VITAMIN AND PROVITAMIN PROFILES OF SELECTED VEGETABLES AS AFFECTED BY DIFFERENT DRYING METHODS

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ABSTRACT

The vitamin profiles of selected common vegetables as affected by three different drying methods were investigated. Seven vegetables were each subjected to three drying methods: air drying, oven drying and freeze drying. The experiment was a 3x7 factorial arrangement in a completely randomized design. Dried leaves were thereafter milled and analyzed for selected phytochemical contents (total carotenoids, pyridoxine, riboflavin, ascorbic acid, tocopherol and ergocalciferol). Air dried sample had significantly higher ($P<0.05$) total carotenoids (1177.49 µg/100g), pyridoxine (0.588 mg/100g), riboflavin (0.455 mg/100g), ascorbic acid (39.114 mg/100g), ergocalciferol (46.554 µg/100g) and tocopherol (57.522 µg/100g) compared with other drying methods. Air dried moringa had significantly higher ($P<0.05$) total carotenoids (1079.482 µg/100g), riboflavin (0.412 mg/100g), ergocalciferol (46.397 µg/100g) and tocopherol (58.445 µg/100g) while air dried gourd melon had the higher ($P<0.05$) pyridoxine (0.732 mg/100g). Interaction of drying methods on leaf types was significantly higher ($P<0.05$) for air dried samples compared to other drying methods. In conclusion, vitamin and provitamin profiles were most preserved by air drying method.

Keywords: Drying leaves, Phytonutrients profile, vitamin and provitamin assays, Nutritional additives.

INTRODUCTION

Leafy vegetables contain vitamins and minerals which could contribute greatly to dietary provision for normal growth and protection against diseases (Achikanu *et al.*, 2013). Several phytonutrients rich leafy vegetables and plants are available in the tropics (Akoroda, 1990; Oluwole *et al.*, 2003; Achikanu *et al.*, 2013). These plants and leafy vegetables have viable potentials as dietary sources of vitamin and mineral. One of the main limitations to the use of green leaves as alternative nutritional additive for livestock and poultry is the innate moisture content and the challenges of its removal without damaging the valuable phytochemicals.

Most green vegetables are seasonal, drying methods help in their preservation by reducing the high moisture contents (Naikwade *et al.*, 2012). The consideration of the effects of drying methods are therefore, very crucial because of their critical implications on phytonutrient and the residual phytochemicals of dried leaves.

There is limited information on the retention of vitamins by plants and green leafy vegetables when subjected to different drying methods. This research was thus aimed at evaluating the effects of three different drying methods on selected phytochemical profiles of seven different plant leaves.

MATERIALS AND METHOD

The experiment was carried out at the Central Laboratory, Department of Animal Science, University of Ibadan, Ibadan, Nigeria. Seven vegetables assessed were: fluted pumpkin (*Telfairia occidentalis*); African wild lettuce (*Launaea taraxacifolia*); African spinach - green (*Celosia argentea*); gourd melon pumpkin (*Curcubita maxima*); African spinach - red (*Celosia argentea*); moringa leaves (*Moringa oleifera*) and bitter leaf (*Vernonia amygdalina*). Freeze drying; air drying and oven drying at 55 °C were the three methods of drying.

Freeze drying: Leaves were separated from the stems of plant samples, washed with deionised water and drained before storing in the freezer at -20 °C before freeze drying, freeze dried samples were ground to fine powder for analyses.

Oven Drying: Leaves were cleaned with deionised water, drained, weighed and placed in

the oven at 55°C and turned at intervals until dried to constant weight. The leaves were then put in a desiccator and reweighed after cooling before grinding to fine powder for analyses.

Air Drying: Leaves were cleaned with deionised water, drained, blotted dry with absorbent paper and spread inside perforated plastic trays to dry at room temperature to a consistent dried weight while turning regularly. The leaves were then weighed and milled to powder for analyses

Phytochemical assays (total carotenoids, pyridoxine, riboflavin, ascorbic acid, tocopherol and ergocalciferol) of the samples were according to AOAC (2000).

Data analysis: Data were subjected to analysis of variance (SAS 2000) and means were separated using Duncan's option of the same software.

RESULTS AND DISCUSSION

The vitamin and provitamin profile of some selected vegetable leaves as affected by drying method is shown in Table 1. There were variable effects of drying methods on vitamin and provitamin profiles of analyzed leaves. Air drying had the least effect on residual phytochemicals followed by freeze drying and the highest impact on vitamin and provitamin parameters was by oven drying. This observation was in agreement with reports that air or shade drying preserved higher amounts of vitamins in green leafy vegetables (Lakshi and Vimala, 2000; Krokida and Maroulis, 2007; Sagar, and Suresh, 2010; Naikwade, 2014) but was at variance with the documentation of Negi and Roy (2000) that oven drying at low temperature had least effect on nutrients. Freeze drying has been earlier reported (Krokida and Maroulis, 2007) to cause higher porosity in the drying materials than air drying which may be the reason for its higher effect compared to air drying on the phytochemicals considered. Moringa, bitter leaf and *Celosia* recorded higher retention ($P<0.05$) of vitamin content. Also, *Celosia* (green) had significantly higher levels of total carotenoids, riboflavin, ascorbic acid and tocopherol compared with the red variety which had higher levels of pyridoxine and ergocalciferol only.

Interaction of drying methods × leaf types on vitamin and provitamin parameters of some selected leafy vegetables is shown in Table 2. Air dried samples had significantly higher ($P<0.05$) components compared with oven dried and freeze dried samples. The levels of 40.097mg/100g ascorbic acid in fluted pumpkin in this study is higher than 35.97 mg/100g documented by Ukegbu and Okereke (2013) in bitter leaf. The observations for other phytochemicals conformed to the findings of Nangula *et al.* (2010) though riboflavin content was higher in this study.

