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Nutritional potential and mineral profiling of selected rice variety available in Ethiopia

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A B S T R A C T

Rice, *Oryza sativa* (Asian rice) and *Oryza glaberrima* (African rice) is an important staple food crop in many Sub-Saharan African and Asian countries, so the consumer's daily bowl of rice needs to be safe and of good quality. In the present study, five different rice varieties, one locally grown, three hybrids (NERICA) and imported rice were evaluated for proximate and mineral composition using AOAC standard method of analysis. The results of this study revealed that all selected rice varieties contained considerable amounts of proximate values and mineral elements (Ca, Mg, K, Na, Fe, Cu, Ni, Mn, and Zn). NERICA rice had the highest concentration of most proximate values and mineral elements that in most of the other rice varieties. The present analysis revealed that the hybrid NERICA rice variety contained a considerable amount of nutrients.

Capsule Summary: Nutritional potential through proximate analysis and trace mineral contents of five rice varieties available in Ethiopian were determined using AOAC standard method of analysis. The proximate and trace metal value were found relatively higher in hybrid NERICA rice than locally available and imported rice.

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INTRODUCTION

Rice is the seed of the monocot plant of the genus *Oryza* and of the grass family *Poaceae* which includes twenty wild species and two cultivated, *Oryza sativa* (Asian rice) and *Oryza glaberrima* (African rice). South-East Asia and South-West China as the primary center of origin of *Oryza sativa*, and the delta of River Niger in Africa for that of *Oryza glaberrima*, the African rice and *Oryza sativa* is the most commonly grown species throughout the world today (Oko and Ugwu, 2011; Tegegne et al., 2017).

Rice is one of the most important foods in world supplying as much as half of the daily calories of the world population and the rice plant is highly adaptable to local environment and because human has succeeded in modifying local agro ecosystem, rice can now be grown in many different locations and under a variety of climates (Tegegne et al., 2017). Rice is also an important staple food crop in many Sub-Saharan African countries (Kijima et al., 2013). Ethiopia being the second most populous nation in sub-Sahara Africa, rice is one of the target commodities that have received due emphasis in promotion of agricultural production and is considered as the "Millennium Crop". Rice was introduced in Ethiopia during 1970s and has since been cultivated in small but increasing pockets of the country Ethiopia has considerably vast suitable ecologies for rice production which are unsuitable for production of other food crops (Beakal et al., 2016; Gebremeskel, 2010).

Several recent studies on the African rice draw attention to the potential of the indigenous cultivated rice species which presents a rich reservoir of genes for resistance to several stresses, including weeds, for improving regional and global food supplies. African rice, *Oryza glaberrima* is the main and the only cultivated rice among the whole African rice species (Agnoun et al., 2012). In the history of rice breeding, a high-yielding rice variety called NERICA (New Rice for Africa) has been obtained for the first time from crosses between African rice (*Oryza glaberrima*) and Asian rice (*Oryza sativa*) at West African Rice Development Association (WARDA, Cotonou, Benin) (Tegegne et al., 2013). The resulting traits have been considered by many to offer significant opportunities for productivity increases and poverty reduction in Africa (Kijimaa et al., 2008).

The nutritional, ecological and economical focuses on rice are of great importance: cardio-vascular and infant diseases due to excess or deficiency in food diet in elements and macro-nutrients are widely spread in Asia and Africa, and particularly in non-irrigated rice-growing areas. Any improvement of rice grain quality in macro-nutrients and elements content could then help reducing the severity of nutritional problems (Gandebe et al., 2017). The rice grain consists of 75-80 % starch, 12 % water, and only 7 % protein with a full complement of amino acids. Its protein is highly digestible with excellent biological value and protein efficiency ratio owing to the presence of higher concentration (4 %) of lysine (Oko et al., 2012). Rice is a good source of protein, but it is not a complete protein: it does not contain all of the essential amino acids in sufficient amounts for good health and should be combined with other sources of protein, such as nuts, seeds, beans, fish, or meat (Kunlun Liu et al., 2009).

