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Effect of different cooking methods on the nutritional value of some African indigenous leafy vegetables in Kenya

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Abstract A study to determine the effect of four cooking methods, on the nutritional value of three African indigenous leafy vegetables, *Solanum nigrum, Gynandropsis gynandra* and *Amaranthus* hybridus was carried out between October 2011 and March 2012. Levels of eight nutrients, Beta carotene, Ascorbic acid, calcium, copper, magnesium, manganese, zinc and iron were determined. Cooking methods significantly influenced the nutrient composition of vegetables. The raw samples were of higher nutritional value than the cooked samples. The best cooking method retaining most nutrients across the three vegetables was boiling for 5 minutes. *Amaranthu hybridus* had an overall higher nutritional value. Data was analyzed using SPSS version 16.

Key words: Ascorbic acid, beta carotene, boiling, frying, nutrients

Introduction

Most vegetables worldwide are cooked before consuming to improve palatability, texture and taste (Migliot *et al*., 2008). Cooking also eliminates potential pathogens and neutralizes poisonous or irritating substances while bringing spoilage to a halt (Martin & Meitner, 1998). Various cooking methods are used based on convenience and taste preference rather than nutrient retention yet cooking induces significant changes in chemical composition affecting concentration and nutrient bioavailability (Gao-feng *et al*., 2009). Some cooking methods may oxidize anti-oxidants (Shahnaz *et al*., 2003) and affect the vegetable nutrient retention. It is therefore important to choose a cooking method that leads to optimal nutrient retention and bioavailability (Funke, 2011).

Materials and methods

Three African Indigenous leafy vegetables (ALVs) were harvested at vegetative stage early in the morning by breaking the main shoot. They were cleaned then cooked using four methods. Raw samples of each vegetable was used as a control. Levels of Beta carotene, ascorbic acid, and minerals iron, zinc, calcium, copper, magnesium and manganese were determined.

Each vegetable was harvested in batches of about 1000g then thoroughly mixed before selecting a representative sample of 750g. The 750g sample was each further divided into five equal portions (1-5) then washed, drained and finely chopped and thoroughly mixed before preparing.

Sample preparation

Portion 1- boiled in its water for 5 minutes while covered but frequently stirring and then rapidly cooled by spreading on a large surface area (tray) and placing in a refrigerator.

Portion 2- boiled for 5 minutes in its water and a further 3 minutes with fresh milk then rapidly cooled as portion 1.

Portion 3- fried with salad oil for 5 minutes covered, while frequently stirring then rapidly cooled as portion 1.

Portion 4-fried with salad oil for 10 minutes covered while frequently stirring then rapidly cooled as portion1.

Portion 5- the raw vegetables.

Cooking of samples was done at 85^0C while distilled water was only added to prevent the vegetable from burning. Five milliliters of salad oil was used for every 150g of vegetable during frying. On the other hand, only the amount of milk required for the vegetable to continue boiling for a further three minutes was added.

Beta carotene and ascorbic acid were determined immediately after sample preparation followed by mineral determination. The duration of sample preparation from harvesting was a maximum of one hour.

Analytical methods. Beta carotene was determined using spectrophotometer, while ascorbic acid by titration and minerals by atomic absorption spectrophotometry (AOAC, 1980).

Statistical analysis. Statistical analysis was performed using SPSS version 16 (SPSS Inc., Chicago, USA). One-way analysis of variance (ANOVA) was followed by Kruscal Wallis multiple comparisons post hoc test. Results are expressed as means±SD of triplicate samples. Differences were considered significant at 95% confidence interval ($p<0.05$).

Results

The nutritional value of the three vegetables was generally higher in the raw samples for all the eight nutrients (Tables 1, 2, 3) andboiling for 5 minutes retained most nutrients. The raw form of A. hybridus had higher nutritional value in three (Mn, Mg and ascorbic acid) out of the eight nutrients (Table1). On comparing the four cooking methods, boiling for 5 minutes was the best with the highest nutrient retention in five (Zn, Mn, Mg, beta carotene and ascorbic acid) nutrients whilefrying for 10 minutes was the worst with the least nutrients in Ca, beta carotene and ascorbic acid.

Multiple comparisons using Kruscal Wallis showed that there was significant difference ($p<0.05$) between the levels of each nutrient across the 5 preparation methods as indicated by *.

The raw sample of *G. gynandra* had the highest values in six out of the eight nutrients, Cu, Zn, Mn, Mg, Ca and ascorbic acid (Table 2). On comparing the four cooking methods, boiling for 5 minutes was the best and retained five nutrients (Zn, Mn, Mg, Ca and beta carotene) out of the eight. The worst cooking method was boiling for 8 minutes with milk and retained the least values in six nutrients (Zn, Mn, Mg, Ca, beta carotene and ascorbic acid).

Table 1. Micronutrient content (mg/100g dry weight) of *Amaranthushybridus* by cooking method.

	Boiled 5 mins	Boiled/milk 8mins	Fried 5 mins	Fried 10 mins	Raw
Cu	0.51±0.07	0.26±0.01*	0.56±0.56	0.37±0.19*	0.56±0.01
Zn	8.47±1.40*	7.79±0.11	7.10±0.27*	7.43±0.29	7.80±0.22
Mn	28.90±0.78*	22.31±1.24	25.65±0.59*	23.87±0.41	32.45±1.15*
Fe	30.07±0.72	25.27±1.14*	32.71±1.00*	30.42±0.90	31.43±0.58
Mg	557.67±13.07	549.77±6.00	476.47±8.71*	546.35±3.54	733.96±6.14*
Ca	3065.40±199.90	4765.00±55.28*	2756.10±127.86	2644.50±79.27	3153.20±51.29*
Beta carotene	46.58±0.61*	36.53±0.811	36.45±0.66	35.90±1.49	23.84±1.07*
Ascorbic acid	1590.10±0.92*	1431.10±0.83	1394.90±69.13	1229.0±8.25*	3014.60±14.18*

The values in the table are means of triplicate samples of (mean±SD).

