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Effects of cooking on the mineral and oxalate content of some legumes

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Abstract

The diet of many worldwide cultures depends heavily on various legumes. Legumes form an important item of the diet in developing countries that every effort should be made to retain the nutrition during cooking. The effect of cooking with water and coconut milk on the mineral (Na, K, Ca, Mg, Fe, Cu,Zn,Mn P) and oxalate content of some legumes *(Lenus culinaris, Vigna unguiculata Cajanus cajan, Glycine max, Cicer ariethium, Vigna mungo, Vigna radiata, Phosphocarpus tetragonolobus)* was investigated using a clay pot and a aluminium utensil.

In the case of all legumes investigated the greatest depletion was observed for K, the leaching out being greatest when the legumes were cooked in water as compared to coconut milk.The leaching out of Na was also greater in water than in coconut milk. Chick pea *(Cicer ariethium)* leached out the greatest amount of K. The greatest depletion in Na Content was observed for black gram or ulundu *(Vigna mungo)*. Cowpea *(Vingna unguiculata)* and winged bean *(Phosphocarpus tetragonolobus)* were found to have a tendency to retain most of the minerals when compared with other legumes. The loss of Fe was greater for soya bean *(Glycine max)* when cooked with water in a pan. A noteworthy decrease in Mn and Zn content of lentils *(Lenus culinaris)* and black gram or ulundu *(Vigna mungo)* were observed when cooked with water in a pot. The depletion in the Cu content was the highest for black gram or ulundu *(Vigna mungo)*. Only mung bean *(Vigna radiata)* showed a significant depletion in Ca content. The depletion in the P content of legumes was highest when cooked with water in a pan; mung bean *(Vigna radiata)* and Chick pea *(Cicer ariethium)* showing small losses. Yellow dhal *(Cajanus cajan)* and mung bean *(Vigna radiata)* showed the greatest retention in oxalate content when cooked with coconut milk.

Key words : legumes, nutrition, mineral, oxalate, content, effect of cooking

Introduction

All forms of living matter require many minerals for their life processes. The animal body requires many minerals (among them are Na, K, Ca, Mg,P) in relatively large amounts (gram quantities) and some (include Fe,Cu,Zn,Mn,)in lesser quantities (Ranken, 1984, Wickramanayake, 1987). It is important to recognize that, just as protieins, carbohydrates and fat do not play independent roles in human nutrition, the minerals are inter related and balanced against one another. The importance of these and other elements in maintaining a state of complete physical, mental and social wellbeing is well documented (Bamunuarachchi, 1984; Bell *et al* 1972; Davies, 1972;Evans, 1956;Fibane and Williams, 1977; Ranken, 1984; Williams, 1971; Williams and De Silva 1978).

The need to launch a fresh effort to gather information on Sri Lankan foods has been emphasized (Bamunuatachichi, 1984) and such work is currently in progress (Deraniyagala *et al*, 1994). Information is needed about the compositional changes associated with different methods of cooking to allow optimum nutrient retention.These data are needed by nutritionist, pediatricians and other medical personnel, dietitians, and by food and nutrition policy planners. A study of the effect of three methods of cooking on the nutrient content of *D. alata* and *D. esculenta* tubers have been reported (Wanasundera and Ravindran, 1992) The diet of many worldwide cultures depends heavily on various legumes. Legumes form an important part of the diet in developing countries, that every effort should be made to retain the nutrition during cooking. Legumes can be fitted into meal patterns in variety of ways. They may be eaten as the main dish or as a side dish in a vatriety of forms. They serve as a basis for soups, gruels, sauces and savoury snacks.