The proximate composition of rice includes moisture, carbohydrates, proteins, dietary fibers, fatty acids, ash, and dietary minerals. Rice is an excellent source of carbohydrates containing approximately 87 % in grain. It contains 7 to 8 % of protein which has higher digestibility, biological value and more nutritious; possesses 10% moisture, lower crude fiber and lower fat (1 to 2%) and ash (1 to 2%) (Devi et al., 2015).

According to a previous study, rice was investigated as a potential source of fiber and carbohydrates, protein and lipids. It was reported that an increase in fiber content in rice may improve the human health by lowering the plasma cholesterol (Zubair et al., 2012). The nutritional value of raw rice per 100 g has 1510 kJ energy, 79 g carbohydrates, 0.6 g fat, 7 g protein, 0.4 g vitamin B_6 and 12 g water. Rice kernels do not contain vitamin A, so people who obtain most of their calories from rice are at risk of vitamin A deficiency. In terms of calories, carbohydrate-rich foods should make up around 50% of our total calorific intake (Dababneh and Abu, 2008). Unfortunately, rice is a poor source of many essential micronutrients and vitamins, and deficiencies in these micronutrients are common in developing countries (Narayanan et al., 2007).

Vitamin A, iron and iodine deficiencies are the widest spread and devastating forms of micronutrient malnutrition. The most widely consumed staple crops rice; wheat and maize are not good sources of these nutrients. Uptake of heavy metals by plants from soil and contamination of food by heavy metals during harvesting, transportation, storage, marketing, and processing stages are major sources of heavy metals in foods (Chanakan et al., 2009; Kennedy and Burlingame, 2003).

Knowledge about the nutritional status of rice is becoming increasingly important among consumers in view of nutritional deficiency disorders mostly in the developing world especially in Ethiopia, which need to be addressed. There is limited information about the nutritional composition of the different rice varieties available in Ethiopia. Therefore, the objective of this study was to investigate the proximate and elemental composition of selected rice varieties in terms of nutrition.

MATERIAL AND METHODS

Sample collection

Rice sample for the analysis of proximate and mineral composition were collected from supermarket in Addis Ababa the capital city of Ethiopia (Imported rice and Ethiopian rice) and the other sample NERICA (New Rice for Africa) 4, 12 and 14 were collected from Amhara Regional Agricultural Research Institute (ARARI) Bahir Dar, Ethiopia. ARARI was selected because this rice variety is present in this institute in pure form but in other place exist with adulterant.

Sample preparation

Rice samples of NERICA their husks were removed, the samples were winnowed and air dried. All the raw rice samples were washed with tap water followed by deionized water to avoid any dust materials on the grain and dried until constant weight. The dried rice sample was then ground using a blender device in the laboratory and sieved through a 0.5 mm sieve to remove large grains and to get uniformity as possible. Finally, an appropriate amount of aliquot was taken from each sample for analysis.

Proximate composition analysis

Proximate composition (moisture content, total ash content, crude lipid content, crude fiber content, and crude protein content) were determined using standard AOAC methods (AOAC, 1990, 2000), as follows:

Total moisture content

The moisture content of the sample was determined by weighing 2 g of sample into a pre-weighed china dish and drying it in an air forced draft oven at a temperature of 105 ± 5 °C till the constant weight of dry matter was obtained. The moisture content in the sample was determined as follows-
Moisture (%) = [{(Wt. of original sample – Wt. of dried sample) / Wt. of original sample} × 100].

