Improving Nutrition and Income Generation with African Indigenous Vegetables: Selected Lessons Learned

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Horticulture Innovation Lab Nutrition Research Program:

- **Goal of our program is to improve production and increase consumption of AIVs to improve nutrition, generate income and improve health of nutritionally at risk populations in Eastern and Central Zambia and Western Kenya;**
- **Program builds upon a previous studies showing significant interest and acceptance of AIVs by rural farmers;**
- **We use the Rutgers Models of Market-First and Science Driven Development for Income Generation and Increased AIV Consumption.**

Considerations

- Project findings indicate that in the targeted rural and peri-urban households in western Kenya and Eastern and central Zambia **AIVs are known to over 90% of the populations and viewed as culturally acceptable, desired as preferred food options but they are still rarely to periodically only consumed**. This translates to a potential untapped market demand of millions of dollars and a major economic opportunity for growers and a major opportunity for consumers to access nutrient rich foods that are of interest to them.
- **A systems approach to enhance access and adoption** (production and consumption) has been leading to significant new income generation opportunities to those that were not previously involved in commercial horticulture production and a greater awareness to communities of their nutritional and health value.

Horticulture Innovation Lab Nutrition Research Program Builds Upon the 4 A's:

Access

Affordability

African Indigenous Vegetables:

Nutrition, Health, Income Generation

Availability

Adoption

(Increased Consumption)

Leading to Measureable Health Indicators in targeted populations in Kenya and Zambia

Obj. 1 Hypothesis: Appropriate interventions can increase access to and consumption of AIVs among producers & consumers in Kenya & Zambia.

Lesson 1. Developing & identifying the most effective intervention methods toward improved access, affordability, availability, and adoption of AIVs must be based on solid survey consumer data

Pilot survey's conducted indicated:

1. AIVs very popular- but not consumed regularly!
2. Kenya's and Zambians would opt to consume AIVs (at greater frequency and quantities) but don't due to issues of access, affordability, availability, with many unaware of their nutritional benefit.
3. Preference for specific AIVs,. Their popularity drives our R&D.

AIV	Rarely	Sometimes	Everyday
Green Maize (fresh)	66.7	29.4	3.9
Amaranth	24.1	**69.0**	**6.9**
Nightshade	46.2	**53.8**	0
Spider Plant	39.1	**60.9**	0
Cowpea	59.1	**40.9**	0
Jute Mallow	23.1	**76.9**	0
Kale	26.1	**69.6**	**4.3**
Sweet potato leaves	28.6	**71.4**	0
Orange sweet potato	64.3	**35.7**	0
Okra	26.9	**73.1**	0
Ethiopian mustard	35.3	**64.7**	0
African eggplant	41.4	**58.6**	0
Other AIVs	28.6	**71.4**	0

Women's Dietary Diversity

Lessons Learned from Pilot Study in Kenya and Zambia

- Collected data on household consumption and dietary diversity.
- Data were used to inform subsequent baseline data collection conducted in 2016 and with data analysis completed in 2017

WDD is a robust outcome that will allow for differentiation between groups.


Journal of Health, Population and Nutrition

RESEARCH ARTICLE Open Access

Temporal changes and determinants of childhood nutritional status in Kenya and Zambia

Abstract

AIV Consumption: Results from 500 Household survey

	Never %		Rarely (once a month)%		Sometimes (1-2 times a wee) %		Everyday %	
	Zambia	Kenya	Zambia	Kenya	Zambia	Kenya	Zambia	Kenya
Field Maize	0	0	1.6	6.	7.4	10.8	91	83.2
Maize/Millet/Sorghum	0	4.7	35.8	16.6	36.5	21.5	27.7	57.2
Amaranth	0	2.6	16.2	4.4	57.1	67.7	26.8	25.3
Nightshade	2.6	2.3	60.5	4.1	34.2	70.9	2.6	22.7
Spider Plant	0.6	7.3	44.8	11.7	47.2	64.2	7.4	16.8
Cowpea	0	2.8	11	1.2	58.5	67.8	30.5	28.1
Jute Mallow	0.3	5.4	27.2	10.9	60.6	64.9	11.9	18.8
Kale	0	3.1	6	4.6	36	53.1	58	39.3
Okra	0	98.3	13.7	0.3	67.3	0.3	19	0.3
Ethiopian Mustard	0	41.9	50.0	10.3	6.5	37.8	43.5	10
African Eggplant	0	89.2	43.1	4.7	50.9	4.7	6	1.4
Pumpkin Leaves	0	5.2	6.3	14.7	34.1	63.8	59.6	16.3
Lumanda (hibiscus)	0	98.3	44.3	0	5.1	1.3	50.6	0.4
Mundambi (hibiscus)	1.5	100	57.4	0	33.8	0	7.4	0
Moringa	0	99.6	56.3	0.4	25	0	18.8	0

Consumer Surveys to compare effect of production and nutrition-education interventions

500 households with at least one woman of childbearing age and at least one child were surveyed in both Kenya and Zambia in 2016 to evaluate baseline AIV consumption in communities prior to intervention activities.

