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Short Communication

Mineral Contents of Sri Lankan Rice Varieties as Affected by Inorganic Fertilization

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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 fertilizers. 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, mineral contents, rice*

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. Ca and Mg are known as major minerals which require >100mg/day for the body functions and Zn and Mn are known as trace minerals which require <100mg/day. One of the major reasons for the loss of essential micronutrients from rice is the high polishing rate (Abbas *et al*., 2011).

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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 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 nitrogen, phosphorus and potassium. The aim of the current study was to determine the impact of the application of fertilizers on the mineral contents of bran and kernel fractions of newly improved rice varieties in Sri Lanka.

METHODOLOGY

Sample preparation

Random sampling method was used to obtain the rice grain samples from rice fields in the Rice Research and Development Institute in Bathalagoda, Rice Research Station. Twenty inorganic fertilized (Urea, Mureate of Pottash and Triple super Phosphate in 225 : 60 : 55 kg/ha, respectively) and non-fertilized Sri Lankan rice varieties, *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 obtained. 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 were finely ground using a grinder (Phillips HR 2011, Koninklijke Phillips Electronics N.V., China). The ground samples were passed through a sieve with the mesh size of 1 mm. Rice grains and counterpart bran samples were oven dried at 105ºC for constant weight to remove moisture. All the samples were stored in freezer (DW-86L626 Haier, U.K.) at -80ºC until further analysis.

Determination of mineral contents

A 0.5 g sample was measured into 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 for predigesting and digested for one hour using microwave digestion system (MARS 6 One touch technology CEM Corporation, North Carolina). The digested samples were filtered and volume up to 50 ml using deionized water. Mineral contents were determined using atomic absorption spectrophotometry. 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/land 3 mg/l. The mineral contents of the standards and the samples were measured using atomic absorption spectrophotometer (iCETM 3000 series Thermo Scientific, USA). The mineral contents were calculated on drymatter basis. All the samples were analyzed in triplicates.

Statistical Analysis

The differences of mean values among kernels and brans of fertilized and non fertilized treatments 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. SPSS version (16.0) was used for the statistical analysis.

RESULTS AND DISCUSSION

Tables 1 to 3 present Ca, Mg, Zn and Mn contents of rice varieties constituted of red and white pericarps. In general, higher Ca, Mg, Zn and Mn contents were observed in bran than the kernel for all rice varieties with red pericarp (Table 1). Further, it was noted that Ca, Mg, Zn and Mn contents of fertilized brans and kernels were higher than those of corresponding non-fertilized rice samples.

Ca content of rice varieties

The bran fraction of fertilizer added rice showed a range of Ca contents varying from 1368 to 1911 mg/kg (Table 1). The fertilized kernel fractions had Ca contents varying from 613 to 1107 mg/kg of rice varieties with red pericarp. The variety BG 305 reported the highest content of Ca for fertilized bran and kernels whereas BW 451 and AT 309 had the highest contents of Ca of non- fertilized bran and kernels, respectively.

Mg content of rice varieties

The Mg contents of fertilized and non- fertilized rice kernels varied 224-655 and 237- 452 mg/kg, respectively. Non-fertilized kernels of AT 362, AT 303 and H4 red rice varieties showed higher Mg content than those of fertilized counterparts. 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 of the bran and kernel, respectively.

Zn content of rice varieties

Fertilized and non-fertilized brans of rice with red pericarp had a Zn content ranged from 121-192 and 123-163 mg/kg, respectively. In general, fertilized and non-fertilized kernels of rice with red pericarp showed a Zn content ranged from 15 to 26 mg/kg. The Zn contents of kernels were 6-10 times lesser than that of bran of rice with red pericarp. The Zn and Mn contents of the rice varieties were comparatively lower than the Ca and Mg contents (Table 3). Among non-fertilized rice brans AT 309 had the highest (210.5 mg/kg) and BG 360 had the lowest (106.7 mg/kg) zinc contents. The rice varieties except AT 309, AT 306, BG 300 and BG 379-2, explicated significantly higher Zn contents in fertilized brans compared to those of non-fertilized (P<0.05).

