Evaluation of Oxalate Content of Some Indigenous and Produced Spices and Seasonings in Ghana

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Abstract
In this paper, six indigenous (LS) and fifteen industry produced spices and seasonings (IPS) available to consumer have been examined for its oxalate content using Ultra Violet –Visible spectroscopy with a view to provide useful information towards their effective use. The oxalate content of the LS was found to be between 0.74±0.04 –4.99±0.26 mg/g whereas that of the IPS was between 0.05±0.0-7.5±0.0 mg/g. Although the LS recorded a higher average oxalate content than the IPS, the difference was not statistically significant ($p<0.05$). Among the IPS samples curry based spices had higher oxalate content.
Keywords: anti-nutritional factors, oxalate, seasonings, spices, Ghana

1. Introduction

Oxalates are dicarboxylic acid anions produced and accumulated in many crops, plants and pasture weeds. Though the physiological role of oxalate in plants is not precisely known it is proposed to be involved in seed germination, calcium storage and regulation, ion balance, detoxification, structural strength, and insect repulsion (Lane, 1994). Oxalates may occur in plants as the soluble anion of potassium (K), sodium (Na) and ammonium ($NH4^{+}$) salts, oxalic acids ($H_2C_2O_4$) or as insoluble crystalline form, as calcium oxalates (Holmes and Kennedy, 2000).

Certain plant and related foods contain considerable amounts of oxalates: spinach, 0.30-1.29 %; rhubarb, 0.20-1.30 %; beet leaves, 0.30-1.00 %; tea, 0.30-2.00 %; and cocoa, 0.50-0.90 % (Fasset, 1973). Some other foods known to contain high amounts of oxalate include nuts (42-469 mg/100 g) (Ritter and Savage, 2007); legumes (4-80 mg/100 g); and flours (37-269 mg/100 g) (Chai and Liebman, 2005). Chocolates, wheat brans and strawberries have also been shown to contain appreciable amount of oxalate (Noonan and Savage, 1999); Charrier *et al.* (2002).

The consumption of high oxalate containing diets increase the risk of renal calcium absorption, since oxalates bind minerals such as calcium and magnesium and interfere with their metabolism, particularly their absorption. High oxalate intake may also cause muscular weakness and paralysis, gastrointestinal tract irritation, blockage of the renal tubules by calcium oxalate crystals, development of urinary calculi, hypocalcaemia nephrotic lesions in the kidney (Oke, 1969). As a result of this anti nutritional property, people with a predisposition to forming kidney stones are advised to avoid oxalate-rich foods (Adeniyi et al., 2009). These anti-nutritional properties make it important to determine the oxalate content of commonly used food stuffs and related ingredients.

One of these commonly used ingredients in Ghanaian foods is spices. Spices consist of a collection of usually dried leaves and/or branches of plants, ripened fruits, seeds, root/bulbs of certain plants that are used to season foods because of their distinctive flavours and aromas. They could also be defined as aromatic vegetable substances, in whole, broken, or ground form, whose significant function in food is seasoning rather than nutrition (Lampe, 2003). They consist also of rhizomes, barks, and other parts of plants (Satter *et al.,* 1989).

Table 1: Some Ghanaian indigenous spices

Code	Sample	Local name*	Scientific name	English name
LS1		Pepere	*Syzygium aromaticum*	Cloves
LS2		Esurowisa	*Piper guineese*	Ashanti pepper/W. African pepper
LS3			*Rosmarinus officinalis*	Rosemary
LS4		Nkitikiti		Aniseed/Anise
LS5		Efomwisa	*Aframomum melegueta/ Melegueta pepper*	
LS6			*Myristica fragrans*	Nutmeg

* Local name is in Akan-a Ghanaian language

The indigenous spices are thought to constitute a large proportion of the daily diets of rural dwellers. These are used generally in the preparation of "pepper-soups", especially during the cold seasons, to make these soups "hot" and spicy. Additionally, spices are very important in the post parturition diets of women, during which time it is claimed that these spices aid in uterine contraction (Achinewhu, 1996). They are also used to spice drinks, in nutritionally insignificant quantities, as food additives for flavouring and indirectly for their antibacterial and antioxidant properties (Ogunka-Nnoka, et al, (2008). Some spices indigenous to Ghana that were included in this study are shown in Table 1.