Table 2. Micronutrient content (mg/100g dry weight) of *Gynandropsis gynandra* by cooking method.

	Boiled 5 mins	Boiled/milk 8mins	Fried 5 mins	Fried 10 mins	Raw
Cu	0.20±0.01*	10.37±0.04	0.46±0.05*	10.39±0.520	0.78±0.02*
Zn	13.56±0.57*	7.70±0.05*	8.61±0.08*	9.31±0.17*	14.77±0.29*
Mn	10.70±0.97*	5.42±0.16*	29.27±0.24	29.11±0.29	15.96±0.09*
Fe	17.32±0.48*	319.61±0.71	320.23±0.95	424.94±0.96	423.54±1.36
Mg	217.05±3.99*	113.95±1.31*	5185.96±2.41	5180.20±3.48	266.28±5.82*
Ca	1244.60±5.27*	839.37±8.04*	61056.30±85.49	61066.40±10.42	1627.30±61.89*
Beta carotene	732.00±0.52	718.37±0.72	31.39±0.36*	28.29±0.57*	29.394±0.53*
Ascorbic acid	687.78±7.02*	615.50±6.13*	720.13±0.75*	730.68±0.92*	1193.70±0.91*

The values in the table are means of triplicate samples (mean ± SD)

Table 3. Micronutrient content (mg/100g dry weight) of *Solanum nigrum* by cooking method.

	Boiled 5 mins	Boiled/milk 8mins	Fried 5 mins	Fried 10 mins	Raw
Cu	0.26±0.04*	0.35±0.02	0.38±0.02	0.49±0.01*	0.60±0.02*
Zn	4.24±0.17	3.73±0.12	3.83±0.11	3.80±0.01	4.37±0.03
Mn	17.21±0.35*	8.84±0.42*	15.64±0.08*	14.11±0.44*	19.69±0.06*
Fe	39.61±0.87	32.87±0.63*	38.35±0.84	36.53±0.93*	42.44±0.21*
Mg	197.88±4.44*	165.43±3.60	154.50±3.53*	170.62±0.73	252.80±2.18*
Ca	880.89±8.28	758.08±15.26*	866.76±26.06	991.71±6.16*	1369.70±5.59*
Beta carotene	23.57±0.37	23.51±0.28	34.62±0.53*	39.86±0.34*	30.59±0.82*
Ascorbic acid	684.23±14.56*	425.04±5.19*	509.39±6.63*	561.79±7.78*	748.99±14.74*

The values in the table are means of triplicate samples (mean ± SD).

Multiple comparisons using Kruscal Wallis showed that there was significant difference ($p<0.05$) between the levels of each nutrient across the 5 preparation methods as indicated by *.

Nutrient values in the raw sample of *S. nigrum* had higher nutrient values in seven out of the eight nutrients, except for beta carotene which was highest in the sample fried for 10 minutes (Table3). On comparing the four cooking methods, boiling for 5 minutes was the best cooking method and retained the highest nutrients in five out of the eight (Zn, Mn, Fe, Mg and ascorbic acid). The worst cooking method was boiling for 8 minutes with milk and retained the least nutrients for six out of the eight (Zn, Mn, Fe, Ca, beta carotene and ascorbic acid).

Multiple comparisons using Kruscal Wallis showed that there was significant difference ($p<0.05$) between the levels of each nutrient across the 5 preparation methods as indicated by *.

A. hybridus was of higher nutritional value than the other two ALVs across the preparation methods and boiling for 5 minutes had the highest nutrient retention in 5 nutrients out of the eight in each of the three vegetables, *A. hybridus* (Zn, Mn, Mg, Beta carotene and Ascorbic acid), *G. gynandra* (Zn, Mn, Mg, Ca and Beta carotene) and *S. nigrum* (Zn, Mn, Fe, Mg and Ascorbic acid).

Discussion

The results of the nutritional value analysis with different preparation methods indicate that the raw vegetables are generally of a higher nutritional value than the variously cooked within the same vegetable. It would appear that raw vegetables are of more benefit to consume than cooked, yet cooking of vegetables is important to soften the matrix of cells and increase extractability of nutrients (Migliot *et al*., 2008) while destroying anti-nutritional factors (Martin & Meitner, 1998). Cooking for a longer time however leads to a higher loss of most of the nutrients (Mathooko & Imungi, 1994; Funke, 2011) especially if cooking water is discarded since most nutrients leach into it (Gao-feng *et al*., 2009; Jimenez-Monreal *et al*., 2009). The same was observed in the current study whereby most nutrients were retained when the vegetables was boiled for only 5 minutes in its water with no water discarded, further cooking led to loss of most nutrients.

The higher nutritional value of *A. hybridus* in this study corroborate with those of Funke, (2011) in which Amaranth had high values of micronutrients including Ascorbic acid which is an important nutrient in the absorption of iron from food thus red blood cell formation (Lonnerdal, 1988). The findings also indicate different cooking methods have different effects on different nutrients and since vegetables worldwide are consumed for the high micronutrient content, it is important to choose a cooking method which best retains most nutrients in a vegetable. In this case, boiling for 5 minutes retained most nutrients across the three vegetables.

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