Mn content of rice varieties

Among rice varieties with red pericarp LD 368 reported the highest content of Mn of fertilized and non-fertilized rice bran whereas BW 276-6B had the highest content of Mn of kernels (Table 1). The Mn contents of the rice varieties with white pericarp were comparatively lower than those of Ca and Mg. Among fertilized bran, Mn contents varied from 214 to 131 mg/kg. Among non-fertilized rice brans BG 450 had the highest Mn content (Table 3).

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

	Calcium			
	Fertilized		**Non-fertilized**	
	Bran	**Kernel**	**Bran**	**Kernel**
AT 353	1368.4 ± 29.3^{a1}	682.5 ± 6.6^{b*}	904.9 ± 15.5^{c2}	545.6 ± 8.2$^{d\#}$
AT 362	1428.6 ± 8.2^{a1}	696.4 ± 7.7^{b*}	903.8 ± 4.5^{c2}	520.7 ± 7.4$^{d\#}$
AT 303	1604.9 ± 17.1^{a1}	613.4 ± 12.5^{b*}	749.5 ± 12.2^{c2}	690.9 ± 17.1$^{c\#}$
H4	1571.6 ± 31.5^{a1}	616.4 ± 4.6^{b*}	689.1 ± 13.7^{c2}	589.6 ± 8.2$^{c\#}$
BW 276-6B	1486.3 ± 14.5^{a1}	1107.2 ± 11.7^{b*}	671.7 ± 2.2^{c2}	561.7 ± 6.8$^{c\#}$
LD 368	1911.1 ± 2.7^{a1}	730.1 ± 4.4^{b*}	836.2 ± 18.0^{c2}	560.0 ± 6.2$^{d\#}$
	Magnesium			
AT 353	1208.5 ± 6.8^{a1}	279.2 ± 0.4^{b*}	1157.5 ± 6.3^{c2}	242.2 ± 1.2$^{d\#}$
AT 362	1206.5 ± 0.6^{a1}	224.4 ± 2.6^{b*}	1175.3 ± 6.5^{c2}	271.9 ± 1.8$^{d\#}$
AT 303	1203.8 ± 12.5^{a1}	240.8 ± 2.1^{b*}	1112.9 ± 6.2^{c2}	287.6 ± 1.0$^{d\#}$
H4	1181.6 ± 6.0^{a1}	223.8 ± 0.6^{b*}	1117.4 ± 11.4^{c2}	237.0 ± 1.6$^{d\#}$
BW 276-6B	1176.9 ± 13.0^{a1}	655.0 ± 6.7^{b*}	1094.2 ± 10.5^{c2}	452.3 ± 2.8$^{d\#}$
LD 368	1204.5 ± 6.6^{a1}	410.1 ± 1.4^{b*}	1162.2 ± 11.5^{c2}	344.5 ± 2.2$^{d\#}$
	Zinc			
AT 353	127.5 ± 1.2^{a1}	17.5 ± 0.4^{b*}	153.5 ± 0.7^{c*}	16.1 ± 0.1$^{d\#}$
AT 362	192.2 ± 1.6^{a1}	21.5 ± 0.2^{b*}	152.0 ± 1.8^{c*}	18.5 ± 0.3$^{d\#}$
AT 303	121.1 ± 1.9^{a1}	15.1 ± 0.4^{b*}	163.1 ± 1.3^{c*}	24.6 ± 0.2$^{d\#}$
H4	188.1 ± 1.4^{a1}	24.8 ± 0.2^{b*}	128.7 ± 1.0^{c*}	22.9 ± 0.3$^{d\#}$
BW 276-6B	144.3 ± 0.8^{a1}	23.5 ± 0.2^{b*}	122.8 ± 1.0^{c*}	26.4 ± 0.2$^{d\#}$
LD 368	154.7 ± 0.6^{a1}	18.4 ± 0.1^{b*}	130.3 ± 0.7^{c*}	22.4 ± 0.4$^{d\#}$
	Manganese			
AT 353	122.0 ± 1.6^{a1}	20.6 ± 0.8^{b*}	99.5 ± 2.2^{a1}	16.8 ± 0.4$^{c\#}$
AT 362	157.5 ± 1.5^{a1}	22.1 ± 1.2^{b*}	120.6 ± 1.3^{c2}	18.7 ± 0.8$^{d\#}$
AT 303	126.1 ± 0.7^{a1}	20.0 ± 0.8^{b*}	106.3 ± 2.3^{a1}	19.8 ± 1.7$^{c\#}$
H4	125.9 ± 0.6^{a1}	21.7 ± 1.2^{b*}	106.6 ± 1.5^{a1}	21.5 ± 1.4$^{c\#}$
BW 276-6B	203.2 ± 2.5^{a1}	29.2 ± 0.6^{b*}	121.8 ± 1.0^{c2}	24.3 ± 0.9$^{d\#}$
LD 368	273.1 ± 2.8^{a1}	25.1 ± 1.0^{b*}	176.5 ± 1.7^{c2}	26.6 ± 1.0$^{d\#}$