Nkitikiti is the schizocarpic fruit of the annual anise plant of the parsley family. The spice contains essential oils and other ingredients which have a strong seasoning action. *Pepere* are the aromatic dried flower buds of a tree that is often used in Asian, African and the Middle Eastern. It is used in cooking to add flavour to meats, curries and meat marinades. *Esurowisa* contain 5-8% of the chemical piperinewhich gives them their 'heat'. They contain large amounts of beta-caryophyllene. *Rosemary* is a woody, perenil herb with fragrant, evergreen, needle-like leaves and white, pink, purple or blue flowers. The leaves are used as flavouring in foods like stuffing roast lamb, pork, chicken and turkey. *Efomwisa* is specie in the ginger family and is obtained from the ground seeds. It gives a pungent, pepery flavour and this flavour is attributed to the presence of some aromatic ketones. *Nutmeg* is the seed of an evergreen tree that has a characteristic, pleasant fragrance and slightly warm taste. It is used widely to flavour a variety of dishes. Used in the powdered form, it contains oil that makes it psychoactive (Wikipedia).

As a result of the pleasant flavours and aroma characteristics of spices and seasonings and the wide usage, much attention has not been paid to the possible presence of anti-nutritional factors. The thrust of this paper is to evaluate oxalate, an anti-nutritional factor, in some indigenous and produced spices and seasonings available to the Ghanaian consumer with a view to provide useful information towards their effective use.

2. Materials and Methods

2.1 Sample preparation and analysis

The spices and seasoning samples were purchased from the markets around the capital city, Accra. Each of the indigenous spice samples was air dried and then triturated and homogenized into a very fine powder using a grinding mill (FRITSCH Pulverisette 2, Germany). The oxalate determination was carried out based on the method of Muñoz Leyva *et al*. (1990). The solution was prepared and the absorbance read at 269nm on the spectrophotometer (SHIMADZU UV-1201, Australia). Standard stock solutions were prepared and diluted with reference solvent in a series to obtain six working standard solutions in concentration range of 80-1000 µg/ml.

The absorbance of the solutions was read and calibration curve was plotted between absorbance and concentrations.
2.1.1Recovery and Statistical analysis
Recovery studies were carried out employing the known addition method. Known amount of oxalate was added to preanalysed sample at three different levels (80%, 100% and 120%) and the percentage mean recoveries of oxalate in the samples were calculated. All data were expressed as mean ± standard deviation (n= 3 replicates). Data were analyzed using one-way ANOVA using SPSS 15.0. Duncan's multiple-range test was used to determine the difference between means. A significant difference was considered at the level of $p \leq 0.05$.

3. Results and Discussions:
The oxalate spectrum showed a maximum absorption (λmax) at 269nm (Figure 1) with a calibration regression equation y=0.0002x + 0.0115. The percent mean recovery obtained was 98.27 at the three levels (i.e. 80, 100 and 120 %). Percent mean recoveries greater than 99% with low standard deviation is enough justification of the accuracy of the method. The percent mean recovery lies within the desirable confidence interval of 98-102%, hence it can be said that the method is accurate.