In the present investigation the effects of two methods of cooking using two different kinds of utensils, (viz. boiling with water and boiling with coconut milk in an aluminium pan and clay pot) on the mineral (Na,K,Ca,Mg,P,Fe,Cu,Zn,Mn,) and oxalate content was determined. The legumes used in the study were lentil *(Lenus culinaris)*, cowpea *(Vigna unguiculata)*, yellow dhal *(Cajanus cajan)*, soya bean *(Glycine max)*, chick pea *(Cicer ariethium)*, black gram or ulundu *(Vigna mungo)*,green gram or mung bean *(Vigna radiata)* and winged bean *(Phosphocarpus tetragonolobus)*. The cooking methods were designed to stimulate the domestic cooking methods generally employed in Sri Lanka to prepare legumes for the table. Cooking in a clay pot in a an open fire is very common among the villagers and the lower income groups of Sri Lanka, whereas the more affluent society use pans made of aluminium. Coconut milk is used to prepare legume curry for main meals to be consumed with rice. Boiling in water is mainly done for preparation of breakfast, side dishes or snacks.

2 Materials & methods

Sample Analysis

500g of each variety of legumes (lentil *(Lenus culinaris)*, cowpea *(Vigna unguiculata)* , yellow dhal *(Cajanus cajan)*, soya bean *(Glycine max)*, chick pea *(Cicer ariethium)*, black gram or ulundu *(Vigna mungo)*, green gram or mung bean *(Vigna radiata)* and winged bean *(Phosphocarpus tetragonolobus)* was purchased and used for the entire study. The legumes were rinsed free of dirt with deionized water and air dried.

5.0g of legume sample was used for cooking. Cooking was carried out in a newly bought and washed clay pot and an aluminium pan. The volume of water was kept the same for the analysis of all the legumes.Similarly the concentration and volume of coconut milk was also kept constant throughout the analysis. (Coconut milk was prepared by dissolving 24.0g of milk powder in in 100.0ml of distilled water). After cooking, the samples were drained with a strainer, allowed to dry and used for analysis. Cooking of each legume by each cooking method was carried out in triplicate. Analysis in triplicate was also carried out on the uncooked sample.

Metal Ion Analysis

All glassware were soaked overnight in dilute nitric acid and washed thoroughly with deionized water. Determination of the metal ion contents were carried out after digestion of the food sample with concentrated nitric and sulphuric acid by atomic absorption spectrophotometry (Osbane and Voogt, 1978). P was determined colorimetrcally using potassium dihydrogen phosphate as standard (Osbane and Voogt,1978). Total oxalate contents were determined by the methob of Abaza et al (1979)

Data were subject to analysis of variance and means were compared by Duncan's multiple range test at $P<0.05$ level.

The mineral contents are reported in mgs per 100g fresh weight of legume.

The results of the metal ion and oxalate analysis on the fresh legumes and the cooked legumes (with water and coconut milk in clay pot and pan) are summarized in Tables 1-8.

3 Results and Discussion

Diseased states arising from the lack of minerals is well documented (Bamunuarachi, 1984; Bell *et al* 1972; Davies, 1972;Evans, 1956; Fibane and Williams, 1977; Ranken, 1984; Williams, 1971;Willams and De Silva 1978). Even recent research (PACTSEH 1993), has shown that low Mg diets could be linked to diabetes, high blood pressure, pregnancy problems and cardiovascular diseases. Symptoms such as weakness, leg cramps, anxiety, irritability and confusion are reported to clear up with Mg therapy. Mg is said to activate 76%of the enzymes in the body. In order to maintain a complete state of health, the minerals are inter-related and balanced against one another. K is primarily concerned with the way in which the human body use Ca and Na. A patient with a K deficiency will also be depleted in Mg. A diet that is high in Ca increases the body's need for Mg and may also increase the excretion of P and Ca (PACTSEH, 1993), Ca and P are in a defined relationship in the formation of bones and teeth (Wickramanayake, 1987). Oxalates are present in legumes and are of interest because of the adverse effect of oxalate on Ca utilization. Na, K, Mg, Phosphate and chloride ions serve individual and collective purposes in the control of body fluids. A deficiency in one mineral may cause a deficiency in another. Cu deficiency may cause a physiological deficiency of Fe. Zn deficiency may cause a Cu deficiency (Wickramanayake, 1987). Not only are the minerals inter-related, but they control the metabolism of proteins, fats and carbohydrates: e.g Mg helps in the use of fat in the diet. The higher the amount of protein consumed, the more Mg is needed (PACTSEH, 1993), Grain legumes and cereals are reported to contain signficant amount of Phytate (400-2060 mg/1000g). Phytic acid not only lowers the availability of P to humans, but also adversely affects the utilization of Ca, Zn, Fe and Mg through the formation of insoluble complexes. Cooking has been reported to lower the phytate levels in grain legumes (Wanasundera and Ravindran, 1992). It is also suggested that the phytate removal by cooking is low when it is associated with proteins and/or cations (Wanasundera and Ravindran, 1992). Therefore, the retention of minerals during cooking processes should be of nutritional concern specially when legumes are consumed as the staple food. Hence, it is important for users of food tables to have some information about the changes in the nutritionally important minerals content of these legumes, during the cooking process.

