solar dried vegetables. *Journal of Food Science,* 46, 1288-1290.

Masure M., Campbell H. (1944). Rapid estimation of peroxidase in vegetable extracts-an index of blanching adequacy for frozen vegetables. *Fruit Production Journal,* 23, 369-374.

Mensah J., Okoli R., Ohaju-Obodo J., Eifediyi K. (2008). Phytochemical, nutritional and medical properties of some leafy vegetables consumed by Edo people of Nigeria. *African Journal of Biotechnology,* 7.

Mepba H., Eboh L., Banigo D. (2007). Effects of processing treatments on the nutritive composition and consumer acceptance of some Nigerian edible leafy vegetables. *African Journal of Food, Agriculture Nutrition and Development,* 7, 1-18.

Mkandawire K. T., Masamba K. G. (2014). Effect of lemon juice treatment and sun drying on vitamin C retention in three steam and water blanched indigenous vegetables over six weeks storage period. *African Journal of Food Science,* 8, 316-321.

Mosha T., Pace R., Adeyeye S., Laswai H., Mtebe K. (1997). Effect of traditional processing practices on the content of total carotenoid, β-carotene, α-carotene and vitamin A activity of selected Tanzanian vegetables. *Plant foods for human nutrition,* 50, 189-201.

Nguyen M., Francis D., Schwartz S. (2001). Thermal isomerisation susceptibility of carotenoids in different tomato varieties. *Journal of the Science of Food and Agriculture,* 81, 910-917.

Oboh G. (2005). Effect of blanching on the antioxidant properties of some tropical green leafy vegetables. *LWT-Food Science and Technology,* 38, 513-517.

Oduse K., Idowu M., Adegbite A. (2012). Chemical and Phytochemical Profile of Some Uncommon Green Leafy Vegetables Consumed In South West, Nigeria. *IOSR Journal of Environmental Science, Toxicology and Food Technology,* 1, 22-26.

Okpala L. C., Ekechi C. A. (2014). Rehydration characteristics of dehydrated West African pepper (Piper guineense) leaves. *Food science & nutrition,* 2, 664-668.

Oladele O., Aborisade A. (2009). Influence of different drying methods and storage on the quality of Indian spinach (Basella rubra L.). *American Journal of Food Technology,* 4, 66-70.

Onayemi O., Badifu G. O. (1987). Effect of blanching and drying methods on the nutritional and sensory quality of leafy vegetables. *Plant foods for human nutrition,* 37, 291-298.

Qian C., Decker E. A., Xiao H., McClements D. J. (2012). Physical and chemical stability of β-carotene-enriched nanoemulsions: Influence of pH, ionic strength, temperature, and emulsifier type. *Food Chemistry,* 132, 1221-1229.

Rajeswari P., Bharati N., Naik R., Johri S. (2011). Value addition to amaranthus green herbage through dehydration and drying. *Research Journal of Agriculture* 2, 348-350.

Sakpere A. M., Ayisire E. R., Abioye O. I. (2011). Potential of *Launea taraxacifolia* (Willd) Amin Ex. C. Jeffrey for in Vitro Regeneration. *Notulae Scientia Biologicae,* 3, 93-96.

Speek A. J., Speek-Saichua S., Schreurs W. H. (1988). Total carotenoid and β-carotene contents of Thai vegetables and the effect of processing. *Food Chemistry,* 27, 245-257.

Turkmen N., Sari F., Velioglu Y. S. (2005). The effect of cooking methods on total phenolics and antioxidant activity of selected green vegetables. *Food chemistry,* 93, 713-718.

Wang Y., Zhang M., Mujumdar A. S., Mothibe K. J., Roknul Azam S. (2013). Study of drying uniformity in pulsed spouted microwave–vacuum drying of stem lettuce slices with regard to product quality. *Drying Technology,* 31, 91-101.

Yekeen T., Adetiba O., Azeez M., Falodun M., Akintaro S., TA Y. (2011). Studies on the proximate analysis of *Solanum aethiopicum*, *Lactuca taraxacifolia* and *Talinum triangulare* and potential cytotoxic effects of theri aqeous extracts using *Allium cepa* assay. *Annals of Biological Research,* 2, 696-706.

Zhang D., Hamauzu Y. (2004). Phenolics, ascorbic acid, carotenoids and antioxidant activity of broccoli and their changes during conventional and microwave cooking. *Food Chemistry,* 88, 503-509.