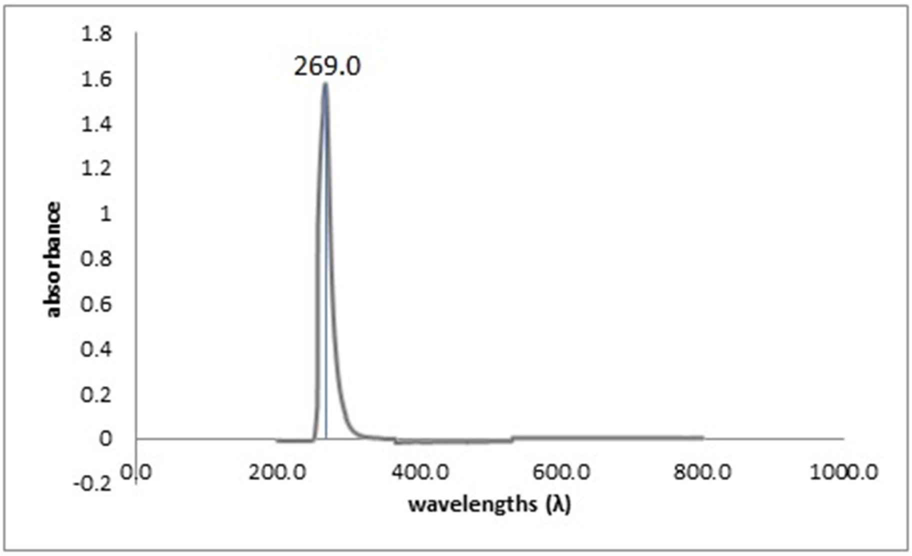

Figure 1: The UV spectrum of oxalate as determined by T70 UV-Vis spectrometer

The amounts of oxalate obtained from natural Indigenous Spices (LS) ranged between 0.74 and 4.99 mg/g with each significantly different from each other (Figure 2). Out of the six different types of spices analysed, LS6 and LS3 (n=2; 33.3%) recorded moderate amounts of oxalate (between 0.5mg/g and 1.0 mg/g). Only one, (16.7%) LS5 recorded a high amount of oxalate (between 1.0 mg/g and 2.0 mg/g) while the others, (n=3; 50%) recorded very high (>2mg/g) amounts of oxalate. It was also observed that fruits spices tended to have higher oxalate content while seed spices recorded the least oxalate contents, with a linear correlation coefficient (R) of 0.80.

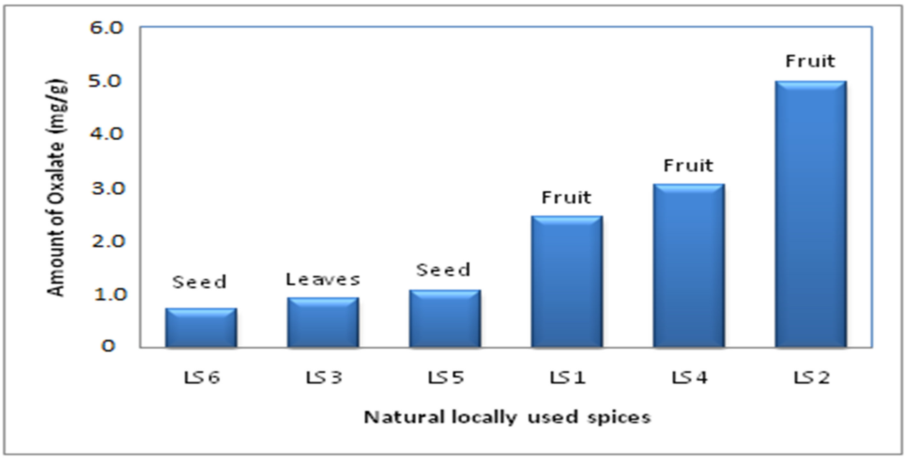

Figure 2: Oxalate content of selected Indigenous Spices (LS)

The amount of oxalate obtained for the Industrially Produced Spices (IPS) as depicted in Figures 3 and 4 ranged between 0.05 and 7.5 mg/g and differed for each product. Out of the 15 types of IPS analysed, 8 (53.3%)

contained low amounts of oxalate < 0.5 mg/g; 5 (33.3%) contained moderate amounts of oxalate (0.5 mg/g to 1.0 mg/g) while 2 (13.3%) contained very high amounts of oxalate (> 2.0 mg/g).