The effect of cooking on lentils *(Lenus culinaris)* is summarized in Table 1. In the case of lentils Ca was the only mineral that did not show a significant ($P<0.05$) reduction during cooking with any of the methods employed. The K content of lentils was greatly depleted during all cooking methods (56% depletion when cooked with water in a pot).The greatest leaching of Mg (32%), Mn(42%) and Zn(34%) was observed when lentils were cooked with water in a pot; Cu leached to the extent of 22% whereas Na leached out only to the extent of 11% when cooked with water in a pot. Cooking with water in a clay pot brought about the greaest reducition in the K, Mg, Mn and Zn content. However, it is possible that the lentils may have absorbed these minerals from the coconut milk thereby showing a less reduction in the Mg, Mn and Zn content of lentils when cooked in coconut milk. The loss in oxalate content was between 31- 26%; the difference between different cooking methods was not significant ($P<0.05$). The P content of lentils was depleted by 21% when cooked with water in a pan.

In the case of chick pea *(Cicer ariethium)* (Table 2) there was a high reduction (64%)in the K content when cooked with water in a pan. Significant reductions were also noted in Na (30%) and Mg (23%) when cooked with water in a pan. The depletion of Cu was also observed (32-26%) but there was no significant difference between cooking methods. The loss in oxalate ranged between 34-09%; the loss being a minimum when cooked with coconut milk in a pot. The difference between other three methods was not significant ($P<0.05$). The loss in the P content was only 16%, that too when cooked with water in a pan.

Table 1 Mineral and Oxalate Content of Lentils (*Lenus culinaris*)

Minerals	Fresh	Cooked in H_2O in a pot	Cooked in H_2O in a pan	Cooked in C.milk in a pot	Cooked in C.milk in a pan
K	305.8±2.0a	135.0±1.0b	213.0±1.0c	142.0±1.0d	156.00±1.0e
Na	9.3±0.8b	8.3±0.3a	9.2±0.3b	9.2±0.2b	9.4±0.2b
Ca	12.7±1.0a	11.6±1.0a	10.7±1.1a	11.8±1.0a	11.7±0.5a
Mg	56.7±5.0a	38.2±2.0b	48.7±1.0c	42.3±1.0d	44.3±1.0d
Fe	3.7±0.0a	3.6±0.0b	3.5±0.0c	3.7±0.1d	3.5±0.1c
Mn	1.3±0.0a	0.7±0.0b	0.8±0.1c	0.9±0.0c	0.9±0.0c
Cu	1.1±0.0a	0.8±0.0b	0.1±0.0b	0.9±0.1c	0.9±0.0b
Zn	37.6±0.0a	24.7±0.5b	26.7±0.5c	28.8±0.0d	29.3±0.5d
P	169.3±1.0a	165.2±1.2b	132.3±1.0c	165.0±1.5b	166.0±1.0b
Oxalale	435.0±40.0a	311.3±32.0b,c	298.3±51.0b	351.3±24.0c,d	323.7±31.0b,d

All values are in mgs per 100g of edible portion.

