World Vegetable Center

Nutritional quality of traditional African vegetables as affected by drying methods

Ray-Yu Yang[1,2], Ngoni Nenguwo[3], Tsvetelina Stoilova[3], Antonio Acedo Jr.[3], Didit Ledesma[2] and **Peter Hanson**[2*]

[1] Food and Fertilizer technology Center for the Asian and Pacific Region (FFTC), Taipei, Taiwan; [2] World Vegetable Center, Tainan, Taiwan; [3] World Vegetable Center, Arusha, Tanzania;
*Corresponding: peter.hanson@worldveg.org

Introduction

Traditional African vegetables (TAV) are inexpensive and high-quality nutrient sources in human diets. Availability of fresh vegetables is highly seasonal and postharvest losses can be high during gluts.

Preservation by drying can extend TAV availability during lean periods but drying method may affect nutrient contents.

Sun-drying (SuD) is common in Africa but it is weather dependent and exposes product to dust and microorganisms. Low-cost Solar-drying (SoD) equipment is increasingly available in Africa and does not require electricity but works best under sunshine. Freeze drying (FD) is a low temperature process and has less effects on chemical properties of compounds than heat processing. Oven drying (OD) allows even temperature control and is common in industrial food processing.

Objective

Assess the nutrient contents of popular African leafy vegetables as affected by four drying methods (sun, solar, freeze-dry, oven-dry).

Materials and Methods

- Two related studies were conducted at WorldVeg-Taiwan (Study I) and WorldVeg-Tanzania (Study II).
- Treatment design: split plot with varieties and drying method as mainplot and subplot factors, respectively. Mainplots were arranged in a RCBD with three replications.
- Two varieties each of 5 TAV were grown in field trials at Taiwan and Tanzania. Study I samples were assigned to freeze drying or oven drying. Study II samples were subjected to solar drying or direct sun drying.
- Vegetable yields were harvested, and samples of 3-5 kg were subjected to different drying methods.
- WorldVeg Nutrition group analyzed samples from both Studies for minerals, carotenoids, protein, vitamin C, and oxalate contents

Conclusions

- Drying method significantly affected most macro-and micro-nutrients of the tested TAV
- Minerals and protein are heat-stable and contents were preserved across the four drying treatments.
- Vitamin C is lost after sun-drying and solar drying, and best preserved by freeze-drying
- Beta-carotene and other carotenoids are reduced by sun or solar drying and best preserved by oven-drying
- Oxalates were notably high in amaranth across locations and drying methods
- Solar drying and Sun-drying had similar effects on nutritional quality of traditional vegetables

