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Short Communication

Mineral Contents of Bran and Kernel of Rice Grains as Affected by Fertilization

H.M.A.J. Herath, G.A.P. Chandrasekara[1*], U. Pulenthiraj[1], C.M.N.R. Chandrasekara[2] and D.G.N.G. Wijesinghe[3]

Postgraduate Institute of Agriculture
University of Peradeniya
Sri Lanka

ABSTRACT: *Application of inorganic fertilizers may incorporate minerals into rice grains. Distribution of minerals in rice grains vary in bran and kernel. The aim of the present study was to compare mineral contents (MCs) of bran and kernels of selected newly improved rice varieties in Sri Lanka with and without fertilizer applications. Twenty rice varieties were tested. Rice bran and rice kernels were analyzed for Ca, Mg, Mn and Zn using Atomic Absorption Spectrophotometer. Calcium contents of brans and kernels ranged from 952 to 1605 mg/kg and 613 to 1107 mg/kg dry matter in fertilized varieties, respectively. High MCs were observed in fertilizer applied varieties. Higher MCs were found in the bran of rice grains. The MCs of rice grains were significantly different among the varieties and affected by fertilizer application and processing. Applications of inorganic fertilizers strengthened the MCs of rice kernels and bran.*

Keywords*: Bran, fertilizer, kernel, minerals*

INTRODUCTION

Cereals are the edible grains of *Gramineae* family. There are a variety of cereals including rice, wheat, rye, oats, barley, maize, millet and sorghum. Rice is the staple food for more than half of the worlds' population being the second most leading cereal next to wheat worldwide (Anjum *et al*., 2007). Rice grain provides 75-80% of starch, 12% water, 7% of protein, fats, B vitamins mainly thiamine, riboflavin and niacin and minerals such as calcium, magnesium, phosphorus, manganese, copper, and iron (Oko *et al*., 2012). The prominent cultivating species of rice in Sri Lanka is *Oryza sativa.*

Minerals are essential nutrients for human growth and development. They play a vital role in the effective functioning of the human systems. Calcium and Mg are known as major minerals which require >100 mg/day for the body functions. Zinc and Mn are known as trace minerals which require <100 mg/day. One of the major reasons for the loss of essential micronutrients from rice is high polishing rate (Abbas *et al*., 2011). Department of Agriculture has introduced newly developed rice varieties having higher yield potential, pest and disease resistance, response to fertilizers and better grain quality. The growing environment has a great influence

[1] Department of Applied Nutrition, Faculty of Livestock, Fisheries and Nutrition Wayamba University of Sri Lanka, 60170, Sri Lanka
[2] Department of Agriculture, Sri Lanka School of Agriculture, Kundasale, Sri Lanka;
[3] Department of Food Science and Technology, Faculty of Agriculture, University of Peradeniya, Sri Lanka
* Corresponding author: anomapriyan@yahoo.ca

on the composition of the rice grain. (Abbas *et al*., 2011). Urea, Triple Super Phosphate and Muriate of potash are the three key chemical fertilizers used in Sri Lanka (Ekanayake, 2009). These chemical fertilizers commonly consist of three major components, namely as N, P and K. Calcium is an important mineral for the synthesis of skeletal functions. Mg is a significant facilitator for many of the biochemical functions. Manganese and Zn which are identified as trace minerals are important for many of the physiological functions.

The aim of the current study was to determine the impact of the application of fertilizers on the mineral contents (MCs) of bran and kernel fractions of newly improved rice varieties in Sri Lanka.