Total ash content

Total ash content of the rice sample was determined using AOAC method as described in (AOAC, 1990). About 2.0 g of rice samples from each variety were weighed in triplicates. The sample were incinerated in a muffle furnace at 550°C for 4 h, cooled in desiccators and weighed until the weight is constant after dried and powdered.

$$\text{Total ash (\%)} = \frac{\textit{Weight of ash}}{\textit{weight of sample}} \times 100$$

Crude lipids content

In the present study, 2.0 g of rice samples from each variety were weighed in triplicate and Soxhlet apparatus was set-up and the samples were extracted with 200 mL of petroleum ether for 6 h. The solvent-free fat in the flux was dried in an oven for an hour at 105°C, cooled in desiccators and reweighed until the weight is constant.

$$\text{Crude lipid (\%)} = \frac{\text{Weight of extract}}{\text{weight of sample}} \times 100$$

Crude fiber content

Crude fiber content was determined by introducing 2.0 g sample into the extraction unit and 150 mL of hot 0.2N H_2SO_4 was added and digested for 30 min. Then, the acid was drained and the sample was washed with hot deionized water and with the HCI solution and then again with boiling water, for 1 h. The crucible was removed and oven dried overnight at 105°C, cooled, weighed, and heated at 550°C in a muffle furnace overnight and reweighed after cooling. Percentage of extracted fiber was calculated as:

$$\text{Crude fiber (\%)} = \frac{\text{Weight of digested sample} - \text{weight of the ash}}{\text{weight of the sample}}$$

Crude protein content

Crude protein was determined using the method as described in (AOAC, 2000) that is a micro Kjeldahl method. The percentage of crude protein in the sample was calculated as:
Nitrogen as % crude protein = % N x F, where, N, nitrogen, and F (conversion factor), is equivalent to 6.25 (Mahan et al., 2016).

Carbohydrate and energy value

The carbohydrate content was determined by difference, that is, the addition of all the percentages of moisture, ash, crude lipid, crude protein, and crude fiber was subtracted from 100%. This gave the amount of nitrogen-free extract otherwise known as carbohydrate (Mahan et al., 2016). Thus: % carbohydrate = 100 – (% moisture + % crude fiber + % protein + % lipid + % ash).

The energy value was estimated (in kcal/g) by multiplying the percentages of crude protein, crude lipid, and carbohydrate with the recommended factors (2.44, 8.37, and 3.57 respectively) as used by (Mahan et al., 2016).

Determination of mineral elements in rice

Mineral elements like (Fe, Ni, Cu, Mn, and Zn) were determined by atomic absorption spectrophotometric method metals like (Ca and Mg) determined by EDTA titration and the rest metals (Na and K) were determined by flame photometer using AOAC official method (AOAC, 1998). According to the analytically accepted procedure, all analysis was done in triplicate with their respective calibration curve and a blank sample.

Statistical analysis

Each experimental analysis was done in triplicate. Data obtained from experiments were analyzed by one way ANOVA (Analysis of Variance) using SPSS version 20. Significance was accepted at 0.05 level of probability ($p < 0.05$). The analysis was used to compare the proximate and elemental composition of rice samples

RESULTS AND DISCUSSION

Proximate analysis of rice sample

The proximate composition of rice sample was presented in Table 1. The percentage of protein content ranges between 6.9 - 9.27 %. The highest protein content was found in imported rice followed by Ethiopian rice and the lowest content was recorded in NERICA 12. As it was indicated in Table 1, the content of protein was slightly higher than similar study done in different rice varieties in Bangladesh (Zubair et al., 2015). The hybrid rice NERICA 4 protein content in (Beakal et al., 2016) was also comparable with this study NERICA 4 rice variety. Another study was done on indigenous rice cultivar in India, the protein content ranges between 7.77 - 11.48 % which was relatively higher than this study (Thongbam et al., 2012) and comparable with wild rice varieties in Malaysia (Fasahat et al., 2012).

The total moisture content of the rice sample ranges between 10.57 – 12.51 %. The highest was found in Ethiopian rice and the lowest in NERICA 12 hybrid rice sample. The moisture content of the finding from Indian (Oko and Ugwu, 2011) rice variety ranges between 3.67–18.00 % in which the result in this study falls in this range.

