Micronutrients and secondary plant metabolites composition of commonly consumed African indigenous vegetables (AIVs) from Tanzania

James S. Chacha[1, 2*], Nadja Förster[1], Susanne Huyskens-Keil[1], Christian Ulrichs[1] and Constance Rybak[1, 3]

INTRODUCTION

The “triple burden of malnutrition” is a growing challenge in sub-Saharan Africa. Socio-economic and environmental changes are fostering nutrition transition in Tanzania leading to high prevalence of all forms of malnutrition. To characterize local food environments in Dar es Salaam focusing on food quality, the potential of African indigenous vegetables (AIVs) to combat different forms of malnutrition was assessed. The edible part of selected AIVs (Figure 1) samples were analyzed to determine their contents of selected minerals (calcium, iron, potassium, magnesium, zinc) and secondary plant metabolites (carotenoids and phenolic acids).

Figure 1: Selected AIVs (from left to right: Amaranth (*Amaranth spp.*), Chinese cabbage (*Brassica chinensis*), Black nightshade (*Solanum nigrum*), Pumpkin leaves (*Cucurbita maxima*)

METHODS

Vegetable samples of *Amaranth spp*. (AM), *Brassica chinensis* (CC), *Solanum nigrum* (NS) and *Cucurbita maxima* (PL) were procured from Ilala and Kisutu markets, Ilala district, Dar es Salaam region, Tanzania. Leaf material was shipped on dry-ice to Humboldt-Universität zu Berlin for freeze-drying and further analysis. Mineral contents were extracted and quantified by Inductively Coupled Plasma-Optical Emission Spectrometry (ISO 11464; ISO 11465). Secondary plant metabolites were extracted and quantified by High-Performance Liquid Chromatography (carotenoids: Mageney et al., 2016; phenolic acids: Förster et al., 2015).

RESULTS

Mineral contents of AIVs from Ilala and Kisutu markets

- The type of vegetable, the market and the interaction of both factors had a significant influence on the contents of selected minerals (Eta partial test, $p < 0.05$, partial eta square > 0.904) (Table 1).

Table 1: Mineral contents of selected AIVs from Ilala and Kisutu markets

		ILALA MARKET				
	Mineral	**Ca** [g/100g DW]	**Fe** [mg/100g DW]	**K** [g/100g DW]	**Mg** [g/100g DW]	**Zn** [mg/100g DW]
Vegetable	AM	2.23 ± 0.00^{b}	85.99 ± 3.35^{d}	5.55 ± 0.10^{d}	1.38 ± 0.01^{d}	4.15 ± 0.02^{c}
	CC	3.55 ± 0.01^{d}	66.98 ± 0.36^{c}	3.43 ± 0.04^{a}	0.71 ± 0.00^{a}	3.93 ± 0.02^{a}
	NS	2.02 ± 0.00^{a}	22.08 ± 0.16^{a}	3.60 ± 0.01^{b}	0.84 ± 0.00^{b}	4.051 ± 0.01^{b}
	PL	3.48 ± 0.03^{c}	34.52 ± 0.47^{b}	4.42 ± 0.01^{c}	1.07 ± 0.00^{c}	5.56 ± 0.05^{d}
		KISUTU MARKET				
	Mineral	**Ca** [g/100g DW]	**Fe** [mg/100g DW]	**K** [g/100g DW]	**Mg** [g/100g DW]	**Zn** [mg/100g DW]
Vegetable	AM	2.49 ± 0.00^{b}	55.54 ± 2.23^{c}	3.20 ± 0.02^{b}	1.46 ± 0.01^{d}	8.60 ± 0.07^{c}
	CC	2.51 ± 0.01^{b}	30.73 ± 0.12^{b}	6.01 ± 0.02^{d}	0.55 ± 0.00^{a}	3.92 ± 0.09^{a}
	NS	1.89 ± 0.01^{a}	27.07 ± 1.08^{a}	4.14 ± 0.03^{c}	0.83 ± 0.01^{b}	4.19 ± 0.02^{b}
	PL	3.76 ± 0.03^{c}	26.91 ± 0.55^{a}	2.95 ± 0.02^{a}	0.92 ± 0.00^{c}	14.06 ± 0.07^{d}

Mineral contents of selected AIVs from Ilala and Kisutu markets. *(Mean ± SD, n = 3, Tukey’s HSD test, $p < 0.05$. Different superscripts indicate significant differences between the values in each market).*

Carotenoids content of AIVs from Ilala and Kisutu markets

- Significant higher total carotenoids in pumpkin leaves and amaranth compared to Chinese cabbage and black nightshade from Ilala market (Figure 2).
- Significant higher total carotenoids in black nightshade compared to amaranth, Chinese cabbage and pumpkin leaves from Kisutu market (Figure 2).
- The interaction of the factors vegetable and market had a significant influence on the total carotenoids, violaxanthin and lutein contents (Eta partial test, $p < 0.05$, partial eta square > 0.523). For neoxanthin and β-carotene contents, only vegetable type had a statistically significant effect (partial eta square > 0.466).