METHODOLOGY

Sample preparation

Random sampling method was used to obtain rice grain samples from the fields in Rice Research and Development Institute in Bathalagoda. Twenty fertilized (Urea, Muriate of Potash and Triple Super Phosphate at the rates of 225, 60, 55 kg/ha, respectively) and non-fertilized rice varieties namely, *At 353, At 362, At 303, H4, Bw 276 - 6B, Ld 368, Bg 450, Bg 400 - 1, Bg 360, Bg 94 - 1, Bg 379 - 2, Bg 300, Bg 305, Bg 357, Bw 367, Bw 451, Ld 371, At 306, At 309* and *At 405* were used. Three representative samples from each variety were obtained. Rice samples were dehusked using a rice milling machine (Rice machine, Satake Engineering Co Ltd, Japan). The whole grains were polished (up to 90%) with a rice miller (Rice husker and polisher PM 500, Satake Engineering Co Ltd, Japan). Milling and polishing processes were performed at the Institute of Postharvest Technology of Sri Lanka, Anuradhapura. Rice grains and bran were separately collected. Polished raw rice grains (kernels) were finely ground using a grinder (Phillips HR 2011, Koninklijke Phillips Electronics N.V., China). Then the samples were passed through a sieve with the mesh size of 1 mm. Kernels and bran samples were oven dried at 105ºC until achieving a constant weight to remove moisture. All the samples were stored in a freezer (DW-86L626 Haier, U.K.) at 80 ºC until further analysis.

Determination of MCs

A 0.5 g sample was measured into a microwave digestion vessel using a top loading balance (Adventurer^{TM} OHAUS, U.S.A.), followed by addition of 2 ml of concentrated HCl (35%) and 2 ml of concentrated HNO_3 (69%). The mixture was allowed to predigest. Then the mixture was digested for one hour using microwave digestion system (MARS 6 One touch technology CEM Corporation, North Carolina). The digested samples were filtered and volumerized to 50 ml using deionized water. Mineral contents were determined using Atomic Absorption Spectrophotometry (iCETM 3000 series Thermo Scientific, USA). A series of standards for selected minerals were prepared from the standard stock solutions (1000 mg/l) of corresponding minerals as 1 mg/l, 2 mg/l and 3 mg/l. The MCs were calculated on dry matter basis. All the samples were analyzed in triplicates.

Statistical Analysis

The differences of mean values of MCs among fertilized and non-fertilized kernels and brans were determined using multivariate analysis of variance (MANOVA) followed by Tukey's

Honestly Significant Differences (HSD) multiple rank test at $P \leq 0.05$ significance level. Statistical analysis were done using SPSS version (16.0).

RESULTS AND DISCUSSION

Calcium, Mg, Mn and Zn contents of rice varieties constituted of red and white pericarps are given in Tables 1 to 3. In general, higher Ca, Mg, Mn and Zn contents were observed in the bran than in the kernel for all the rice varieties with red pericarp (Table 1). The Zn and Mn contents of the rice varieties were comparatively lower than the Ca and Mg contents (Table 3). Further, Ca, Mg, Mn and Zn contents of the brans and the kernels of rice varieties grown with fertilizers were higher than those of corresponding rice varieties grown without fertilizers.

Ca content of rice varieties

The bran fraction of fertilizer added rice showed a range of Ca contents varying from 1368 to 1911mg/kg (Table 1). The kernels of rice grains with red pericarp grown with fertilizers had Ca contents ranging from 613 to 1107 mg/kg. The variety, BG 305 reported the highest content of Ca in bran and kernels of rice grains grown with fertilizers, whereas BW 451 and AT 309 had the highest contents of Ca in the bran and kernels of grains grown without fertilizers.

Mg content of rice varieties

The Mg contents of kernels were 224-655 and 237-452 mg/kg in rice grown with and without fertilizers, respectively. In AT 362, AT 303 and H4 red rice varieties, the kernels of rice grains grown without fertilizers had higher Mg contents than those grown with fertilizers. The range of Mg contents of rice bran and kernel with white pericarp ranged from 1230 to 1068 and from 487 to 212 mg/kg, respectively.

Zn content of rice varieties

Brans of rice grains with red pericarp grown with and without fertilizers had Zn contents ranging from 121-192 and 123-163 mg/kg, respectively. Kernels of rice with red pericarp grown with and without fertilizers had Zn contents ranging from 15 to 26 mg/kg. The Zn contents of kernels were 6 to10 times lower than that of bran of rice with red pericarp. Among the bran of rice grains grown without fertilizers, AT 309 had the highest (210.5 mg/kg) and BG 360 had the lowest (106.7 mg/kg) Zn contents. The rice varieties, except AT 309, AT 306, BG 300 and BG 379-2, explicated significantly higher Zn contents in bran of grains grown with fertilizers compared to those grown without fertilizers ($P<0.05$).