Table 1: Proximate compositions of rice varieties (% dry weight basis)

Samples	Sample origin	Protein % w/w	Moisture % w/w	Crude fiber % w/w	Crude lipid % w/w	Ash % w/w
NERICA 4	Ethiopia	6.95±0.83	11.05±1.11	0.68±0.67	1.55±0.59	0.90±0.46
NERICA 12	Ethiopia	6.91±0.09	10.57±0.87	0.75±1.02	2.07±0.24	1.15±0.67
NERICA 14	Ethiopia	7.19±0.43	11.51±0.67	3.07±0.51	2.35±0.89	1.42±0.35
Imported rice	Pakistan	9.27±0.56	11.23±0.83	0.36±0.56	1.02±0.91	1.76±0.97
Ethiopian rice	Ethiopia	8.20±0.48	12.51±0.64	2.52±0.89	0.61±1.23	0.46±1.78

Values are reported as means ±SD of triplicate determination

Table 2: Calculated carbohydrate and energy value of rice samples

Samples	Sample origin	Carbohydrate (%)	Energy value (kcal/g)
NERICA 4	Ethiopia	78.87±1.01	311.50±0.81
NERICA 12	Ethiopia	78.55±0.58	314.59±0.30
NERICA 14	Ethiopia	74.46±0.57	303.03±0.63
Imported rice	Pakistan	76.36±0.70	317.51±0.74
Ethiopian white rice	Ethiopia	75.70±1.01	295.38±0.91

Values are reported as means ±SD of triplicate determination

Table 3: Concentration (mean ± SD, n=3, mg/kg air dry weight) of metals in rice sample

	Metal concentration (mg/kg)				
Metals	NERICA 4	NERICA 12	NERICA 14	Imported rice	Ethiopian rice
Ca	160.08±13	287.55±15	359.03±18	79.30±9.2	143.61±11
Mg	1027.70±48	1207.72±49	1249.43±51	294.99±16	430.84±18
Na	26.54±1.6	30.27±2	18.90±1.4	31.93±2.1	37.79±2.3
Fe	27.87±1.8	45.14±3.4	54.42±4.7	16.49±1.3	2.49±0.2
Cu	2.88±0.6	4.62±0.8	4.80±0.8	3.57±0.7	2.49±0.3
Ni	1.21±0.1	1.59±0.2	2.27±0.6	1.13±0.1	0.53±0.01
K	1744.01±53	2080.97±68	2645.50±70	1227.13±51	1247.17±51
Zn	107.20±11	69.95±4.6	41.27±3.2	38.60±2.7	24.98±1.5
Mn	8.43±1.1	12.80±1.1	19.70±1.2	1.67±0.3	1.37±0.2

Values are reported as means ±SD of triplicate determination

The crude fiber of rice sample considered in this study found to be in the range 0.36 – 3.07 %. Higher crude fiber (3.07 %) was recorded in NERICA 14 rice variety and lower (0.36 %) was recorded in imported rice. The crude fiber content reported by (Oko and Ugwu, 2011) was quite lower than this study but falls in the range obtained. The study on Bangladesh rice was lower than two varieties and higher than the rest varieties (Zubair et al., 2012).

The crude lipid of five rice variety considered in this study ranges between 0.61 – 2.35 %. The highest crude lipid content was found in NERICA 14 rice variety and the lowest was found in Ethiopian white rice. The result was comparable with the crude lipid content found in another similar study (Oko and Ugwu, 2011) but much lower than most of the salt-tolerant rice genotypes studied by (Beakal et al., 2016).

Total ash content of the rice varieties in this study ranges between 0.46–1.76 % and the highest was recorded in imported rice and the lowest in Ethiopian rice. The total ash content found in another study in different rice variety in Nigeria (Oko and Ugwu, 2011) ranges between 0.50 – 2.00 % which was comparable similar with this study. However, the total ash content of rice varieties considered was higher than rice varieties in Bangladesh (Zubair et al., 2015).