Means in the same row followed by different digits (fertilized bran: fertilized kernel) /letters (fertilized bran: fertilized krenel)/symbols (fertilized kernel:non fertilized kernel) are significantly different at 95% confidence level($p>0.05$)

Nutritional significance of minerals

Ca is an important mineral for the synthesis of skeletal functions. Mg is a significant facilitator for many of the biochemical functions. Mn and Zn which are identified as trace minerals are important for many of the physiological functions.

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

	Calcium			
	Fertilized		Non- fertilized	
	Bran	Kernel	Bran	Kernel
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$^{d\#}$

Means in the same row followed by different digits(fertilized bran: fertilized kernel) /letters(fertilized bran: fertilized krenel)/symbols(fertilized kernel:non fertilized kernel) are significantly different at 95% confidence level. ($p>0.05$)

The per capita availability of rice is 100Kg/year. Accordingly the contribution of fertilization to the Ca, Mg, Zn content (168.5-304mg), (61.6-124mg), (4.12-7.15mg), respectively is below the RDA value of the above minerals. The reported Mn content (505-7.4mg) is higher than the RDA values.

Effect of processing on the mineral content of rice varieties

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 compared to control (Non-fertilized). They further reported that fertilized husk and grains showed higher Ca and Mg contents than that of control.

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

	Zinc			
	Fertilized		Non-fertilized	
	Bran	Kernel	Bran	Kernel
BG 450	154.0 ± 2.6^{a1}	18.0 ± 0.5^{b*}	127.6 ± 0.6^{c2}	23.7 ± 0.4$^{d\#}$
BG400-1	146.4 ± 0.8^{a1}	21.5 ± 0.4^{b*}	140.7 ± 0.9^{c2}	20.4 ± 0.3$^{d\#}$
BG 360	168.0 ± 0.8^{a1}	17.8 ± 0.3^{b*}	106.7 ± 0.2^{c2}	26.4 ±0.3$^{d3\#}$
BG 94-1	159.9 ± 1.1^{a1}	17.0 ± 0.4^{b*}	153.5 ± 0.7^{c2}	19.2 ± 0.5$^{d\#}$
BG 379-2	139.7 ± 1.3^{a1}	18.8 ± 0.0^{b*}	156.4 ± 0.9^{c2}	17.7 ± 0.0$^{d\#}$
BG 300	139.8 ± 2.0^{a1}	23.0 ± 0.3^{b*}	197.5 ± 0.8^{c2}	23.0 ± 0.5$^{d\#}$
BG 305	149.7 ± 0.7^{a1}	22.3 ± 0.4^{b*}	143.6 ± 0.7^{c2}	22.7 ± 0.4$^{d\#}$
BG 357	155.0 ± 1.7^{a1}	17.9 ± 0.4^{b*}	114.9 ± 0.6^{c2}	18.3 ± 0.2$^{d\#}$
BW 367	158.6 ± 2.2^{a1}	16.9 ± 0.3^{b*}	134.8 ± 2.0^{c2}	20.0 ± 0.1$^{d\#}$
BW 451	171.3 ± 1.4^{a1}	23.7 ± 0.2^{b*}	126.9 ± 1.1^{c2}	19.3 ± 0.3$^{d\#}$
LD 371	132.3 ± 1.7^{a1}	23.1 ± 0.2^{b*}	116.6 ± 1.4^{c2}	25.5 ± 0.2$^{d\#}$
AT 306	167.3 ± 1.4^{a1}	25.3 ± 0.5^{b*}	190.7 ± 2.3^{c2}	31.6 ± 0.4$^{d\#}$
AT 309	146.5 ± 0.7^{a1}	21.9 ± 0.1^{b*}	210.5 ± 2.4^{c2}	32.9 ± 0.3$^{d\#}$
AT 405	166.1 ± 1.9^{a1}	25.2 ± 0.5^{b*}	126.0 ± 2.2^{c2}	25.4 ± 0.1$^{d\#}$
	Manganese			
BG 450	184.3 ± 3.2^{a1}	25.3 ± 0.5^{b*}	175.4 ± 1.7^{a1}	24.3 ± 0.4$^{c\#}$