Mn content of rice varieties

The variety, LD 368 reported the highest content of Mn in the bran of rice varieties with red pericarp grown with and without fertilizers, whereas BW 276-6B had the highest content of Mn in the kernels (Table 1). The Mn contents of bran of rice grains grown with fertilizers ranged from 214 to 131 mg/kg. The variety, BG 450 had the highest Mn content among the varieties grown without fertilizers (Table 3).

Table 1. Mean calcium, magnesium, zinc and manganese contents of rice varieties with red pericarp (mg/kg)

Rice Variety	Grown with fertilizers		Grown without fertilizers	
	Bran	Kernel	Bran	Kernel
		Calcium		
AT 353	1368.4 ± 29.3^{a1}	$682.5 \pm 6.6^{b*}$	904.9 ± 15.5^{c2}	$545.6 \pm 8.2^{d\#}$
AT 362	1428.6 ± 8.2^{a1}	$696.4 \pm 7.7^{b*}$	903.8 ± 4.5^{c2}	$520.7 \pm 7.4^{d\#}$
AT 303	1604.9 ± 17.1^{a1}	$613.4 \pm 12.5^{b*}$	749.5 ± 12.2^{c2}	$690.9 \pm 17.1^{c\#}$
H4	1571.6 ± 31.5^{a1}	$616.4 \pm 4.6^{b*}$	689.1 ± 13.7^{c2}	$589.6 \pm 8.2^{c\#}$
BW 276-6B	1486.3 ± 14.5^{a1}	$1107.2 \pm 11.7^{b*}$	671.7 ± 2.2^{c2}	$561.7 \pm 6.8^{c\#}$
LD 368	1911.1 ± 2.7^{a1}	$730.1 \pm 4.4^{b*}$	836.2 ± 18.0^{c2}	$560.0 \pm 6.2^{d\#}$
		Magnesium		
AT 353	1208.5 ± 6.8^{a1}	$279.2 \pm 0.4^{b*}$	1157.5 ± 6.3^{c2}	$242.2 \pm 1.2^{d\#}$
AT 362	1206.5 ± 0.6^{a1}	$224.4 \pm 2.6^{b*}$	1175.3 ± 6.5^{c2}	$271.9 \pm 1.8^{d\#}$
AT 303	1203.8 ± 12.5^{a1}	$240.8 \pm 2.1^{b*}$	1112.9 ± 6.2^{c2}	$287.6 \pm 1.0^{d\#}$
H4	1181.6 ± 6.0^{a1}	$223.8 \pm 0.6^{b*}$	1117.4 ± 11.4^{c2}	$237.0 \pm 1.6^{d\#}$
BW 276-6B	1176.9 ± 13.0^{a1}	$655.0 \pm 6.7^{b*}$	1094.2 ± 10.5^{c2}	$452.3 \pm 2.8^{d\#}$
LD 368	1204.5 ± 6.6^{a1}	$410.1 \pm 1.4^{b*}$	1162.2 ± 11.5^{c2}	$344.5 \pm 2.2^{d\#}$
		Zinc		
AT 353	127.5 ± 1.2^{a1}	$17.5 \pm 0.4^{b*}$	$153.5 \pm 0.7^{c*}$	$16.1 \pm 0.1^{d\#}$
AT 362	192.2 ± 1.6^{a1}	$21.5 \pm 0.2^{b*}$	$152.0 \pm 1.8^{c*}$	$18.5 \pm 0.3^{d\#}$
AT 303	121.1 ± 1.9^{a1}	$15.1 \pm 0.4^{b*}$	$163.1 \pm 1.3^{c*}$	$24.6 \pm 0.2^{d\#}$
H4	188.1 ± 1.4^{a1}	$24.8 \pm 0.2^{b*}$	$128.7 \pm 1.0^{c*}$	$22.9 \pm 0.3^{d\#}$
BW 276-6B	144.3 ± 0.8^{a1}	$23.5 \pm 0.2^{b*}$	$122.8 \pm 1.0^{c*}$	$26.4 \pm 0.2^{d\#}$
LD 368	154.7 ± 0.6^{a1}	$18.4 \pm 0.1^{b*}$	$130.3 \pm 0.7^{c*}$	$22.4 \pm 0.4^{d\#}$
		Manganese		
AT 353	122.0 ± 1.6^{a1}	$20.6 \pm 0.8^{b*}$	99.5 ± 2.2^{a1}	$16.8 \pm 0.4^{c\#}$
AT 362	157.5 ± 1.5^{a1}	$22.1 \pm 1.2^{b*}$	120.6 ± 1.3^{c2}	$18.7 \pm 0.8^{d\#}$
AT 303	126.1 ± 0.7^{a1}	$20.0 \pm 0.8^{b*}$	106.3 ± 2.3^{a1}	$19.8 \pm 1.7^{c\#}$
H4	125.9 ± 0.6^{a1}	$21.7 \pm 1.2^{b*}$	106.6 ± 1.5^{a1}	$21.5 \pm 1.4^{c\#}$
BW 276-6B	203.2 ± 2.5^{a1}	$29.2 \pm 0.6^{b*}$	121.8 ± 1.0^{c2}	$24.3 \pm 0.9^{d\#}$
LD 368	273.1 ± 2.8^{a1}	$25.1 \pm 1.0^{b*}$	176.5 ± 1.7^{c2}	$26.6 \pm 1.0^{d\#}$