All values represent mean± standard deviation of analysis of 3 samples.

Means followed by different letters (a,b,c....) within a row are significatly different ($P<0.05$) by Duncan's multple range test.

Table 2 Mineral and Oxalate Content of Chick pea *(Cier ariethium)*

	Fresh	Cooked in H_2O in a pot	Cooked in H_2O in a pan	Cooked in C. milk in a pot	Cooked in C. milk in a pan
K	535.0±10.0a	350.8±7.0b	310.5±2.0c	369.9±1.0d	382.3±1.0e
Na	16.6±0.6a	11.7±0.0b	19.7±1.1c	14.3±0.3d	15.0±0.1d
Ca	41.7±2.0a,b	44.0±3.0c	43.0±0.5a,c	39.8±1.0d,b	38.9±0.5d
Mg	200.0±2.0a	155.0±2.0b	178.0±2.0c	162.4±2.0d	173.±40.4b,c
Fe	3.7±0.0a	3.4±0.0b	3.2±0.0c	3.5±0.5a,b	3.7±0.4b,c
Mn	2.5±0.2a	2.3±0.5b	2.1±0.0c	2.4±0.0a,b	2.4±0.1a,b
Cu	0.5±0.1a	0.4±0.1b	0.4±0.0b	0.4±0.0b	0.4±0.0b
Zn	33.5±0.5a	29.5±0.5b	26.0±0.5c	30.7±1.0d	31.4±0.5e
P	209.0±6.1a	202.4±1.4b	170.1±1.0c	203.1±1.0b	203.0±3.6b
Oxalate	466.3±35.0a	326.3±20.1b	309.3±24.0b	423.1±36.1c	327.5±21.3b

All values are in mgs per 100g of edible portion.
All values represent mean±standard deviation of analysis of 3 samples
Means followed by different letters within a row are significantly different (P<0.05) by Duncan's multiple range test.

Soya bean*(Glycine max)* (Table 3) also showed a high reduction in the K content (54% when cooked with water in a pot). The greatest depletion in Mg (35%) was also noted when cooked with water in a pot. The depletion in Fe content (46% with water in a pan) was the highest depletion noted in the Fe contents among the legumes investigated. The loss in oxalate content ranged between 22-34%; the loss when cooked with water was greater than when cooked with coconut milk. P was lost to the extent of 49% in this case when cooked with water in a pan. The loss with other cooking methods was less than this.

Table 3 Mineral and Oxalate Content of Soya bean *(Glycine max)*

Mineral	Fresh	Cooked in H_2O in a pot	Cooked in H_2O in a pan	Cooked in C. milk in a pot	Cooked in C. milk in a pan
K	477.2±3.0a	218.0±5.0b	291.3±6.0c	333.7±1.0d	347.5±1.0d
Na	9.0±0.5a	7.3±0.3b	7.2±0.5b	10.3±0.5c	11.2±0.3d
Ca	141.7±10.0a	136.7±7.0a,b	130.0±5.0b	138.5±1.0a,b	138.3±1.0a,b
Mg	289.8±3.0a	188.3±3.0b	200.0±2.0c	212.0±2.0a	227.0±1.0d
Fe	5.9±0.1a	4.5±0.0b	3.3±0.1c	4.7±0.5b	4.6±0.5b
Mn	3.1±0.1a	2.9±0.1a,b,c	2.7±0.1b	2.7±0.1b,c	3.0±0.0a,c
Cu	1.4±0.0a	1.3±0.1b	1.2±0.0c	1.3±0.0b	1.3±0.1b
Zn	38.0±0.1a	31.2±1.0b	33.5±0.1c	36.1±0.1d	37.5±0.5a,d
P	473.0± 5.0a	268.1±3.2b	241.7±2.0c	351.7±2.7d	367.2±2.0e
Oxalate	539.3±40.0a	378.3±31.0b	356.7±35.0b	419.7±24.0c	413.3±28.0c

All values are in mgs per 100 g of edible portion.
All values represent mean± standard deviation of analysis of 3 samples
Means follwed by different lerrers (a,b,c...) within a row are significantly different (P<0.05)by Duncan's multiple range test.