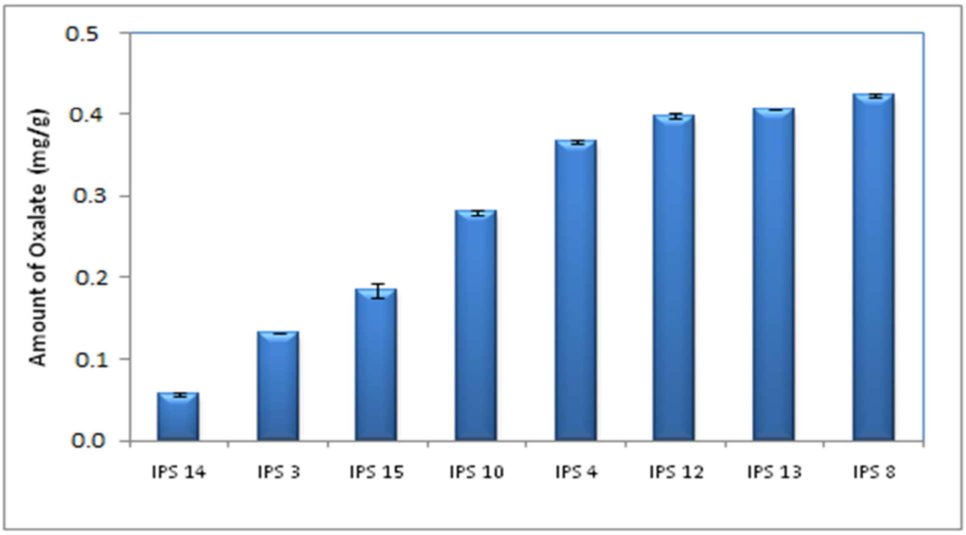

Figure 3: Industry Produced Spices (IPS) with low amounts of oxalate

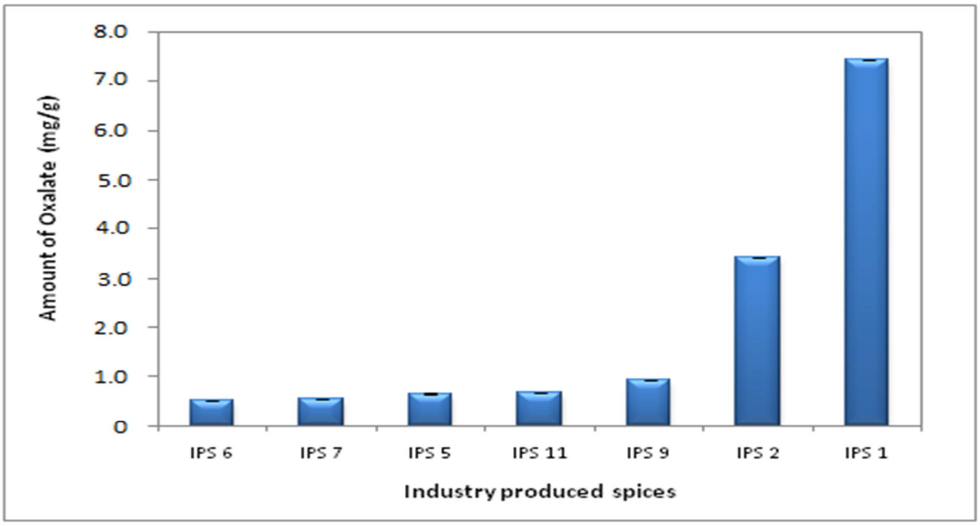

Figure 4: Industry Produced Spices (IPS) with moderate to high amounts of oxalate.

An association between the components of the Industry Produced Spices and their oxalate content was determined using a 'heat-map-like' table of presence and absence, Table 2. Of the 53 components identified for the 14 IPS studied, the following seven (7), Ginger, Paprika, Fenu greek, Nutmeg, Cumin, Coriander and Fennel, were observed to have been present only in spices that recorded amounts of oxalate of more than 3.0 mg/g of spice (Table 2). It was also observed that Corn powder, Tomato powder, Bonito powder and Cardamon were only present in spices with moderate amounts of oxalate (0.5 to 1.0 mg/g).