All the values are given in dry matter basis. Means in the same row followed by different digits (fertilized bran: fertilized kernel) /letters (fertilized bran: fertilized kernel)/symbols (fertilized kernel: non-fertilized kernel) are significantly different at 95% confidence level (p>0.05)

Table 2. Mean calcium and magnesium contents of rice varieties with white pericarp (mg/kg)

Rice variety	Grown with fertilizers		Grown without fertilizers	
	Bran	Kernel	Bran	Kernel
		Calcium		
BG 450	1296.0 ± 29.6^{a1}	772.5 ± 10.0^{b*}	675.3 ± 14.1^{c2}	620.4 ± 2.5$^{c\#}$
BG400-1	1325.6 ± 32.9^{a1}	670.5 ± 17.5^{b*}	552.4 ± 5.3^{c2}	167.8 ± 50.1$^{d\#}$
BG 360	1467.8 ± 4.9^{a1}	693.7 ± 13.2^{b*}	593.8 ± 8.0^{c2}	760.5 ± 0.7$^{d\#}$
BG 94-1	1380.7 ± 17.0^{a1}	684.4 ± 5.1^{b*}	492.2 ± 7.9^{c2}	522.9 ± 10.6$^{d\#}$
BG 379-2	1442.8 ± 5.5^{a1}	734.3 ± 5.5^{b*}	1251.5 ± 11.2^{c2}	659.5 ± 14.7$^{d\#}$
BG 300	1456.2 ± 24.6^{a1}	687.0 ± 0.4^{b*}	1345.1 ± 2.0^{c2}	629.2 ± 6.4$^{d\#}$
BG 305	1510.8 ± 6.2^{a1}	829.2 ± 3.4^{b*}	1281.1 ± 88.2^{c2}	501.9 ± 0.9$^{d\#}$
BG 357	1437.6 ± 12.2^{a1}	693.1 ± 8.5^{b*}	1291.6 ± 17.8^{c2}	655.2 ± 10.4$^{d\#}$
BW 367	1476.0 ± 6.7^{a1}	671.0 ± 13.9^{b*}	1309.7 ± 4.1^{c2}	618.4 ± 16.3$^{d\#}$
BW 451	1162.1 ± 14.8^{a1}	643.0 ± 7.1^{b*}	1445.3 ± 9.7^{c2}	603.9 ± 6.5$^{d\#}$
LD 371	1345.5 ± 10.6^{a1}	709.8 ± 10.3^{b*}	1202.0 ± 8.5^{c2}	682.1 ± 8.4$^{d\#}$
AT 306	1254.2 ± 30.3^{a1}	537.0 ± 6.3^{b*}	1441.3 ± 26.3^{c2}	761.4 ± 6.3$^{d\#}$
AT 309	1151.6 ± 31.3^{a1}	631.1 ± 5.7^{b*}	1418.4 ± 16.5^{c2}	892.0 ± 9.6$^{d\#}$
AT 405	952.5 ± 20.6^{a1}	616.4 ± 5.8^{b*}	1319.9 ± 20.9^{c2}	806.9 ± 8.8$^{d\#}$
		Magnesium		
BG 450	1174.3 ± 13.3^{a1}	373.1 ± 3.8^{b*}	1158.2 ± 1.9^{c2}	384.8 ± 2.5$^{d\#}$
BG400-1	1173.1 ± 7.4^{a1}	227.8 ± 1.9^{b*}	1117.7 ± 11.3^{c2}	227.4 ± 1.3$^{d\#}$
BG 360	1152.0 ± 6.8^{a1}	285.0 ± 2.4^{b*}	1128.5 ± 12.8^{c2}	366.7 ± 1.5$^{d\#}$
BG 94-1	1178.0 ± 0.6^{a1}	193.3 ± 2.4^{b*}	1144.0 ± 6.2^{c2}	211.7 ± 0.4$^{d\#}$
BG 379-2	1144.6 ± 6.5^{a1}	276.5 ± 3.5^{b*}	1172.3 ± 1.7^{c2}	241.7 ± 3.5$^{d\#}$