Our Approach:

125 households are now either being provided with: (T1) Nutrition education intervention activities; (T2) Production intervention activities; (T3) Both types of intervention activities; and (T4) A Control group treatment

Follow-up consumption surveys following intervention activities will allow a quantitative evaluation of the effect of each intervention approach.

Sites of Surveys and Interventions in Zambia and Kenya

Lesson 2: ***98.8%*** producers want access to better management practices, technology and pest management

Nutrition Education Intervention (BCC)

500 Individuals in Kenya and Zambia will be provided with on-going nutrition education trainings (BCC):

- **Nutrition content of AIVs**
- **Recommended intake amount**
- **Health Applications**
- **Recipes and meal preparations**

Let's Eat Leafy Greens

General Nutrition

Dark leafy greens are high in essential vitamins and minerals.

- **Vitamin A** – strong eyes
- **Folic Acid** – healthy blood
- **Iron** – healthy blood
- **Vitamin C** – immune system support
- **Protein** – bones and muscles
- **Zinc** – healthy growth

Recommended Servings

5 servings of fruit or vegetables daily. One serving is the size of the person's fist.

Cooking Recommendations

Cook the vegetables for a short time to preserve the nutrients.

Keep Food Fresh and Fun

Create different meals by adding local spices such as garlic, onion, turmeric and chili peppers.

Amaranth with Groundnuts

Ingredients

- 2 bunch amaranth leaves
- 1 onion
- 2 tomatoes
- ½ cup groundnut flour
- 1 cup coconut milk
- 4 tbs cooking oil
- Salt, to taste

Directions

1. Sort amaranth leaves, wash and chop finely.
2. Wash and chop onion and tomato.
3. Fry the onion lightly, add tomatoes and stir until soft.
4. Add chopped amaranth and salt. Stir well and cover the pan for 5 minutes. Simmer.
5. Prepare individually the coconut milk and groundnut flour.
6. Mix the coconut milk with groundnut flour thoroughly and add to vegetable while stirring for 5 minutes.
7. Season to taste, serve hot.

Created In Collaboration With

Lesson 4 Learned: Parents, grandparents and even school teachers far more excited about AIVs when they understand their nutritional content! Source of pride, source of tradition, easy to collect yet still perceived to be wild harvested not cultivated and "*undervalued*".

This mama feeds her family vegetables to keep them healthy and happy.

Select vegetables that are clean, bright green, and not wilted.

Bring variety to your family's meals by cooking local leafy greens high in iron and vitamins.

Even if your family eats enough food every day, they may not eat the right foods for good health and vitality. If your family's diet is high in ugali, they might not get important nutrients. Foods like ugali are high in calories but lack vitamins and minerals. A lack of vitamins and minerals leads to malnutrition. Children require nutrients for healthy growth and development. If their bodies do not receive proper nutrition they are more vulnerable to getting sick.

The above photo is an example of a balanced dinner high in vegetables. Beans are a great source of protein.

Local vegetables such as spider plant and amaranth provide essential nutrients for a healthy life. Below are examples of vegetables you can find in the market.

Amaranth

Nightshade

Moringa

Spider Plant

Obj. 2: Hypothesis: Appropriate promotion and expansion of availability of AIVs at the local level will strengthen market access and sales for producers of AIVs:

In each Zambia and Kenya, 300 AIV producers and 75 intermediaries were surveyed to identify the most substantial bottlenecks in productivity to guide the focus of production interventions.

Lesson 3: Growers report AIV requires same level of management and skills as vegetables and report difficulties in:
*Access to seeds and plant materials; unaware of different germplasm that is available with some problems with current AIVs; high price of fertilizers and farm credit limiting, and insect problematic with a few AIVs. **75% of producers cant access credit** (agric. inputs after medical bills identified as primary use of credit)

Paragraph Styles

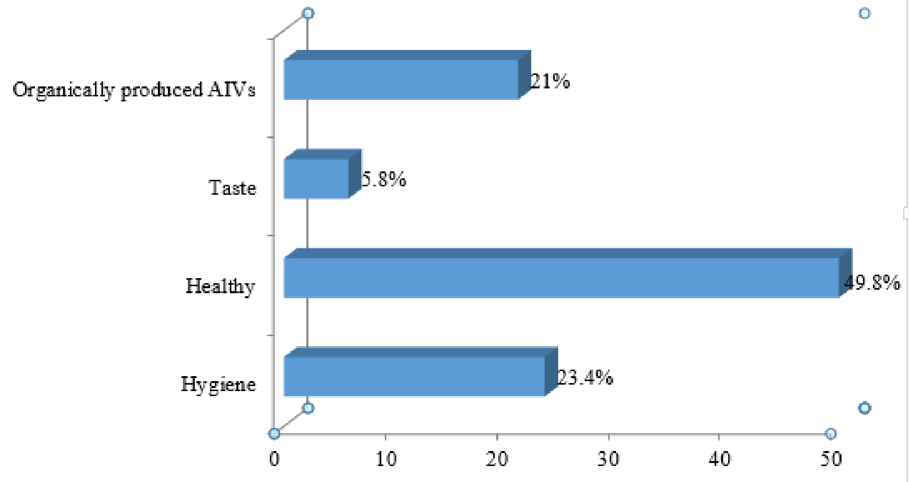
A vast majority (88%) of the respondents felt that there was no difference in overall farming experience between the production and sale of AIVs compared to other vegetable (Table 3.6.5).