In the case of black gram or ulundu *(Vigno mungo)* (Table 4) there was ca 52% decrease in the K content when cooked with water. The greatest depletion in the Na (47%) and Cu (48%) contents were noted for Ulundu when cooked with water in a pot. The depletion in Zn content (31%when cooked with water) is also noteworthy. The loss in oxalate content was between 13-28%; the retention of oxalate being greatest when cooked with coconut milk in a pot. Ulundu showed 36% reduction in P content when cooked with water in a pan, the highest reduction observed among the cooking methods

Table 4 Mineral and Oxalate Content of Black gram or Ulundu *(Vigna mungo)*

Mineral	Fresh	Cooked in H_2O in a pot	Cooked in H_2O in a pan	Cooked in C.milk in a pot	Cooked in c.milk in a pan
K	442.5±3.0a	222.5±2.0b	212.7±2.0c	305.7±1.0d	312±2.0e
Na	15.1±0.5a	9.9±0.3b	7.9±0.5c	12.4±0.4d	13.3±0.5e
Ca	21.0±1.0a	18.9±1.0b	19.1±1.0b	19.1±0.5b	18.9±0.5b
Mg	225.8±5.5a	157.5±3.0b	167.8±3.0c	181.5±1.0d	197.3±1.0e
Fe	3.5±0.1a	3.4±0.0b	3.2±0.0b	3.5±0.0c	3.4±0.1b
Mn	2.0±0.1a	1.6±0.1b	1.9±0.0c	2.0±0.0a	2.0±0.1a
Cu	0.7±0.1a	0.5±0.0b	0.4±0.0c	0.5±0.0b	0.5±0.0b
Zn	44.0±1.0a	32.1±1.0b	30.5±1.0b	39.3±0.5c	39.3±1.0c
P	425.0±4.0a	322.5±2.0b	281.5±2.0c	351.5±1.0d	367.0±2.0e
Oxalate	568.3±27.0a	422.0±32.0b,c	406.7±28.0b	496.3±28.0b	435.3±30.0c

All values are in mgs per 100 g of edible portion

All values represent mean± standard deviation of analysis of 3 samples

Means follwed by diferent letters (a,b,c.....) within a row are significantly diefferent ($P<0.05$) by Duncan's multiple range test.

It is interesting to note that the loss in mineral content during cooking was a minimum with cowpea *(Vigna unguiculata)* (Table 5) and winged bean *(Phosphocarpus tetragonolobus)* (Table 6). The greatest loss in mineral content was that of Na (21%in cowpea and 16% in winged bean when cooked with water in a pot). Cowpea and winged bean did not show a significant loss of K and Mg when compared with other legumes. In the case of winged bean the depletion in the oxalate content was between 12-36%,The loss when cooked with water was greater than when cooked with coconut milk. The greatest retention was when cooked with coconut milk in a pot. A similar loss of oxalate was observed for cowpea (15-32%), the greatest loss being observed when cooked with water in a pan.

Winged bean showed a 47% reduction in P content whereas cowpea showed only a 20% reduction when cooked with water in a pan.