BG 300	1124.3 ± 11.1^{a1}	250.0 ± 0.9^{b*}	1129.6 ± 11.6^{a2}	338.2 ± 1.9$^{b\#}$
BG 305	1166.2 ± 6.9^{a1}	272.3 ± 3.0^{b*}	1118.4 ± 12.0^{c2}	217.9 ± 0.4$^{d\#}$
BG 357	1152.2 ± 0.5^{a1}	230.3 ± 1.9^{b*}	1146.6 ± 0.7^{a2}	269.2 ± 1.1$^{b\#}$
BW 367	1127.1 ± 0.9^{a1}	313.8 ± 1.8^{b*}	1136.9 ± 11.8^{a2}	296.5 ± 0.7$^{b\#}$
BW 451	1184.2 ± 11.4^{a1}	487.3 ± 3.7^{b*}	1095.1 ± 13.1^{c2}	254.5 ± 0.2$^{d\#}$
LD 371	1184.1 ± 6.3^{a1}	353.6 ± 2.2^{b*}	1068.2 ± 6.5^{c2}	257.2 ± 2.2$^{d\#}$
AT 306	1205.7 ± 13.8^{a1}	286.7 ± 1.5^{b*}	1142.7 ± 7.2^{c2}	285.0 ± 2.6$^{d\#}$
AT 309	1229.6 ± 8.6^{a1}	453.0 ± 3.9^{b*}	1192.6 ± 0.7^{c2}	349.2 ± 1.8$^{d\#}$
AT 405	1132.6 ± 13.2^{a1}	262.6 ± 1.4^{b*}	1147.4 ± 11.4^{a2}	348.4 ± 2.0$^{d\#}$

All the values are given in dry matter basis. Means in the same row followed by different digits (fertilized bran: fertilized kernel) /letters (fertilized bran: fertilized kernel)/symbols (fertilized kernel: non-fertilized kernel) are significantly different at 95% confidence level ($P<0.05$).

Effect of processing on the MCs of rice grains

Sarwar *et al.,* (2009) reported a similar trend in the variations of Ca and Mg of husk and whole grain fractions of Pakistani rice variety with application of different levels of organic and inorganic fertilizers. They further reported that fertilized husk and grains showed higher Ca and Mg contents than that of non-fertilized ones. The Ca and Mg contents of husks of grains under Non fertilized condition were 2007 mg/kg and 401 mg/kg, respectively, whereas husk of the grains grown with inorganic fertilizers reported 3477 mg/kg and 530 mg/kg of Ca and

Mg, respectively. Calcium and Mg contents in rice grains grown without fertilizers were 778mg/kg and 255mg/kg, respectively, and rice grains grown with inorganic fertilizers showed 1041 mg/kg and 355 mg/kg of Ca and Mg, respectively. This supported the findings of the present study that the application of inorganic fertilizers strengthened the MCs of rice grains.