Table 3.6.5: Existence of difference between production and sale of AIVs

S.NO	Particulars	Frequency	Percent
1.	No	256	88
2.	Yes	35	12
	Total	291	100

The respondents attributed their willingness to pay a premium (Figure 3.6.7) for certain improved characteristics like healthiness (50%), hygiene (23%), taste (6%), and organically produced AIVs (21%) if they were to buy their AIVs in the market.

Figure 3.6.7: Willing to pay (WTP) a Premium Price



Amongst the respondents, about 61% had sold AIVs in the past 2 years (Table 3.6.6). Orange sweet potato ranked first at 318 kg in terms of quantity sold (Table 3.6.7) in the last completed

41

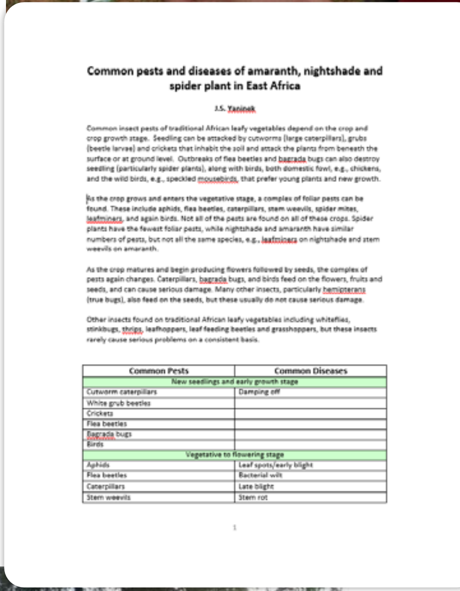
Obj. 3. Determine best management practices for AIV production, increase capacity and access to AIVs

Participatory research prioritized by survey results to provide accurate information and recommendations for farmers

- Cultural practices
- Management technologies
- Improved seed
- Integrated pest management
- Irrigation and drought tolerance

Lesson 5: ***90.9%*** producers ant better AIV seed quality.

Lesson 6: 75% of producers want training for production during dry seasons & drought.



Common pests and diseases of amaranth, nightshade and spider plant in East Africa

J.S. Yaninek

Common insect pests of traditional African leafy vegetables depend on the crop and crop growth stage. Seedling can be attacked by cutworms (large caterpillars), grubs (beetle larvae) and crickets that inhabit the soil and attack the plants from beneath the surface or at ground level. Outbreaks of flea beetles and bagrada bugs can also destroy seedling (particularly spider plants), along with birds, both domestic fowl, e.g., chickens, and the wild birds, e.g., speckled mousebirds, that prefer young plants and new growth.

As the crop grows and enters the vegetative stage, a complex of foliar pests can be found. These include aphids, flea beetles, caterpillars, stem weevils, spider mites, leafminers, and again birds. Not all of the pests are found on all of these crops. Spider plants have the fewest foliar pests, while nightshade and amaranth have similar numbers of pests, but not all the same species, e.g., leafminers on nightshade and stem weevils on amaranth.

As the crop matures and begin producing flowers followed by seeds, the complex of pests again changes. Caterpillars, bagrada bugs, and birds feed on the flowers, fruits and seeds, and can cause serious damage. Many other insects, particularly hemipterans (true bugs), also feed on the seeds, but these usually do not cause serious damage.

Other insects found on traditional African leafy vegetables including whiteflies, stinkbugs, thrips, leafhoppers, leaf feeding beetles and grasshoppers, but these insects rarely cause serious problems on a consistent basis.

Common Pests	Common Diseases
New seedlings and early growth stage	
Cutworm caterpillars	Damping off
White grub beetles	
Crickets	
Flea beetles	
Bagrada bugs	
Birds	
Vegetative to flowering stage	
Aphids	Leaf spots/early blight
Flea beetles	Bacterial wilt
Caterpillars	Late blight
Stem weevils	Stem rot

1

Solar Dryer < $100 to build

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African Journal of Biotechnology

Full Length Research Paper

Ascorbic acid content in leaves of Nightshade (*Solanum spp.*) and spider plant (*Cleome gynandra*) varieties grown under different fertilizer regimes in Western Kenya

Emmanuel Ayua[1], Violet Mugalavai[1*], James Simon[2], Stephen Weller[3], Pamela Obura[3] and Naman Nyabinda[4]

Vitamin C is an important micronutrient because of its antioxidant and health promoting properties. With the introduction and commercialization of improved African indigenous plants, few studies have examined the impact of leaf age or the nutrient status of the plants by fertilizer. This study sought to determine amounts of vitamin C using redox titration in mature and immature leaves of spider plant

Obj. 4. Evaluation of nutrient composition of AIVs:

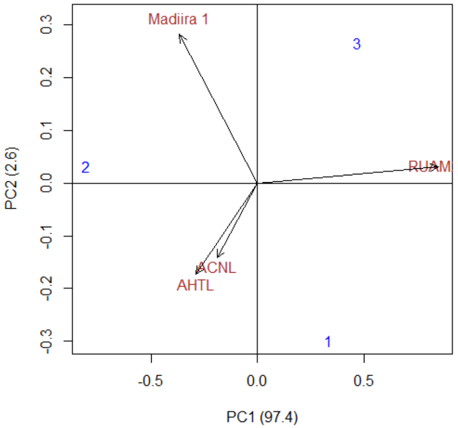
Determining the content and stability of micronutrients in AIVs

Lesson 7: Selection and breeding for micronutrients possible.