Table 2: Components and oxalate content of industry produced spices

	Spices													
INGREDIENTS	IPS14	IPS3	IPS15	IPS4	IPS12	IPS13	IPS8	IPS6	IPS7	IPS5	IPS11	IPS9	IPS2	IPS1
Sugar	1	1		1	1	1	1	1	1	1	1	1		
Salt	1		1	1	1	1	1	1		1			1	1
Starch	1	1		1	1	1		1		1	1	1		
Garlic	1		1	1					1	1	1	1	1	1
Flavour Enhancement (E621, E631,E627)		1	1				1	1	1		1	1		
Monosodium Glutamate	1	1		1	1	1				1				
Vegetable fat	1	1	1					1	1			1		
Pepper	1				1	1		1				1		
Turmeric						1			1				1	1
Dried/ dehydrated (onion &carrot)					1	1		1			1			
Spices			1				1		1		1			
Onion				1				1			1	1		
Iodated Salt		1							1		1	1		
Shrimp powder				1			1				1			
Flavourants							1		1		1			
Onion Powder				1		1				1				
Spice extracts							1		1			1		
Anti-caking Agent (E551)			1						1					
Glutamate								1		1		1		
Dextrin		1		1						1				
Fennel													1	1
Colourant (E150, E153,E172)							1				1			
Malt dextrin			1								1			
Corn Powder										1	1			
Maize							1		1					
Hydrolysed Vegetable Protein	1						1							
Coriander													1	1
Herbs			1						1					
Cumin													1	1
Nutmeg													1	1
Acidulants (E330, E363)			1						1					
Black Pepper Powder				1						1				
Chilli Pepper								1				1		
Fish Flavour		1			1									
Soy Sauce Powder				1						1				
Preservation											1			
Antioxidants											1			
Chicken Seasoning Powder				1										
Fenu Greek														1
Paprika													1	
Ginger													1	
Vegetables			1											
Tomato Powder								1						
Anchovy Powder										1				
Bonito Powder										1				
Disodium Inosinate		1												
Disodium Guanylate		1												
Water Colour (E150c)												1		
Free Flowing Agent (E551)												1		
Cardamon												1		
Inosinate guanylate												1		
Goat meat Flavour	1													
Curry													1	1
Oxalate Content (mg/g)	0.06	0.13	0.18	0.37	0.40	0.41	0.42	0.53	0.54	0.65	0.66	0.93	3.41	7.43

Dark gray = components associated with high oxalate content. Light gray = components associated with moderate oxalate content.

Similarly, unspecified components identified as preservatives, antioxidants, free flowing agents and water colour were observed to only be present in spices with moderate amount of oxalate. The two spices (IPS1 and IPS2) with the very high amounts of oxalate (>3.0 mg/g) were the only curry powder based spices studied.

A comparison of the average amount of oxalate obtained for the IPS and LS indicates that the indigenous spices contained more oxalate than the industry produced spices; nonetheless, the difference was not significant, $p > 0.05$ (Figure 5).

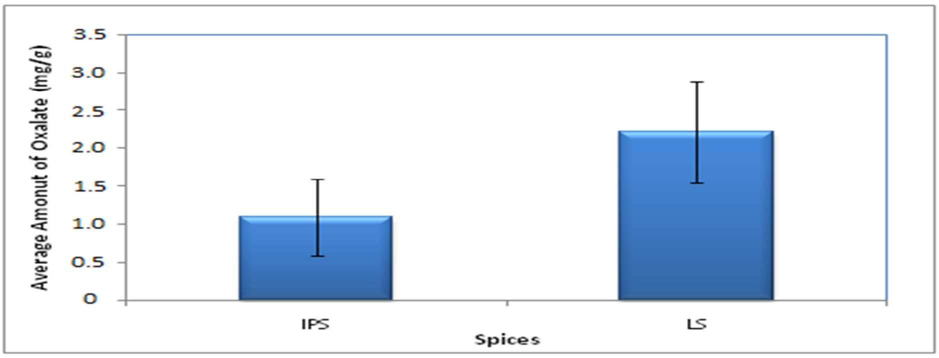

Figure 5: Average amounts of oxalate in industry produced spices (IPS) and indigenous spices LS.