The calculated carbohydrate and energy values of five rice varieties which are three hybrids (NERICA), one imported and one locally cultivated rice varieties were reported in Table 2. The % carbohydrate of the rice sample ranged between 74.36 - 78.87 %. The differences among the varieties are not significantly higher. The highest concentration was recorded in NERICA 4 and the lowest was in NERICA 14 hybrid rice. The energy calculated using relations given by (Mahan et al., 2016) was ranged between 295.38 - 317.51 kcal/g. The highest amount of energy was found in imported rice, followed by NERICA 12, NERICA 4, NERICA 14 and Ethiopian rice is the lowest energy level. The result of the carbohydrate content of the rice varieties is comparable with rice varieties considered in other similar study but higher energy value that this study (Devi et al., 2015).

Elemental composition of rice samples

The elemental composition of rice sample was shown in Table 3. As shown in the Table, calcium concentration was found in the range between 79.30 – 359.03 mg/kg. The highest concentration found in NERICA 14 rice variety and the lowest found in imported rice. Calcium plays an important role in nerve conduction, muscle contraction, and blood clotting. Inadequate intakes of calcium have been associated with increased risks of osteoporosis, nephrolithiasis (kidney stones), colorectal cancer, hypertension and stroke, coronary artery disease, insulin resistance, and obesity. World health organization daily recommended intake of calcium is 3500 mg/ day (WHO, 2009). A similar study done on different rice variety in Pakistan showed calcium concentration ranges between 825 – 1330 mg/kg (Zubair et al., 2012) which was higher than found in this study.

The concentration of magnesium another important element was found to be 294.99 – 1249.43 mg/kg in the rice sample. Low magnesium status has been implicated in hypertension, coronary heart disease, type 2 diabetes mellitus, and metabolic syndrome. The daily recommended range of magnesium in the human diet is 320-420 mg/day (WHO, 2009). The highest concentration found in NERICA 14 rice variety and the lowest found in imported rice like that of calcium element. The hybrid rice varieties give high concentration when comparisons were made between parents with the hybrid. The concentration of magnesium in Pakistan rice variety was found in the range of finding in this study (Zubair et al., 2012). It was reported that NERICA rice (the hybrid of *Oryza sativa* and *Oryza gelaberiuma*) variety was a good source of magnesium that the parent rice varieties (Tegegne et al., 2017).

The average concentration of sodium in the rice variety was found in the range of 18.90 – 37.79 mg/kg. The highest concentration was found in Ethiopian white rice and the lowest found in NERICA 14. The rice variety NERICA 14 was a poor source of sodium but a good source of calcium and magnesium. Sodium intake is one factor involved in the development of high blood pressure, otherwise known as hypertension. The daily recommended range of sodium in the human diet is 240 mg/day. Consuming excess sodium may lead to edema or water retention (WHO, 2006). The concentration of sodium in rice varieties of Pakistan was found higher than this study (Zubair et al., 2012).

Concentrations of iron in the rice varieties were found in the range between 2.49 - 54.42 mg/kg. NERICA 14 iron concentration was the highest and Ethiopian white rice was the lowest concentration among the rice varieties. From the hybrid rice varieties, NERICA 14 was a good source of iron like magnesium and calcium than the parent rice varieties imported and Ethiopian rice. Iron concentration was found higher than this study in Pakistan rice variety (Zubair et al., 2012). However, most of the rice varieties concentration of iron in this study was higher than what was done previously in Malaysia(Yap et al., 2009).

Copper analyzed in five rice varieties found in the range between 2.49 – 4.80 mg/kg. Similar to elements like calcium, magnesium, and iron, copper concentration was highest in NERICA 14 rice variety. The lowest concentration of copper similar to the concentration of Iron was found in Ethiopian rice variety. Deficiency of copper causes low white blood cell count and poor growth. Excess intake of copper can cause vomiting, nervous system disorder and Wilson's diseases (Fregal, 2005). The daily recommended range of copper in the human diet is 2 mg/day (Ismail et al., 2011). The higher copper concentration result was obtained in different varieties of commercially available rice done before five years in Ethiopia (Tegegne et al., 2017) and in Pakistan rice varieties (Zubair et al., 2012).