2017. Brynes, D., F. Dinssa, S. Weller and J.E. Simon. Elemental micronutrient content and horticultural performance of vegetable amaranth types. JASHS: 265-271.

Result: A new high Fe Amaranth being developed by us with new variety release expected in 2019.

Lesson 8: Many of the AIVs are Nutrient rich and can be submitted to USDA for inclusion.



Result: Spiderplant flower rapidly ca. 1 month field limiting production. We then screened populations for photoperiodicity and **identified spiderplants that remain vegetative and slow bolting potentially offering multiple harvests/planting cycle.**

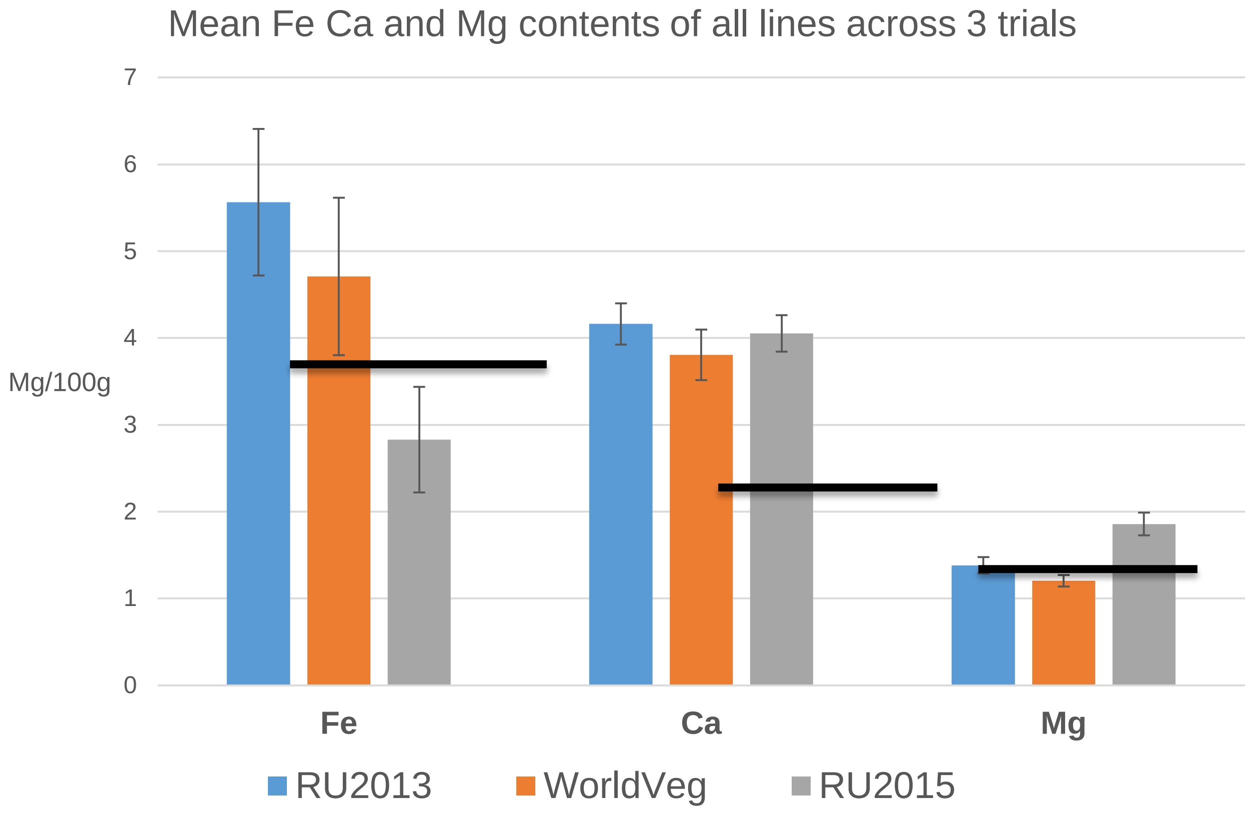
AMMI results

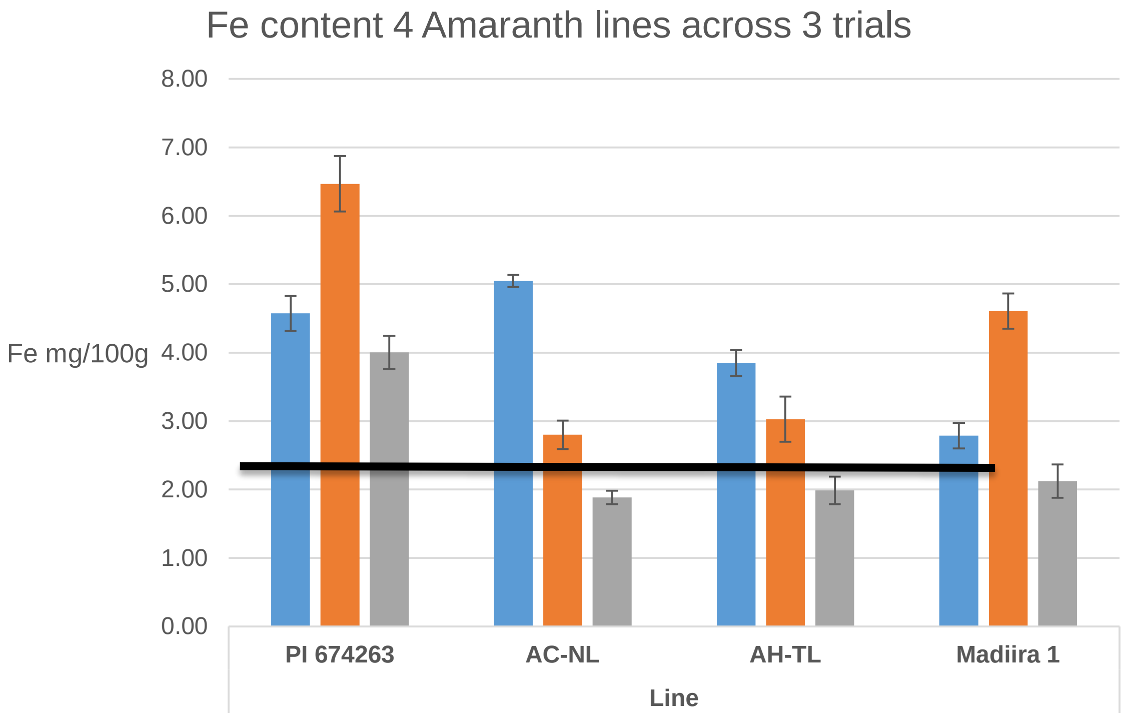
	Fe	Ca	Mg	Zn	Total Yield	Height	Spread
Env	<.0001	0.0009	<.0001	<.0001	<.0001	<.0001	<.0001
