



Assessment of the Effect of Drying Methods on Pumpkin (*Telferia occidentalis*) Leaves

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Abstract: The effect of solar and sun drying on the nutritional composition of *Telferia occidentalis* was evaluated. Direct sun drying was carried out under the sun, while cabinet solar and tunnel solar dryer were used for the drying of the vegetable sample. Proximate and mineral analysis were carried out on the vegetable sample after drying for six days. The results of the proximate analysis showed relatively low moisture content across the three methods. The ash content ranged from 8.0% to 8.5%. The protein content ranged from 10.0% to 13.0% while carbohydrate content was from 66.6% to 67.0%. The result of mineral content of tunnel, cabinet solar drying and direct sun drying vegetable samples showed that the amount of Zn in the vegetable samples ranged from (0.02 to 0.07 mg/100 g), Ca ranged from (5.30 to 5.96 mg/100 g), Mg (0.33 to 0.35 mg/100 g) and Fe ranged from (0.38 to 1.27 mg/100 g). This study showed that tunnel solar dried vegetable samples had higher values of carbohydrate, protein and fiber content when compared with cabinet solar dried and direct sun dried vegetable samples. Mineral content of tunnel solar dried vegetable samples were also higher than cabinet solar and direct sun dried vegetable samples. It concludes that tunnel solar drying serves as a better method of drying because it retains more nutrients, relatively more hygienic with shorter drying time. It is thus recommended for adoption by farmers and market women.

Keywords: *Telferia occidentalis*, Drying Methods, Proximate, Mineral, Solar

1. Introduction

Drying is the simplest technology for preserving green leafy vegetable, especially when they are abundantly available. Over the year's different drying methods have been employed to dry different leafy vegetables and currently, newer technique are being investigated [1]. Some of these techniques include the use of different solar drying system. Vegetable drying is generally done either for preserving the perishable raw commodity against deterioration or to reduce the cost of packaging, handling, storing and transporting. The most serious constraint for shelf-life enhancement is the activity of micro-organisms. Water in food is reduced to a very low level during drying, thus achieving better microbiological preservation and retarding many undesirable reactions during storage [2], owing to the reduction in water activity. Leafy vegetables such as *Telferia occidentalis* are widely used for culinary purposes. *Telferia occidentalis* is

useful for the maintenance of health and the prevention and treatment of various diseases. It also supplies the body with nutrients which are absorbed and used as energy sources, body building, regulatory and protective materials. The consumption of vegetables in Nigeria had been on the increase and currently is estimated to be about 22 - 47.58 kg/person/year [3].

Despite the high nutritional, medicinal and economic value of *Telferia occidentalis* its production in Nigeria has failed to meet the domestic demand for its consumption [4]. This is because it is highly seasonal and perishable resulting into huge post-harvest losses. Post-harvest loss of 30-40% is estimated in developing countries, like Nigeria mainly due to poverty, inadequate postharvest handling techniques, improper processing technology and storage facilities, poor infrastructure as well as poor marketing systems [5, 6].

Drying of fruits and vegetables remains an important method of food preservation. It reduces the moisture content of food to a level, which allows safe storage over an extended period, and prevents the growth of mold and fungi and thus minimizing microbial degradation [7, 8]. Therefore the aim of this study is to compare the effect of different drying methods: tunnel solar drier, cabinet solar drier and sun drying systems on the nutritional content of *Telfaria occidentalis*.

2. Materials and Methods

2.1. Sample Collection and Preparation

Fresh leaves of *Telfaria occidentalis* were obtained at kasuwa chori market in Kaduna metropolis within longitude 10°31'14.16"N and latitude 007°25'33.9"E. The vegetable samples were collected in polyethylene bag and transported to the laboratory where it was further prepared before drying. The plant samples were authenticated and voucher number was issued at the herbarium section in the botany department

3. Results and Discussion

Table 1. Proximate composition (%) of solar dried and sun dried vegetable sample.