Table 3. Mean zinc and manganese contents of rice varieties with white pericarp (mg/kg)

Rice Variety	Grown with fertilizers		Grown without fertilizers	
	Bran	Kernel	Bran	Kernel
		Zinc		
BG 450	154.0 ± 2.6^{a1}	$18.0 \pm 0.5^{b*}$	127.6 ± 0.6^{c2}	$23.7 \pm 0.4^{d\#}$
BG400-1	146.4 ± 0.8^{a1}	$21.5 \pm 0.4^{b*}$	140.7 ± 0.9^{c2}	$20.4 \pm 0.3^{d\#}$
BG 360	168.0 ± 0.8^{a1}	$17.8 \pm 0.3^{b*}$	106.7 ± 0.2^{c2}	$26.4 \pm 0.3^{d3\#}$
BG 94-1	159.9 ± 1.1^{a1}	$17.0 \pm 0.4^{b*}$	153.5 ± 0.7^{c2}	$19.2 \pm 0.5^{d\#}$
BG 379-2	139.7 ± 1.3^{a1}	$18.8 \pm 0.0^{b*}$	156.4 ± 0.9^{c2}	$17.7 \pm 0.0^{d\#}$
BG 300	139.8 ± 2.0^{a1}	$23.0 \pm 0.3^{b*}$	197.5 ± 0.8^{c2}	$23.0 \pm 0.5^{d\#}$
BG 305	149.7 ± 0.7^{a1}	$22.3 \pm 0.4^{b*}$	143.6 ± 0.7^{c2}	$22.7 \pm 0.4^{d\#}$
BG 357	155.0 ± 1.7^{a1}	$17.9 \pm 0.4^{b*}$	114.9 ± 0.6^{c2}	$18.3 \pm 0.2^{d\#}$
BW 367	158.6 ± 2.2^{a1}	$16.9 \pm 0.3^{b*}$	134.8 ± 2.0^{c2}	$20.0 \pm 0.1^{d\#}$
BW 451	171.3 ± 1.4^{a1}	$23.7 \pm 0.2^{b*}$	126.9 ± 1.1^{c2}	$19.3 \pm 0.3^{d\#}$
LD 371	132.3 ± 1.7^{a1}	$23.1 \pm 0.2^{b*}$	116.6 ± 1.4^{c2}	$25.5 \pm 0.2^{d\#}$
AT 306	167.3 ± 1.4^{a1}	$25.3 \pm 0.5^{b*}$	190.7 ± 2.3^{c2}	$31.6 \pm 0.4^{d\#}$
AT 309	146.5 ± 0.7^{a1}	$21.9 \pm 0.1^{b*}$	210.5 ± 2.4^{c2}	$32.9 \pm 0.3^{d\#}$
AT 405	166.1 ± 1.9^{a1}	$25.2 \pm 0.5^{b*}$	126.0 ± 2.2^{c2}	$25.4 \pm 0.1^{d\#}$
		Manganese		
BG 450	184.3 ± 3.2^{a1}	$25.3 \pm 0.5^{b*}$	175.4 ± 1.7^{a1}	$24.3 \pm 0.4^{c\#}$
BG400-1	142.0 ± 1.5^{a1}	$20.5 \pm 0.7^{b*}$	94.8 ± 0.5^{c2}	$21.6 \pm 1.6^{d\#}$
BG 360	214.3 ± 3.3^{a1}	$25.3 \pm 1.5^{b*}$	98.2 ± 1.7^{c2}	$23.0 \pm 0.5^{d\#}$
BG 94-1	150.6 ± 2.4^{a1}	$21.3 \pm 0.5^{b*}$	109.8 ± 0.6^{c2}	$19.9 \pm 1.3^{d\#}$
BG 379-2	188.1 ± 1.1^{a1}	$34.5 \pm 0.4^{b*}$	85.8 ± 0.6^{c2}	$25.7 \pm 0.6^{d\#}$
BG 300	151.4 ± 1.5^{a1}	$24.0 \pm 1.1^{b*}$	126.5 ± 1.3^{c2}	$20.8 \pm 0.6^{d\#}$
BG 305	130.6 ± 0.8^{a1}	$23.6 \pm 1.0^{b*}$	119.5 ± 1.2^{a1}	$18.7 \pm 0.8^{d\#}$
BG 357	131.9 ± 0.6^{a1}	$20.8 \pm 0.6^{b*}$	102.5 ± 1.0^{c1}	$22.5 \pm 1.3^{d\#}$
BW 367	151.3 ± 0.9^{a1}	$20.7 \pm 1.1^{b*}$	158.5 ± 1.4^{a2}	$23.9 \pm 0.7^{d\#}$
BW 451	182.0 ± 1.0^{a1}	$25.9 \pm 1.8^{b*}$	128.7 ± 0.6^{c2}	$20.9 \pm 0.3^{d\#}$
LD 371	164.1 ± 0.2^{a1}	$25.9 \pm 0.4^{b*}$	142.5 ± 1.4^{a1}	$24.8 \pm 0.2^{d\#}$
AT 306	193.7 ± 1.8^{a1}	$22.8 \pm 0.2^{b*}$	130.5 ± 1.5^{c2}	$19.4 \pm 1.1^{d\#}$
AT 309	169.6 ± 1.9^{a1}	$23.6 \pm 0.2^{b*}$	142.3 ± 1.4^{c2}	$20.3 \pm 0.5^{d\#}$
AT 405	210.7 ± 0.3^{a1}	$27.4 \pm 0.4^{b*}$	141.2 ± 1.9^{c2}	$23.3 \pm 0.2^{d\#}$