rep(env)	0.6617	0.264	0.0194	0.0113	0.045	0.0453	0.0001
Gen	<.0001	0.002	0.0366	0.004	<.0001	<.0001	0.0004
env*gen	0.0004	0.0009	0.0624	0.3097	0.0085	0.0035	0.088

Results of additive main effects and multiplicative interaction effect (AMMI) analysis of the four accessions which were grown in common across the three environments: PI 674263, AC-NL, AH-TL, and Madiira 1.

Selecting Vegetable Amaranth for Elevated Fe, Ca and Mg

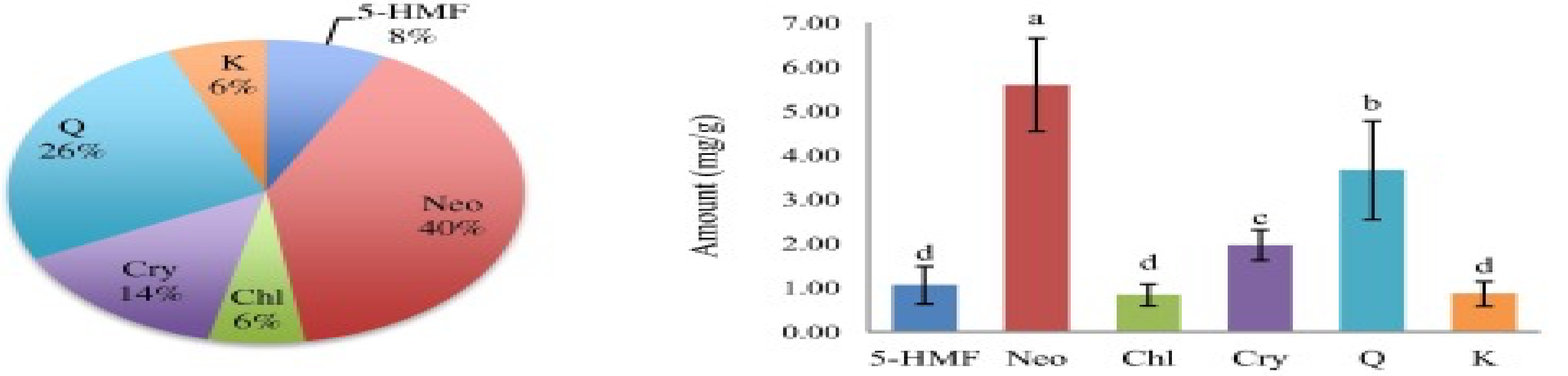
- Ca and Mg above “high-source” thresholds in all amaranth populations *grown in Tanzania and New Jersey in all field trials and across years*
- Fe varies by line and environment; *yet we identified a WVC PI 674263 from which we made further improvements with:* ***RUM24 High Iron Amaranth***