Vegetables	Drying method	Moisture content	Protein content	Ash content	Crude Fiber	Fat content	Carbohydrate
<i>T. occidentalis</i>	TSD	1.7±0.02	13.0±0.03	8.5±0.1	7.0±0.05	3.0±0.1	67.4±0.8
<i>T. occidentalis</i>	CSD	1.72±0.0	12.0±0.5	8.0±0.1	6.6±0.1	5.0±0.1	66.6±0.4
<i>T. occidentalis</i>	SD	1.82±0.15	11.0±0.15	8.3±0.2	6.6±0.1	5.5±0.2	66.7±0.1

TSD =Tunnel solar dried, CSD = Cabinet solar dried, SD =Sun dried

The moisture content in the vegetable samples ranged from 1.70% to 1.82% as shown in Table 1. Moisture content was lowest for tunnel solar dried vegetables followed by cabinet solar dried vegetables and the sun dried vegetables. The result showed that moisture content was lower in the two different solar dryer than in sun dried vegetables, that is because solar dryer have some advantages over sun drying they give faster dry rates by heating the air to 30-40°C and above ambient, which causes the air to move faster through the dryer, reduces its humidity and the fact that the higher the temperature, the higher the absolute humidity, and the larger the uptake of moisture [10]. The lower water content of both solar and sun dried vegetables was also reported by Dupriez and Coener with moisture content ranging from 1.0 – 1.55% in vegetables [11]. Generally removal of moisture, according to Morris *et al.*, leads to an increase in concentration of the nutrients [12]. Therefore, for *Telfaria occidentalis* to be preserved for a long time before use, the moisture content has to be reduced.

Protein content in the vegetable sample ranged from 11.0 – 13.0%. The protein content of the tunnel solar dried vegetables was significantly ($p<0.05$) different compared to the cabinet solar dried and sun dried vegetables. Tunnel solar drying was more efficient over cabinet solar drying and sun drying with respect to the level of protein. However, Wachap [13] noted that nutrient from sun dried foods are less bio-available than those from solar dried foods. Plant foods that

of Ahmadu Bello University, Zaria. The vegetables were thoroughly washed with water to remove adhering dirt and sorted to remove the stalks. After washing with water, the green leaves were drained with plastic sieve and thereafter sliced. The samples were then divided into three portions (A, B and C) each of about 500 g each and dried using the three drying methods. After drying for 6 days, the individual vegetables were milled into powder and stored in air tight container for proximate and mineral analysis.

2.2. Determination of Proximate Analysis

Proximate analysis was determined using standard procedures as described by AOAC [9].

2.3. Determination of Mineral Elements

The minerals (Ca, Mg, Mn, Fe, Zn) were determined using Atomic absorption spectrophotometer (Buck scientific Model 210).

provide more than 12% of their calorific value from protein have been shown to be good source of protein [14]. This shows that *Telfaria occidentalis* is a good source of protein despite the drying methods. Similar observations were also made by Isaac *et al* [15]. Results of ash content ranged from 8.0 – 8.5% as shown in Table 1. The results obtained were [$p<0.05$] statistically significantly across the different drying methods. The higher ash content obtained in the tunnel solar dried samples was similar to that reported in other literatures [16, 17]. Ash content indicates the availability of mineral content of food substances [17].

Crude fiber content ranged from 6.6% – 7.0% and was statistically ($p<0.05$) significant. The results obtained indicate that tunnel solar dried vegetables contain more fiber than cabinet solar dried and sun dried vegetables. Dietary fiber in vegetables increase bulk and reduces food transit time in alimentary canal and incidence of constipation and other related diseases [18]. Fiber is useful for maintaining bulk, motility and increasing intestinal tract. It is also necessary for healthy condition, curing of nutritional disorders and food digestion [19]. Carbohydrate content was higher for tunnel solar dried vegetable samples (67.4%) compared to cabinet solar dried (66.6%) and sun dried vegetables (66.7%). Carbohydrate content of vegetables increases after drying [20]. Low carbohydrate content of vegetables shows that they supply little or no energy when consumed except when supplemented with other food [21].