BG400-1	142.0 ± 1.5^{a1}	20.5 ± 0.7^{b*}	94.8 ± 0.5^{c2}	21.6 ± 1.6$^{d\#}$
BG 360	214.3 ± 3.3^{a1}	25.3 ± 1.5^{b*}	98.2 ± 1.7^{c2}	23.0 ± 0.5$^{d\#}$
BG 94-1	150.6 ± 2.4^{a1}	21.3 ± 0.5^{b*}	109.8 ± 0.6^{c2}	19.9 ± 1.3$^{d\#}$
BG 379-2	188.1 ± 1.1^{a1}	34.5 ± 0.4^{b*}	85.8 ± 0.6^{c2}	25.7 ± 0.6$^{d\#}$
BG 300	151.4 ± 1.5^{a1}	24.0 ± 1.1^{b*}	126.5 ± 1.3^{c2}	20.8 ± 0.6$^{d\#}$
BG 305	130.6 ± 0.8^{a1}	23.6 ± 1.0^{b*}	119.5 ± 1.2^{a1}	18.7 ± 0.8$^{d\#}$
BG 357	131.9 ± 0.6^{a1}	20.8 ± 0.6^{b*}	102.5 ± 1.0^{c1}	22.5 ± 1.3$^{d\#}$
BW 367	151.3 ± 0.9^{a1}	20.7 ± 1.1^{b*}	158.5 ± 1.4^{a2}	23.9 ± 0.7$^{d\#}$
BW 451	182.0 ± 1.0^{a1}	25.9 ± 1.8^{b*}	128.7 ± 0.6^{c2}	20.9 ± 0.3$^{d\#}$
LD 371	164.1 ± 0.2^{a1}	25.9 ± 0.4^{b*}	142.5 ± 1.4^{a1}	24.8 ± 0.2$^{d\#}$
AT 306	193.7 ± 1.8^{a1}	22.8 ± 0.2^{b*}	130.5 ± 1.5^{c2}	19.4 ± 1.1$^{d\#}$
AT 309	169.6 ± 1.9^{a1}	23.6 ± 0.2^{b*}	142.3 ± 1.4^{c2}	20.3 ± 0.5$^{d\#}$
AT 405	210.7 ± 0.3^{a1}	27.4 ± 0.4^{b*}	141.2 ± 1.9^{c2}	23.3 ± 0.2$^{d\#}$

Means in the same row followed by different digits(fertilized bran: fertilized kernel) /letters(fertilized bran: fertilized krenel)/symbols(fertilized kernel:non fertilized kernel) are significantly different at 95% confidence level. (p>0.05)

The Ca and Mg contents of control husk (Non fertilized) were 2007mg/kg and 401mg/kg, respectively, whereas inorganically fertilized husk was reported 3477mg/kg and 530mg/kg of Ca and Mg, respectively. Ca and Mg contents in control rice grains were 778mg/kg and 255mg/kg, respectively, and inorganically fertilized rice grains showed 1041mg/kg and 355mg/kg of Ca and Mg, respectively. This supported the findings of the present study that the application of inorganic fertilizers strengthened the mineral content of rice grains and husk.

Recently, Verma and Srivastav (2017) showed that the mineral contents of polished counterparts of some aromatic and non-aromatic rice varieties grown in India. Their results showed that Ca, Mg and Zn contents of rice ranged 63-99 mg/kg, 83-182 mg/kg and 9-17 mg/kg, respectively. 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 mineral contents. The mineral content variations among 100% rough rice, 82% brown rice and 72% milling rice. 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 mineral content 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 52-76, 19-29 and 10-28 mg/kg of Ca, Zn and Mn, respectively were reported for kernel fractions. 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 mineral content of newly improved Sri Lankan rice varieties. Further research are warranted to validate the results obtained in this study.

CONCLUSIONS

The application of inorganic fertilizers strengthen the mineral contents (Ca, Mg, Mn, and Zn) of rice kernels and brans of selected Sri Lankan newly improved rice varieties.

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