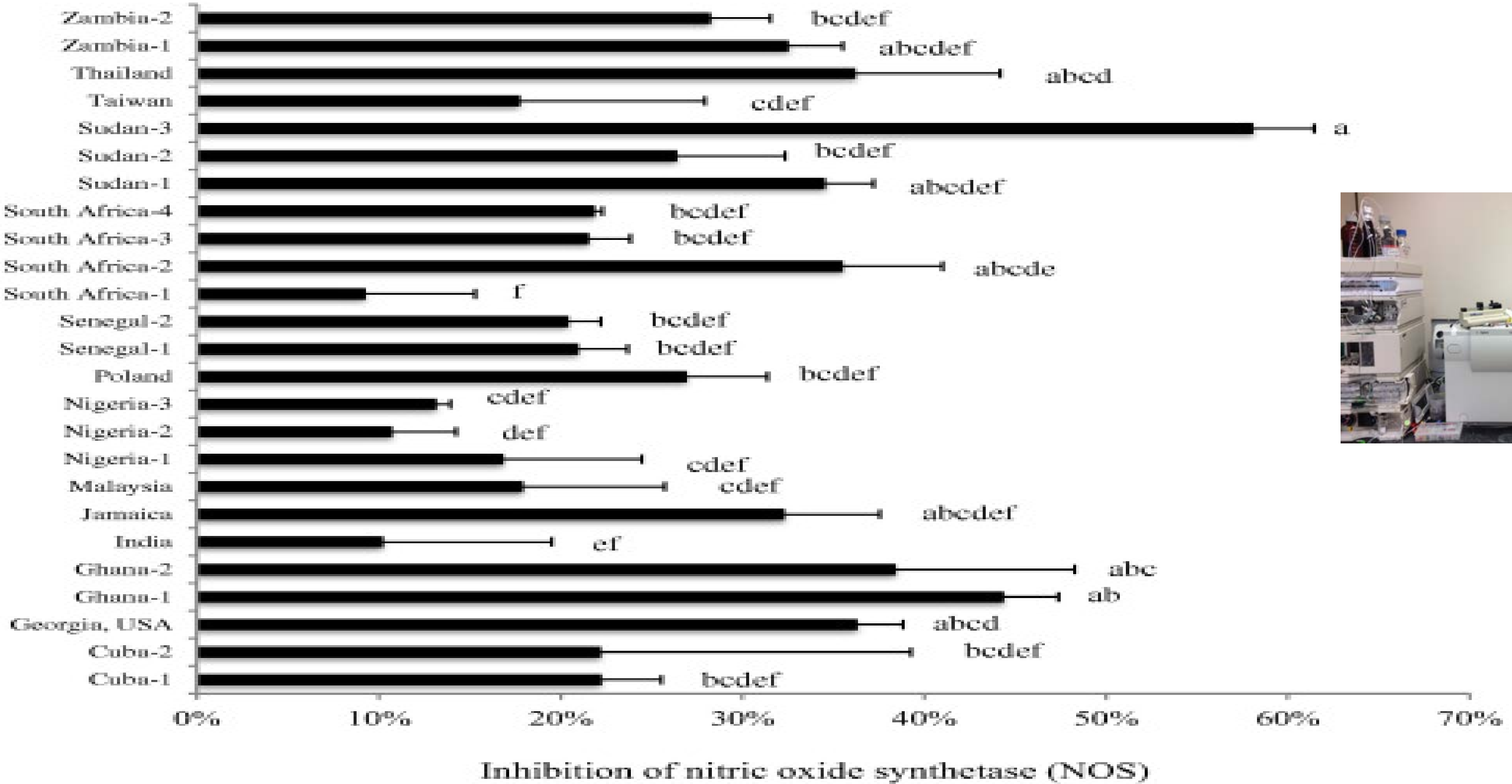
Black horizontal lines represents *Codex Alimentarius* “high-source” thresholds per micronutrient

A



Evaluation of Hibiscus leaves from a Global Collection for Nutrient Composition

B



(A) Relative and absolute mean chemical compositions of the population of hibiscus eaves.

Abbrev: “5-HMF” 5-(hydroxymethyl)furfural; “Neo” =neochlorogenic acid; “Chl” =chlorogenic acid; “Cry”= =chlorogenic acid; “Q”= cryptochlorogenic acid; “Q”= quercetin; “K”= kaempferol.

(B) Inhibition of nitric oxide synthetase (NOS) by extracts of *H. sabdariffa* leaf (80 μg/ml) on LPS induced RAW 264.7 cells;.

Zhen J., T.S. Villani, Y. Guo, Y. Qi, K. Chin, M.H. Pan, C.T. Ho, J.E. Simon and Q.L. Wu. 2016. Phytochemistry, antioxidant capacity, total phenolic content and anti-inflammatory activity of *Hibiscus sabdariffa* leaves. J. Food Chemistry 190: 673-680.

Science-Driven

Hoffman et al. Journal of Health, Population and Nutrition (2017) 36:27
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RESEARCH ARTICLE Open Access

Temporal changes and determinants of childhood nutritional status in Kenya and Zambia

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Abstract

Background: The prevalence of undernutrition is decreasing in many parts of the developing world, but challenges remain in many countries. The objective of this study was to determine factors influencing childhood nutrition status in Kenya and Zambia. The objective of this study is to determine factors associated with temporal changes in childhood nutritional status in two countries in sub-Saharan Africa.