The lower concentrations of oxalate in the industry produced spices compared to the indigenous spices generally brings to the fore the effect of processing on anti-nutritional factors. For example the author Aye PA, studied the effect of processing on nutrition and anti-nutrient and concluded thus: 'Processing techniques in the treatment of *Cnidoscolus aconitifolius* enhanced the proximate, mineral, energy and decreased anti-nutrients' (Aye, 2012). Processing therefore could account for the differences in the values obtained between the indigenous and industry produced spices. The in vivo levels will be worth considering since in the long run the indigenous spice is processed before consumption. It could therefore be speculated that prior to ingestion the levels of oxalate is attenuated and may not result in high oxalate related diseases.

3. Conclusions and Recommendations:

The presence of curry appears to be responsible for the presence of high oxalate in the industry produced spices. Alternative to curry based spices and seasonings or the reduction of their use could improve the nutritional value of food and is thus recommended.

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References

Achinewhu, S. C., Ogbonna, C. C., & Hart, A. D. 1995. Chemical composition of indigenous wild herbs, spices, fruits, nuts and leafy vegetables used as food. *Plant Foods for Human Nutrition*, *48*(4), 341-348.

Aye, P. A. 2012. Effect of processing on the nutritive characteristics, anti-nutritional factors and functional properties of Cnidoscolus aconitifolius leaves (Iyana Ipaja). *Am. J. Food. Nutr*, *2*(4), 89-95.

Bsc, S. Noonan. 1999. Oxalate content of foods and its effect on humans. *Asia Pacific Journal of Clinical Nutrition*, *8*(1), 64-74.

Charrier, M. J., Savage, G. P., & Vanhanen, L. 2002. Oxalate content and calcium binding capacity of tea and herbal teas. *Asia Pacific journal of clinical nutrition*, *11*(4), 298-301.

Fasset DW *Toxicants Occurring Naturally in Foods*. 2nd ed. Washington: Washington Academy of Sciences. 1973; 346-362.

Holmes, R. P., & Kennedy, M. 2000. Estimation of the oxalate content of foods and daily oxalate intake. *Kidney international*, *57*(4), 1662-1667.

Lampe, J. W. 2003. Spicing up a vegetarian diet: chemopreventive effects of phytochemicals. *American Journal of Clinical Nutrition,* 78(3): 579S-583S.

Lane, B. G. 1994. Oxalate, germin, and the extracellular matrix of higher plants. *The FASEB journal*, *8*(3), 294-301.

Leyva, J. A., Artiga, M. P., Méndez, M. M., & Pérez, J. J. 1990. Atomic absorption and UV-VIS absorption spectrophotometric determination of oxalate in urine by ligand exchange extraction. *Clinica chimica acta*, *195*(1), 47-56.

Ogunka-Nnoka, C. U., & Mepba, H. D. 2008. Proximate composition and Antinutrient contents of some common spices in Nigeria. *The Open Food Science Journal*, *2*, 62-62.

Oke, O. L. 1969. Oxalic acid in plants and in nutrition. *World review of nutrition and dietetics*, *10*, 262.

Ritter, M. M. C., & Savage, G. P. 2007. Soluble and insoluble oxalate content of nuts. *Journal of Food Composition and Analysis*, *20*(3), 169-174.

Satter, A., Wahid, M and Durrani, S. K. 1989. Concentration of selected heavy metals in spices, dry fruits and plants nuts. *Plant Food for Human Nutrition,* 39(4): 279-286.

Wikipedia, http://en.wikipedia.org/wiki:/spice/2004. Retrieved 28/08/2012