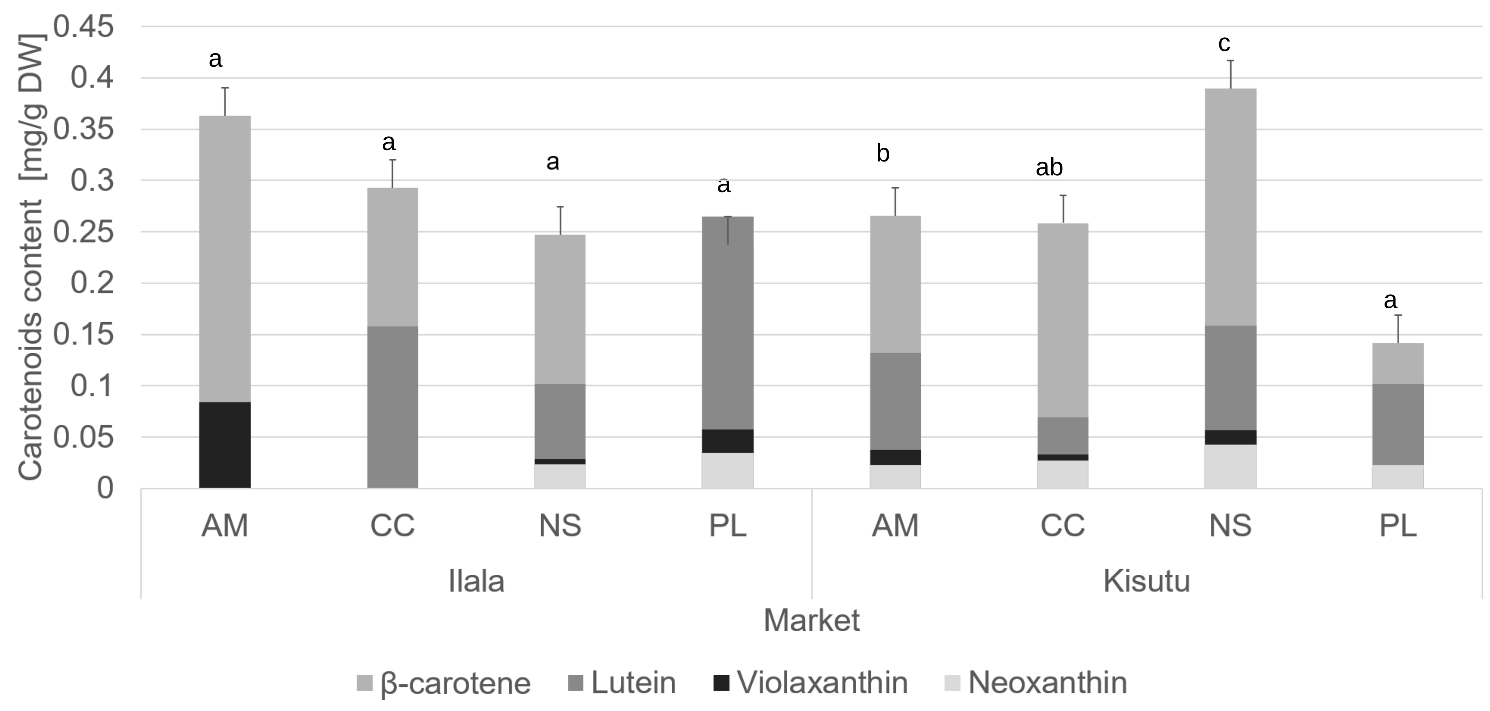

Figure 2: Pro-vitamin A (β-carotene) and non-pro-vitamin A (lutein, violaxanthin, neoxanthin) contents of selected AIVs from Ilala and Kisutu markets *(Mean ± SE, n = 3, Tukey’s HSD test, $p < 0.05$. Different superscripts indicate significant differences of total carotenoids between the values in each market, AM =* Amaranth*, CC = Chinese cabbage, NS = Black nightshade, PL = Pumpkin laves)*

Total phenolic acid contents of AIVs from Ilala and Kisutu markets

- Significant higher total phenolic acid contents in black nightshade compared to other AIV samples obtained from Ilala market (Figure 3).
- Significant higher total phenolic acid contents in both amaranth and Chinese cabbage (compared to black nightshade and pumpkin leaves from Kisutu market (Figure 3).
- The type of vegetable, the market and the interaction of both factors had a significant influence on the total phenolic acid contents of the AIVs (Eta partial test, $p < 0.05$, partial eta square > 0.970).