Table 2 shows the results of the mineral content of tunnel solar, cabinet solar and sun dried vegetables.

Table 2. Mineral content solar dried and sun dried vegetable samples (mg/100 g).

Vegetables	Drying method	Zn	Ca	Mn	Mg	Fe
<i>T. occidentalis</i>	TSD	0.02	5.96	0.15	0.35	1.27
<i>T. occidentalis</i>	CSD	0.07	5.37	0.13	0.33	0.38
<i>T. occidentalis</i>	SD	0.06	5.30	0.16	0.33	0.45

TSD =Tunnel solar dried; CSD = Cabinet solar dried; SD =Sun dried

The result showed that the amount of Zn in *T. occidentalis* ranged from 0.02 - 0.07 mg/100 g. The cabinet solar drier recorded the highest Zn content. Zn is an essential trace element for protein and nucleic acid synthesis and normal body development [22]. The calcium content was significantly higher for tunnel solar dried vegetables (5.96 mg/100 g) other values obtained were 5.37 mg/100 g for cabinet solar dried vegetables and 5.30 mg/100 g for the sun dried vegetable. Ukegbu and Okeke [16], also reported high Ca values for solar dried vegetables than sun dried ones. Ca is an essential mineral for proper growth and maintenance of the body. It helps to build and maintain healthy life [23]. Mg content of tunnel solar dried vegetables was higher than cabinet solar dried and sun dried vegetables with values ranging from 0.33 to 0.35 mg/100 g. This shows that tunnel solar dried vegetables contain more magnesium than cabinet solar dried and sun dried vegetables. Similar results were reported by Ukegbu and Okeke [16], where solar dried vegetables had higher Mg and this could be attributed to the controlled temperature during the drying process. Fe content was also higher in the vegetable samples using tunnel solar drier (1.27 mg/100 g) than cabinet solar dried (0.38 mg/100 g) and sun dried (0.45 mg/100 g). Fe is said to be an important element in the diet of pregnant women, nursing mothers, infants, convalescing patients and the elderly to prevent anemia and other related diseases [24]. Mn content of tunnel solar dried *T. occidentalis* (0.35 mg/100 g) was higher than cabinet solar dried (0.33 mg/100 g) and sun dried *T. occidentalis* (0.33 mg/100 g). Mn regulates blood sugar level, the production of energy and cell reproduction. Deficiency in Mn may result in birth defects if an expectant mother does not get enough of the important element [25]. Tunnel solar dried *T. occidentalis* had higher mineral content than cabinet solar dried and sun dried *T. occidentalis*. This is because tunnel solar dried *T. occidentalis* were dried in the shade, at high air temperature and low humidity. This hastens the drying rate and helps to retain more minerals as well as enable the products to be stored longer. This is further corroborated by reports of Ruel that solar drying help retain more minerals in fruits and vegetables [26]. On the other hand, cabinet solar dried and sun dried vegetables had lower mineral content. This is because, during sun drying, vegetables with high moisture content are usually dried at low temperature and are therefore exposed for longer time in the sun. This leads to leaching out of soluble minerals and vitamins along with the water during drying processes [26].

4. Conclusion

The effect of solar and sun drying on the nutritional composition of *Telfaria occidentalis* was evaluated. Proximate and mineral analysis was carried out on the dried vegetable samples after drying for six days and the result of proximate analysis showed moisture content to be very low across the three drying methods. The ash content ranged from 8.0% to 10.0% while the protein content ranged from 10.0% to 30.0%. The amount of fat in the vegetable sample ranged from 3.0% to 5.60 %. Tunnel solar dried *Telfaria occidentalis* had higher mineral content than cabinet solar dried and direct sun dried *Telfaria occidentalis*. It is concluded from this study that solar drying is nutritionally viable and that drying had an effect on the nutritional composition of *Telfaria occidentalis*. Tunnel Solar drying was observed to produce relatively better product in terms of nutrient composition compared to sun and cabinet solar drying.

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