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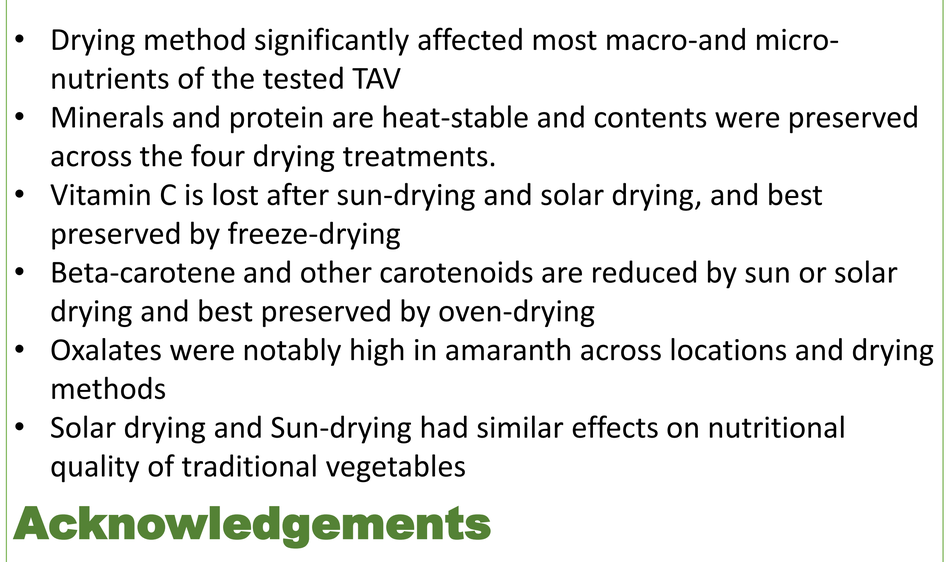
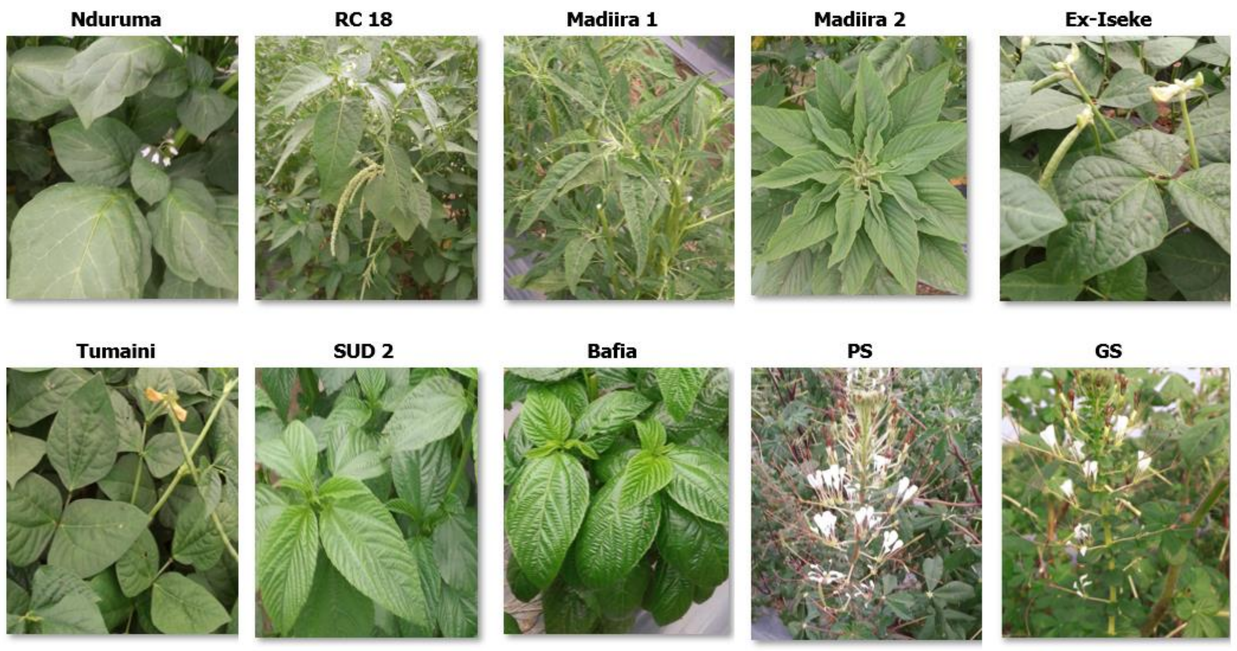


Results:

- The five TAVs were high in protein, minerals, carotenoids, and vitamin C.
- **Study I** (Freeze-drying and Oven-drying) Taiwan:
  - Minerals (iron, zinc, calcium) contents were similar for FD and OD. Protein content was 23% higher under FD versus OD.
  - Vitamin C levels under FD were >11 times higher than OD
- **Study II** (Sun-drying and Solar-drying) Tanzania
  - Mineral and protein levels for SuD versus SoD in Tanzania were similar.
  - Vitamin C was non-detectable in samples after SuD or SoD
- A combined statistical analysis of Study I and II was not possible because locations and drying methods were confounded.



Study I: Mineral and protein contents of traditional African vegetables measured after freeze-drying or oven drying treatments, WorldVeg, Taiwan