CONCLUSION

Air, oven and freeze drying preserved the phytonutrient contents of green vegetables but the best method of vitamin retention was through air drying followed by freeze drying and the least effective method for vitamin retention out of the three was oven drying. Air drying proved the most useful in vitamin profile retention across all the seven selected vegetables.

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Table 1: Vitamin profile of some selected vegetable leaves as affected by drying method

	Total Carotenoids (µg/100g)	Pyridoxine (mg/100g)	Riboflavin (mg/100g)	Ascorbic acid (mg/100g)	Ergocalciferol (µg/100g)	Tocopherol (µg/100g)
Drying method						
Air Drying	1177.491^{a}	0.588^{a}	0.455^{a}	39.114^{a}	46.554^{a}	57.522^{a}
Oven Drying	936.969^{c}	0.385^{c}	0.222^{c}	23.059^{c}	35.416^{c}	44.073^{c}
Freeze Drying	971.373^{b}	0.564^{b}	0.385^{b}	34.183^{b}	44.792^{b}	53.383^{b}
SEM	3.500	0.006	0.004	0.237	0.264	0.243
Vegetable leaves						
Fluted Pumpkin	1059.446^{b}	0.544^{b}	0.360^{c}	40.097^{a}	40.659^{c}	50.057^{d}
Celosia Green	1056.113^{b}	0.376^{f}	0.377^{b}	32.347^{c}	39.931^{c}	52.625^{c}
Bitter Leaf	1072.696^{a}	0.461^{d}	0.404^{a}	38.683^{b}	47.024^{a}	47.333^{f}
Moringa	1079.482^{a}	0.415^{e}	0.412^{a}	39.609^{a}	46.397^{a}	58.445^{a}
Wild Lettuce	982.442^{c}	0.551^{b}	0.264^{e}	23.807^{e}	41.698^{b}	55.029^{a}
Gourd Melon	958.137^{d}	0.732^{a}	0.294^{d}	26.104^{d}	39.249^{d}	48.172^{e}
Celosia Red	991.961^{c}	0.518^{c}	0.259^{e}	24.183^{e}	41.817^{b}	49.955^{d}
SEM	5.340	0.008	0.006	0.362	0.403	0.371

Table 2: Interaction of drying methods × leaf types on Vitamin Parameters of some selected leafy vegetables

DM	LT	Total Carotenoids	Pyridoxine	Riboflavin	Ascorbic acid	Ergocalciferol	Tocopherol
AIR DRYING	1	1238.78^{b}	0.790^{c}	0.557^{a}	45.093^{a}	44.476^{ef}	55.277^{d}
	2	1219.070^{c}	0.409^{ml}	0.518^{b}	42.560^{b}	44.981^{ef}	58.544^{c}
	3	1264.780^{a}	0.547^{g}	0.504^{b}	44.623^{a}	51.819^{b}	55.487^{d}
	4	1239.418^{b}	0.420^{kl}	0.514^{b}	45.433^{a}	51.069^{b}	62.008^{a}
	5	928.858^{fgh}	0.505^{h}	0.196^{i}	20.142^{j}	47.584^{d}	60.543^{b}
	6	1129.539^{d}	0.836^{b}	0.443^{c}	37.370^{f}	45.807^{e}	59.364^{bc}
	7	1122.037^{bc}	0.612^{f}	0.450^{c}	38.576^{def}	40.139^{h}	51.428^{f}
OVEN DRYING	1	994.691^{e}	0.470^{ij}	0.315^{g}	34.130^{g}	33.561^{k}	40.149^{i}
	2	1007.970^{e}	0.350^{op}	0.307^{g}	15.818^{l}	32.527^{kl}	44.225^{h}
	3	1008.955^{e}	0.382^{mn}	0.324^{fg}	33.945^{g}	41.025^{gh}	36.644^{j}
	4	999.962^{e}	0.335^{p}	0.340^{f}	34.436^{g}	38.568^{i}	53.085^{e}
	5	886.555^{i}	0.449^{kj}	0.169^{j}	17.094^{l}	35.081^{j}	49.517^{g}
	6	831.003^{j}	0.425^{kl}	0.027^{l}	14.689^{l}	35.329^{j}	44.739^{h}
	7	829.645^{j}	0.288^{q}	0.074^{k}	11.302^{m}	31.818^{l}	40.151^{i}
FREEZE DRYING	1	944.910^{f}	0.374^{no}	0.209^{i}	41.068^{c}	43.942^{f}	54.745^{d}
	2	941.300^{fg}	0.360^{no}	0.308g	38.663^{de}	42.286^{g}	55.106^{d}
	3	944.353^{f}	0.455^{j}	0.384^{e}	34.480^{ef}	48.227^{cd}	49.867^{g}
	4	999.067^{e}	0.489^{hi}	0.383^{e}	41.063^{d}	49.554^{c}	60.242^{b}
	5	1131.915^{d}	0.700^{d}	0.428^{cd}	34.186^{g}	42.429^{g}	55.026^{d}
	6	913.868^{h}	0.908^{a}	0.411^{d}	26.252^{h}	33.612^{k}	40.412^{i}
	7	924.202^{gh}	0.655^{e}	0.252^{h}	22.672^{i}	53.495^{a}	58.285^{c}
SEM		9.260	0.015	0.011	0.627	0.698	0.643

Means with separate superscripts are significantly different from each other

1 – Fluted pumpkin, 2 – Celosia green, 3 – Bitter leaf, 4 – Moringa, 5 – Wild lettuce (Yanrin), 6 – Gourd / Melon pumpkin, 7 – Celosia red; DM – Drying Methods, LT – Leaf Type