All the values are given in dry matter basis. Means in the same row followed by different fertilized bran: fertilized kernel) /letters (fertilized bran: fertilized krenel)/symbols (fertilized kernel:non fertilized kernel) are significantly different at 95%confidence interval level (p>0.05)

Recently, Verma and Srivastav (2017) showed that the MCs of polished counterparts of some aromatic and non-aromatic rice varieties grown in India. Their results showed that Ca, Mg and

The lower levels of Ca and Mg obtained in their study compared to the present study could be due to the variations in geographical locations, soil properties like pH, cation exchange capacity and leaching level of minerals, fertilization rate and techniques and the plant properties to absorb certain minerals (Leigh and Wyn Jones, 1984). The degree of milling which removes the most of the micronutrients severely affects the mineral composition. Processing operations of rice, namely dehulling, milling, and polishing affect the MCs. The Ca contents reported were 300, 100 and 100 mg/kg for 100% rough rice, 82% brown rice and 72% milling rice, respectively (Abbas *et al*., 2011). In addition, Wang and coworkers (2011) demonstrated the variations of MCs between bran and kernel fractions of three *Indica* rice cultivars. The ranges of Ca, Zn, Mn contents of bran were 682-1331, 38-56 and 160-232 mg/kg, respectively. Further the ranges of of Ca, Zn and Mn were 52-76, 19-29 and 10-28 mg/kg, respectively. The trend of variations revealed in the present work tallied with the previous study by Wang et al. (2011). Mineral contents of the used rice varieties were significantly affected by variety, fertilization and processing $(P<0.05)$. In addition, the interactive effects of variety and fertilization, variety and polishing, fertilization and processing and variety, fertilization and processing also showed a significant effect on the mineral composition of selected rice varieties $(P<0.05)$.There are limited studies on the MC of newly improved Sri Lankan rice varieties. Further research are warranted to validate the results obtained in this study.

CONCLUSIONS

The MCs of rice grains were significantly different among the varieties. Bran was the predominant locality with high MCs in rice grains. Therefore, processing of rice could change the MCs significantly. Application of inorganic fertilizers strengthen the MCs of rice kernels and brans of selected newly improved rice varieties.

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