Table 5 Mineral and Oxalate Content of Cowpea *(Vigna unguiculate)*

Mineral	Fesh	Cooked in H_2O in a pot	Cooked in H_2O in a pan	Cooked in C.milk in a pot	Cooked in C.milk in a pan
K	425.0±1.0a	420.3±1.0b	415.0±1.0c	414.7±1.0c	420.8±2.0d
Na	10.3±1.0a	8.1±0b	9.4±1.0c	9.2±0.5c	9.2±0.1c
Ca	16.2±2.0a	16.3±0.0a	1.5±0.0a	1.5±0.0a	1.5±0.1a
Mg	150.3±1.0a	145.0±1.0b	143.3±1.0b	142.7±1.0b	142.7±1.b
Fe	4.7±0.1a	4.3±0.1b	4.1±0.1b	4.2±0.1b	4.1±0.1b
Mn	1.8±1.0a	1.6±1.0a	1.6±0.5a	1.6±0.5a	1.6±0.1a
Cu	1.6±0.1a	1.5±0.1a	1.5±0.0a	1.5±0.0a	1.5±0.1a
Zn	25.4±1.0a	22.9±1.ob	23.4±1.0b	23.2±0.5b	22.4±1.0b
P	273.0±5.0a	228.4±2.0b	212.5±3.0c	248.0±2.0d	257.5±6.0e
Oxalate	627.0±40.0a	478.3±30.0b	424.1±28.oc	535.3±35.0d	489.2±28.0b

All values are in mgs per 100 g edible portion.
All values represent mean± standard deviation of analysis of 3 samples
Means followed by different letters (a,b,c...) within a row are significaerent different ($p<0.05$) by Duncan's multiple renge test.

Table 6 Mineral and Oxalate content of Winged bean *(Phosphocorpus tetragonolobus)*

Mineral	Fresh	Cooked in H_2O in a pot	Cooked in H_2O in a pot	Cooked in C. milk in a pot	Cooked in C. milk in a pan
K	527.3±1.oa	520.1±1.0b	521.0±1.0b	525.7±1.0c	525.0±2.0a,c
Na	20.4±1.0a	17.1±1.0b91	18.4±0.5c	18.3±0.5c	19.3±0.1d
Ca	65.3±0.1a	63.1±0.1a	64.3±4.0a	64.5±1.0a	64.3±1.0a
Mg	295.0±1.0a	285.3±1.0b,c	278.1±1.0b,d	271.3±3.0d	281.1±1.0b
Fe	15.6±0.1a	14.0±0.0b	10.3±0.1b	15.0±1.0d,a	14.7±1.0d
Mn	3.3±1.0a	2.4±1.0b	2.5±1.0b	2.9±0.1a,b	2.8±0.5a,b
Zn	48.5±0.5a	42.2±1.0b,c	43.3±1.0c,d	41.5±1.0b	43.0±1.0d
P	468.0±6.0a	384.0±2.0b	366.6±2.0c	391.0±3.0d	257.0±4.0e
Oxalate	551.7±45.0a	378.3±35.0b	300.67±45.0b	486.0±40.0d	452.67±40.0d

All values are in mgs per 100 g of edible portion.
All values represent mean± standard deviation of analysis of 3 samples
Means followed by different letters (a,b,c...) wtihin a row are significantly different ($P<0.05$)by Duncan's multiple range test.

The greatest depletion of K in Yellow dhal *(Cajanus cajan)* (Table7) was observed on cooking with water in a pot (28%) The loss in oxalate content was between 12-25% for yellow dhal. A 40% depletion in the P content was observed when cooked with water in a pan.

Table 7 Mineral and Oxalate content of Yellow Dhal *(Cajanus cajan)*

Minearl	Fresh	Cooked in H_2O in a pot	Cooked inH_2O in a pan	Cooked in C.milk in a pot	Cooked in C.milkinapan
K	244.2±3.0a	175.5±2.0b	218.3±2.0c	196.0±1.0d	210.0±2.0e
Na	10.0±0.5a	8.7±1.0b	12.1±0.5c	9.2±0.4d	9.3±0.5d
Ca	14.0±2.0a,b	13.0±1.0a	14.7±0.1b	14.0±1.0a	13.5±0.1a,b
Mg	71.0±1.0a	61.0±1.0b	68.7±1.0c	63.8±2.0d	64.0±1.0d
Fe	2.7±0.0a	2.4±0.0b	3.2±0.1c	2.3±0.1b	2.4±2.0b
Mn	0.8±0.1a	0.8±0.1b	0.7±0.6a	0.8±0.06	0.8±0.1b
Cu	0.4±0.0a	0.4±0.0b	0.4±0.0b	0.4±0.0b	0.4±0.0b
Zn	17.0±1.0a	14.0±5.0b	15.0±1.0c	16.3±0.5a	0.8±0.lb
P	318.0±4.0a	226.0±1.0b	208.5±1.0c	228.0±3.0b	247.5±4.0d
Oxalate	570.3±27.0a	446.7±27.2b	428.3±36.ob	500.3±24.1c	451.3±34.0b

All values are in per 100 g of edible portion.
All values represent mean±standard deviation of analysis of 3 samples
Means followed by different letters (a,b,c....) within a row are significantly different ($P<0.05$)by Duncan's multiple range test.