The concentration of nickel in rice varieties was found to be in the range 0.53 – 2.27 mg/kg. NERICA 14 gives the highest concentration and the lowest concentration found in Ethiopian rice like what was found in copper concentration in the rice varieties. Nonetheless, nickel is persuasive pieces of circumstantial evidence that nickel is essential for humans. Of course, the potential importance of nickel in human nutrition is not limited to deficiency. Like other mineral elements, nickel ingested in high amounts can have adverse effects (WHO, 2006) The daily recommended ranges of nickel in the human diet is 3-7 mg/day (Ismail et al., 2011).

The average concentration of potassium was found in the range between 1227.13 - 2645.50 mg/kg. The highest concentration of potassium was found in NERICA 14 and the lowest concentration in imported rice. Potassium is one of the essential element of human diet, play important in a vital cellular mechanism, as cofactor it catalysis the conversion of the ADP to ATP, excitability of the nerve and it is a major electrolyte of intracellular fluid (WHO, 2006). The result obtained in this study was comparable with the study done in Pakistan on proximate composition and minerals profile of the selected rice (*Oryza sativa*) varieties i.e., super basmati, basmati 515, basmati 198 and basmati 385 etc. (Zubair et al., 2012).

Table 4: Correlation coefficients among proximate composition values observed in this study

	Protein	Moisture	Crude fiber	Crude lipid	Ash	Carbohydrate	Energy
Protein	1	0.39102 (0.51514)	-0.17408 (0.77948)	-0.72234 (0.16812)	0.32769 (0.59036)	-0.38758 (0.51916)	0.08959 (0.88609)
Moisture		1	0.67854 (0.20792)	-0.62666 (0.25794)	-0.52717 (0.36132)	-0.65835 (0.22703)	-0.87151 (0.05421)
Crude fiber			1	0.14363 (0.81775)	-0.31682 (0.60347)	-0.78832 (0.11312)	-0.88104 (0.04837)
Crude lipid				1	0.37819 (0.53021)	0.0559 (0.92886)	0.24257 (0.6942)
Ash					1	-0.17635 (0.77664)	0.68461 (0.20226)
Carbohydrate						1	0.58633 (0.29877)
Energy							1

Values in parenthesis indicate probability levels

Table 5: Correlation Coefficients among mineral elements observed in this study

	Ca	Mg	Na	Fe	Cu	Ni	K	Zn	Mn
Ca	1	-0.74445 (0.14899)	0.89742 (0.03882)	0.65371 (0.23149)	0.77834 (0.12102)	0.91245 (0.03068)	0.52585 (0.36275)	0.91972 (0.02697)	-0.74445 (0.14899)
Mg		1	-0.85632 (0.06395)	-0.66015 (0.22531)	-0.91994 (0.02686)	-0.87187 (0.05398)	-0.30908 (0.61283)	-0.87675 (0.05097)	-0.85632 (0.06395)
Na			1	0.8988 (0.03805)	0.96315 (0.00844)	0.95347 (0.01197)	0.30206 (0.62134)	0.96277 (0.00857)	0.8988 (0.03805)
Fe				1	0.90039 (0.03717)	0.80582 (0.09967)	-0.04092 (0.94792)	0.81321 (0.09415)	0.90039 (0.03717)
Cu					1	0.93399 (0.02016)	0.14158 (0.82034)	0.93944 (0.01773)	0.93399 (0.02016)
Ni						1	0.93399 (0.02016)	0.14158 (0.82034)	0.93944 (0.01773)
K							1	0.20075 (0.74613)	0.99933 (2.06637E-5)
Zn								1	0.22685 (0.71366)
Mn									1