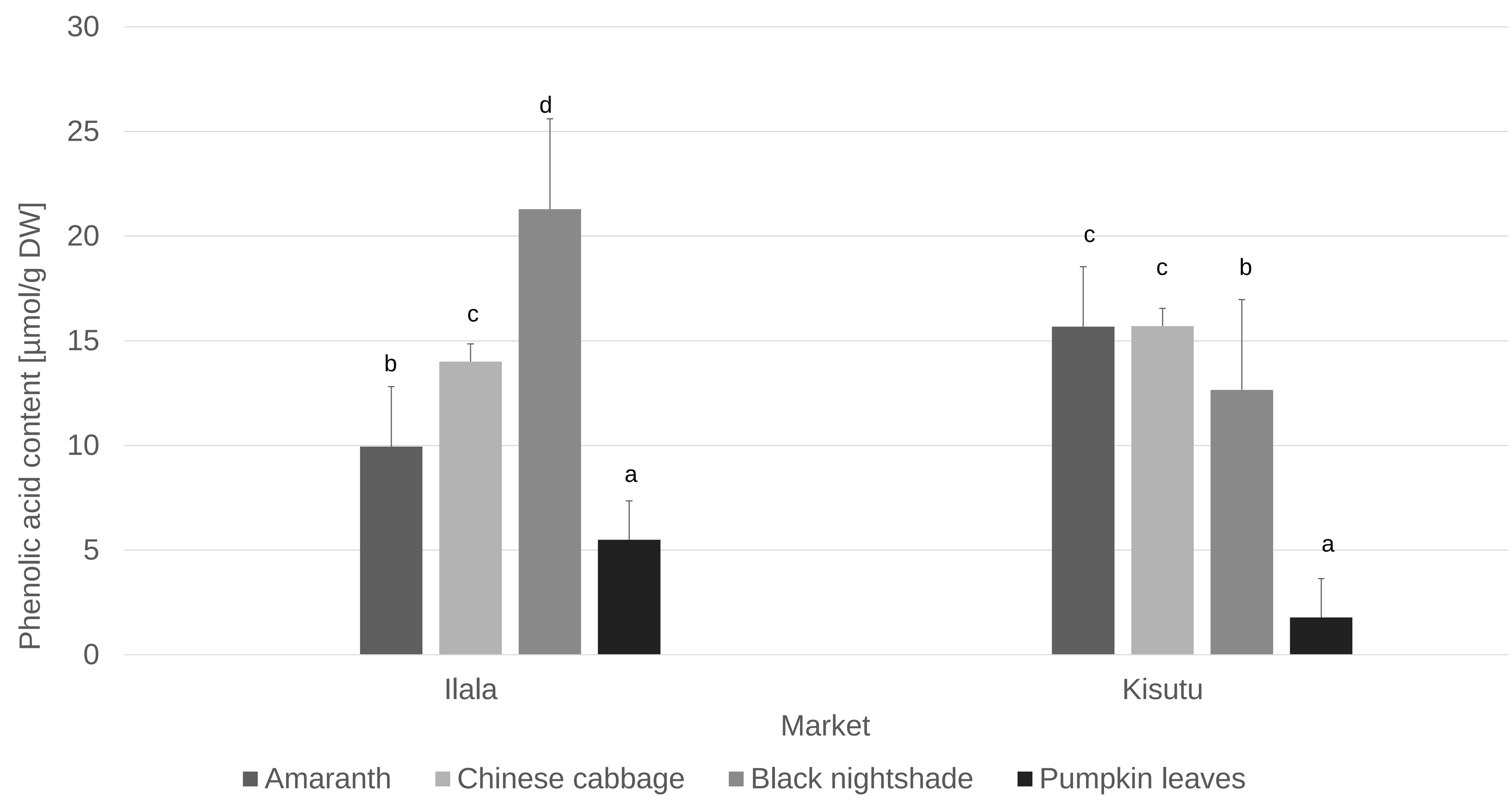

Figure 3: Phenolic acid contents of selected AIVs from Ilala and Kisutu markets *(Mean ± SE, n = 3, Tukey’s HSD test, $p < 0.05$. Different superscripts indicate significant differences between the values in each market).*

CONCLUSION

- The interaction of the factors vegetable and market had a significant influence on the mineral, violaxanthin, lutein, total carotenoids and total phenolic acid contents of the AIVs. For the neoxanthin and β-carotene contents, only the vegetable type had a statistically significant effect.
- The contents of minerals provided by the AIVs indicate that these could contribute to the recommended nutrient intake of people of different age groups. These, alongside the secondary plant metabolites with potential health promoting effects, play a vital role to improve local diets and combat the triple-burden of malnutrition in Ilala district, Tanzania.
- Nutrition-sensitive interventions linked to AIV production and post-harvest treatments should be conducted to improve local food environments by increasing the availability of such affordable nutrient-dense vegetables.

REFERENCES

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[1]Humboldt-Universität zu Berlin, Thaer-Institute-Division Urban Plant Ecophysiology, Germany
[2]Department of Food Science and Agroprocessing, Sokoine University of Agriculture, Tanzania
[3]Leibniz Centre for Agricultural Landscape Research (ZALF), Germany
*james.simon.chacha@hu-berlin.de

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