Green gram or mung bean *(Vigna radiata)* (Table 8) showed a 23% loss in K when cooked with water in a pot. There was a 32% loss in Cu when cooked with water in a pot. Of the legumes investigated mung bean also showed the greatest decrease in Ca content (21%). The loss in oxalate content was between 15-42%. The loss in P content was 16% when cooked with water in a pan

Table 8 Mineral and Oxalate Content of Green geana Mung bean(*Vigna radaita)*

Muberal	Fresh	Cooked in H_2O in a pot	Cooked in H_2O in a pan	Cooked in C. milk in a pot	Cooked in C.milk in a pan
K	457.2±7.0a	348.8±2.0b	398.8±2.0c	373.0±1.0d	394.5±1.0e
Na	10.2±0.5a	9.6±0.5c	12.1±1.0d	10.1±0.1a	10.1±0.2a,c
Ca	29.3±1.0a	22.9±2.0b	24.3±3.0b,c	25.3±1.0c	23.7±1.0b
Mg	193.8±3.0a	165.0±2.0b	173.7±2.0c	166.5±1.0b	158.4±1.0d
Fe	3.7±0.1a	3.4±0.0a	3.2±0.0a	3.7±0.1a	3.5±0.5a
Mu	1.4±0.0a	1.3±0.0b	1.4±0.0a	1.4±0.0a	1.4±0.1a
Cu	1.1±0.0a	0.8±0.1b	0.9±0.0c	0.8±0.1c	0.9±0.0c
Zn	28.8±0.5a	25.8±1.0b,c	24.5±1.0c	26.4±0.1c,d	25.5±0.6c,d
P	267.5±6.0a	247.3±4.0b	242.0±1.0b	251.0±2.0c	255.5±2.0c
Oxalate	381.3±65.0a	250.7±25.0b, c	220.0±40.0b	328.7±42.0d	269.3±36.0

All values are in mgs per 100 g of edible portion.
All values represent mean±standard deviation of analysis of 3 samples
Means followed by different letters (a,b,c....) within a row are significantly different ($P<0.05$) by Duncan's multiple test.

The overall results indicate that the largest depletion in mineral content was observed with K and that the tendency for loss of K when cooked with water was greater than when cooked with coconut milk; although it was not possible to distinguish between the types of utensils.

Depletion in Na content was also greater when cooked with water. Compared to the other legumes investigated cowpea *(Vigna unguiculata)* and winged bean *phosphocarpus tetragonolobus* were found to retain most of the minerals (except P in the case of winged bean).

The greatest loss in Fe content was for soya bean *(Glycine max)* when cooked with water in a pan. There was a noteworthy decrease in Mn and Zn content of lentils *(Lenus culinaris)* and black gram or ulundu *(Vigna mungo)* when cooked with water in a pot. Depletion of Ca was only noteworthy in the case of green gram or mung bean. *(Vigna radiata)*.

Cu depletion was highest for ulundu *(Vigno mungo)* and to a lesser but noteworthy extent for mung bean *(Vigna radiata)*. Mung bean (14%) and Chick pea *(Cicer ariethium)* (16%) showed the least depletion in P content when cooked with water in a pan. The depletion of P for all legumes was highest when cooked with water in a pan. In both yellow dhal *Cajanu cajan* and mung bean *Vigna radiata* the greatest retention of oxalate in legumes was observed when they were cooked with coconut milk in a pot.

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