			Iron (Fe) (mg/100g dw)		Calcium (Ca) (mg/100g dw)		Zinc (Zn) (mg/100g dw)		Protein (g/100g dw)	
Species	Crop	Variety	Freeze dried	Oven dried	Freeze dried	Oven dried	Freeze dried	Oven dried	Freeze dried	Oven dried
Solanum scabrum	African nightshade	Nduruma	17.6	24.2	2151	1987	2.9	3.7	41.3	41.0
S. villosum	African nightshade	RC18	24.4	28.0	1414	1447	2.6	4.7	35.7	55.5
Amaranthus cruentus	Amaranth	Madiira 1	31.8	32.2	3469	3475	3.2	4.1	31.8	7.9
A. cruentus	Amaranth	Madiira 2	39.3	40.2	3598	3481	3.8	3.9	29.4	7.9
Vigna unguiculata	Cowpea	Exlse	15.2	16.1	1208	1292	4.1	3.9	40.8	16.5
V. unguiculata	Cowpea	Tumai	16.2	18.4	1077	1177	4.6	3.6	46.3	20.9
Corchorus olitorius	Jute mallow	Bafia	13.6	13.8	1124	1193	3.4	2.7	36.5	13.7
Corchorus olitorius	Jute mallow	SUD2	16.3	16.4	1121	1280	2.3	1.5	37.5	12.4
Cleome gynandra	Spiderplant	GS	20.7	24.8	2294	2564	4.8	5.8	46.7	63.3
Cleome gynandra	Spiderplant	PS	22.7	24.0	2035	2311	5.3	5.9	46.7	62.4
Mean			21.8	23.8	1949	2021	3.7	4.0	39.3	30.1
LSD (0.05) Compare drying method means at same variety			5.0		211		1.6		2.5	

Study I: Vitamin C, carotenoid and oxalate contents of traditional African vegetables measured after two drying methods, WorldVeg, Taiwan

			Oxalate (mg/100g dw)		Vitamin C (mg/100g dw)		Lutein (mg/100g dw)		Beta-carotene (mg/100 g dw)	
Species	Crop	Variety	Freeze dried	Oven dried	Freeze dried	Oven dried	Freeze dried	Oven dried	Freeze dried	Oven dried
Solanum scabrum	African nightshade	Nduruma	550	897	898	57	41.0	121.1	41.0	36.4
S. villosum	African nightshade	RC18	916	1024	850	144	55.5	115.8	55.5	46.8
Amaranthus cruentus	Amaranth	Madiira 1	2596	2889	547	42	7.9	71.0	7.9	13.3
A. cruentus	Amaranth	Madiira 2	2563	2717	541	13	7.9	76.7	7.9	14.0
Vigna unguiculata	Cowpea	Exlse	1468	1493	505	56	16.5	102.0	16.5	34.0
V. unguiculata	Cowpea	Tumai	1169	1033	611	69	20.9	106.0	20.9	37.8
Corchorus olitorius	Jute mallow	Bafia	650	921	601	63	13.7	107.6	13.7	56.2
Corchorus olitorius	Jute mallow	SUD2	881	888	633	77	12.4	97.7	12.4	59.7
Cleome gynandra	Spiderplant	GS	579	582	750	9	63.3	157.0	63.3	85.5
Cleome gynandra	Spiderplant	PS	550	511	817	45	62.4	148.5	62.4	91.3
Mean			1192	1296	675	58	30.1	110.3	30.1	47.5
LSD (0.05) Compare drying method means at same variety			220		49		9.6		5.8	

Study II: Vitamin C, carotenoid and oxalate contents of traditional African vegetables measured after Sun or Solar drying treatments, Arusha Tanzania

			Oxalate		Vitamin C		Lutein		Beta-carotene	
Species	Crop	Variety	Sun-dried	Solar-dried	Sun-dried	Solar-dried	Sun-dried	Solar-dried	Sun-dried	Solar-dried
Solanum scabrum	African nightshade	Nduruma	1129	2255	—	—	63.9	57.8	12.9	7.9
S. villosum	African nightshade	RC18	1013	1775	—	—	72.8	61.5	23.6	6.0
Amaranthus cruentus	Amaranth	Madiira 1	2297	2871	—	—	42.3	44.5	1.7	7.1
A. cruentus	Amaranth	Madiira 2	2172	2485	—	—	29.7	32.4	0.7	3.0
Vigna unguiculata	Cowpea	Exlse	1371	1368	—	—	53.7	62.0	1.0	5.0
V. unguiculata	Cowpea	Tumai	913	996	—	—	43.8	64.0	1.0	5.4
Corchorus olitorius	Jute mallow	Bafia	586	531	—	—	44.4	48.2	2.4	15.3
Corchorus olitorius	Jute mallow	SUD2	—	—	—	—	—	—	—	—
Cleome gynandra	Spiderplant	GS	940	804	—	—	74.3	87.5	2.5	11.7
Cleome gynandra	Spiderplant	PS	846	816	—	—	56.0	60.1	2.4	8.2
Mean			1252	1545	—	—	54.3	57.6	5.4	7.7
LSD (0.05) Compare drying method means at same variety			387				13.5		4.5	