Values in parenthesis indicate probability levels

Zinc concentration of the rice varieties was found in the range of 24.98 – 107.20 mg/kg. The highest concentration of zinc element was found in NERICA 4 rice variety and the lowest found in Ethiopian rice similar to copper and nickel metal. Zinc plays an important role in growth; it has a recognized action on more than 300 enzymes by participating in their structure or in their catalytic and regulatory actions (Salqueiro et al., 2002). Zinc deficiency triggers an array of health problems in children, many of which can become chronic, such as weight loss, weakened resistance to infections, and early death, while higher uptake of zinc can lead to muscle cramps, kidney damages and digestive problems The daily recommended range of zinc in human diet is 15 mg/day (Ismail et al., 2011). Zinc concentration in Malaysia rice was very low then the present study (Yap et al., 2009).

Manganese concentration in rice varieties was found in the range between 1.37 – 19.70 mg/kg. In similar with the concentration of zinc, the highest concentration was found in NERICA 14 and the lowest concentration found in Ethiopian white rice. Sources of dietary manganese include grain, rice, tea, and nuts. Manganese is toxic in excess; in the brain it can cause a Parkinson-type syndrome (Fregal, 2005). The daily recommended range of manganese in the human diet is 2-5 mg/day (Ismail et al., 2011). The concentration of manganese found in this study was lower than found in other study rice variety which is commercially available in Ethiopian (Tegegne et al., 2017) and comparable with Pakistan rice variety (Zubair et al., 2012).

Person's correlation

A correlation coefficient is a number between -1 and +1 that measures the degree of association between two variables. A positive value for the correlation implies a positive association between the variables and a negative value for the correlation implies a negative or inverse association of the variables. In this study, the Pearson correlation matrices using the correlation coefficient (r) for the samples were used and presented in Table 4 correlation of proximate and metal in Table 5, respectively.

Table 4 shows the correlation coefficients among the proximate values for protein, moisture, crude fiber, crude lipid, ash, carbohydrate, and energy. The correlation coefficients indicated for the proximate composition of rice varieties are not significantly important to show the relationship between the values. The result shows a very weak positive and very weak negative correlation. This analytically indicates no significant relationship between proximate values to be the value obtained in Table 1 and 2, no effect of one to the other.

Table 5 shows the correlation coefficients among the mineral elements in the analyzed rice varieties. The result indicated a strong positive correlation was obtained for Na with Cu and Zn, and K with Mn. On the other hand, a strong negative correlation was obtained for Mg and Cu. A moderate positive and negative correlation was widely observed between mineral elements studied in selected rice varieties. The positive correlation may indicate the presence of one value could be the reason of the other to be higher and for the negative correlation, the existence of one value could be the reason that the other be lower. In addition to this, no significant correlation indicates that the presence of one value has no role in the existence of the other value.

Analyses of variance (ANOVA) are widely used statistical methods to compare group means whether the source for variation was from experimental procedure or heterogeneity among the samples. The statistical analysis of variance (ANOVA) indicates a significant difference in the mean concentration at 95% confidence level. The source for this significant difference between sample means may be the difference in mineral contents of soil, pH of soil, pesticides, and insecticides used during cultivation (Alam et al., 2018; Andrade et al., 2018; Denardin et al., 2019; Li et al., 2019; Ni et al., 2019; Nuemsi et al., 2018; Oladele et al., 2019; Wan et al., 2018; Xiu et al., 2019; Xu et al., 2018; Yang et al., 2019).

CONCLUSIONS

The findings of this study revealed that the hybrid NERICA (new rice for Africa) rice was better than the imported and Ethiopian rice available and considered in this study in terms of nutrient composition. Furthermore, in the concentration of mineral elements in selected rice varieties are found in considerable amount and potassium was found in the highest concentration and nickel in the lowest concentration. Similarly with the proximate composition, NERICA rice provides high concentration of almost all elements determined. The Person correlation indicates that there was a very weak positive and negative correlation in proximate values and strong positive and negative correlation observed in elements determined in selected rice varieties.

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