Methods: Data from national demographic and health surveys from the World Bank for Kenya (1998–2009) and Zambia (1996–2014) were used to select the youngest child of each household with complete data for all variables studied. Multiple linear regression analyses were used for data from 2902 and 11,335 children from Kenya and Zambia, respectively, in each year to determine the relationship between social and economic factors and measures of nutritional status, including wasting, stunting, and overweight.

Results: There was a decreased prevalence of stunting (35% in Kenya and 40% in Zambia), while the prevalence of wasting was unchanged (6–8% in both countries). From 1998 to 2009, there was a protective effect against stunting for wealthier families and households with electricity, for both countries. Finally, better educated mothers were less likely to have stunted children and girls were less likely to be stunted than boys.

Conclusions: Based on the data analyzed, there was a higher risk of stunting in both Kenya and Zambia, for those with lower literacy, less education, no electricity, living in rural areas, no formal toilet, no car ownership, and those with an overall lower wealth index. Improving the education of mothers was also a significant determinant in improving the nutritional status of children in Kenya and Zambia.
More broad-based efforts to reduce the prevalence of undernutrition need to focus on reducing the prevalence of undernutrition without promoting excess weight gain. Future economic advances need to consider integrated approaches to improving economic standings of households without increasing the risk for overnutrition.

Keywords: Stunting, Wasting, Nutritional status, Children, Kenya, Zambia, Dietary diversity

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Elemental Micronutrient Content and Horticultural Performance of Various Vegetable Amaranth Genotypes

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Additional index words. African indigenous vegetables, Ca, Fe, micronutrients, Mg, Zn

Abstract. Vegetable amaranth (*Amaranthus* sp.), a leafy vegetable crop consumed around the world, is actively promoted as a source of essential micronutrients to at-risk populations. Such promotion makes micronutrient content essential to the underlying value of this crop. However, the extent to which micronutrient content varies by effect of genotype is not clear, leaving breeders uninformed on how to prioritize micronutrient contents as the criteria for selection among other performance parameters. A total of 32 entries across seven *Amaranthus* species were field-grown and analyzed for Fe, Mg, Ca, Zn, yield, height, and canopy spread comprising 20 entries at New Jersey in 2013; 12 entries at Arusha, Tanzania, in 2014; and 20 entries at New Jersey in 2015. The genotype effect was significant in all trials for Fe, Mg, Ca, Zn, total yield, marketable yield, height, and canopy spread. The Fe content range was above and below the breeding target of 4.2 mg/100 g Fe in all environments except for New Jersey 2015, where all entries were found to accumulate in levels below the target. All entries in each of the environments contained levels of Ca and Mg above breeding targets, 300 mg/100 g Ca and 90 mg/100 g Mg. None of the entries in any environment met the Zn breeding target of 4.5 mg/100 g Zn.

Vegetable amaranth is a mostly self-pollinated, diploid eu-
yote with C_4 photosynthesis known to be consumed in
r 50 countries, primarily across sub-Saharan Africa, south
a, and southeast Asia (Achigan-Dako et al., 2014; Jain et al.,
2; National Resource Council, 2006). Vegetable amaranth
ommonly cited as having unrealized potential to deliver
eral and vitamin micronutrients as well as protein to at-risk
ulations in regions with high rates of nutritional deficiencies
eller et al., 2015).
Previous studies have shown success in selecting increased
and Zn content in rice (*Oryza sativa*) without consequence to
ld performance; these entries of rice were later observed to

be effective as a food source for the improvement of huma
nutrition (Gregorio et al., 2000; Haas et al., 2005). Sufficie
variability has also been shown to exist within the whe
(*Triticum aestivum*) germplasm to allow for the selection
high-Fe and high-Zn entries (Cakmak et al., 2000). Th
genotype × environment interaction (GEI) effect is a potenti
issue in selecting stable performance in any trait for pla
breeders (Crossa, 2012; Gregorio et al., 2000). Following th
observation of sufficient variability to select high-minera
content entries, studies have shown a sufficiently low GI
effect on mineral contents to facilitate a successful selection f
stable performance in maize (*Zea mays*) and wheat (Feil et a
2005; Velu et al., 2012). Observing whether sufficient variabi
ity in the germplasm exists to select vegetable amaranth
otherwise concluding that no further selection is needed f
these traits is the correct activity to initially assess the viabili
of using this crop as a tool for improving human nutrition.
A fundamental advantage of delivering micronutrien
through staple crops is that it is recognized as less expensi
than supplementation programs (Masuda et al., 2012). How
ever, micronutrients are typically not accumulated in hig
concentrations in either seed or root/tuber tissue, making stap
crops less easily bred or selected for delivering one or mo
micronutrients associated with common deficiencies; where

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tochemistry, antioxidant capacity, total phenolic content anti-inflammatory activity of *Hibiscus sabdariffa* leaves

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ABSTRACT

A liquid chromatography–mass spectrometry method was developed for the simultaneous separation, and determination of natural compounds including phenolic acids and flavonoids in the leaves of *Hibiscus sabdariffa*. By analyzing the UV and MS data, and comparison with authenticated standards, 10 polyphenols including neochlorogenic acid, chlorogenic acid, cryptochlorogenic acid, quercetin, kaempferol and their glycosides were identified together with 5-(hydroxymethyl)furfural. Major constituents in the leaves of 25 different populations from worldwide accessions were quantified and compared with each other. The total phenolic content of each accession was determined using Folin-Ciocalteu assay, ranging from 18.98 ± 2.7 to 29.9 ± 0.5 mg GAE/g. Their in vitro antioxidant activities were measured by ABTS radical cation decolorization assay, varying from 17.5 to 152.5 ± 18.8 μmol Trolox/g. After the treatment of *H. sabdariffa* leaf extract, the reduction of LPS-induced NO production dose-dependently in RAW 264.7 cell indicates the extract's potential anti-inflammatory activity.

roduction

iscus *sabdariffa* (family Malvaceae), commonly known as
e or Bissap, is a non-native species to the United States
2003). The calyx (outer ring of the fruit) is commonly used
erages and foods such as teas, jams, and jellies (Mahadevan,
, & Kamboj, 2009). Hibiscus tea, a popular herbal tea around
orld, from Mexico and the Americas, the Middle East, to
and sub-Sahara Africa to Southeast Asia is thus found in
ational commerce as a sole ingredient in herbal infusions or
imparting a characteristic red color and unique flavor to such
ages (Villani, Juliani, Simon, & Wu, 2013). While the focus has

treatment of hypertension, inflammation, and liver disorders (Lans, 2006; Lin, Chen, Kuo, & Wang, 2007). The anti-hypertensive activity was also further demonstrated in both experimental animals and humans clinically, in which the underlying therapeutic mechanism was explained by a vasodilator effect in the aortic rings (Ajay, Chai, Mustafa, Gilani, & Mustafa, 2007; Herrera-Arellano, Flores-Romero, Chavez-Soto, & Tortoriello, 2004; Onyenekwe, Ajani, Ameh, & Gamaniel, 1999). The calyx extract was shown to inhibit enzymes cyclooxygenase COX-1 and COX-2, and also to down regulate the expression of COX-2 expression in lipopolysaccharide (LPS) treated RAW 264.7 cells, suggesting its anti-inflammatory activity (Christian, Nair, & Jackson, 2006; Kao et al.,

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Original Article

Rapid screening of toxic glycoalkaloids and micronutrients in edible nightshades (*Solanum* spp.)

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ABSTRACT

African indigenous vegetables (AIVs) because of their nutrient density have the unique potential to reduce micronutrient deficiencies in sub-Saharan Africa, yet some may also contain anti-nutritive compounds. Vegetable nightshades from *Solanum americanum*, *Solanum nigrum*, *Solanum scabrum* and *Solanum villosum* are among the major AIVs used as a leafy vegetables and consumed regularly in many countries in sub-Sahara Africa. These under-recognized food crops have not been subjected to extensive studies for their nutritional and antinutritive factors. In this study, 15 entries of the vegetable nightshades were field-grown and the leaves which are the consumed product of commerce chemically profiled by LC/ESI-MS. Twenty-three flavones, eight saponins, and two glycoalkaloids along with a phenolic acid of chlorogenic acid were identified by MS and UV data. Anti-nutrient glycoalkaloids were quantified as total aglycones after acidic hydrolysis using MS detection and found to be within safe-consumption thresholds by comparison with the glycoalkaloid level in the globally consumed *Solanum* member eggplants. Edible nightshades were also found to be sources of β-carotene, vitamin E and total polyphenols and exhibited high antioxidant activity. Results of this study support that consumption of vegetable nightshades are safe from the presence of glycoalkaloids and thus, can contribute to the reduction of micronutrient deficiency in sub-Sahara Africa.

Increasing Access to Youth: Peri-Urban; Urban, Schools

Evaluating Sack-Gardens: Tumaini Center for Street Boys, Kenya

Our Project is:
Providing Training in AIV production, research methods and marketing to the boys and assisting in farm productivity
Lesson 9: Linking to Youth within our project provides new avenue to reach 'new generation of farmers', urban gardening/farming and families to improve health and generate income
In Years 4 and 5: We will now test these sac gardens out in Kibera, Nairobi (w/ Mirror of Hope,NGO)

Key Takeaways

- **Households and communities in rural areas are far more interested in AIVs (and other horticultural crops) when used to generate income streams and for their own household consumption.**
- **We found a statistically significant difference between consumption patterns in rural versus urban Zambia.**
- **Effective BCC venues can be identified by community members.**
- **AIVs targeted in this project are among those selected by those surveyed and which can be scientifically shown to be nutrient rich. Nutritional benefits can be a key driver in the increased consumption & trade in indigenous plants such as AIVs.**

Summary

- **Our key goal is to link and bridge horticultural production by producers to increased consumption by consumers using the four 'A's: Access, Availability, Affordability, and Adoption.**
- **For Growers: Adoption=producing and consuming AIVs.**
- **For others, Adoption means purchasing and/or possibly starting to grow AIVs increasing consumption to improve health.**
- **We are tracking the nutrient content of the AIVs grown locally, identifying those which are rich sources of vitamins & minerals.**
- **We are now tracking dietary diversity now of 1,000 households (500 in Kenya; and 500 in Zambia) and separating them into different treatment groups to allow us to better understand what drives individuals to consume more AIVs or to grow AIVs.**

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