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Mineral nutrient contents of some potato accessions of USA and Bangladesh

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Abstract

Twenty two potato accessions from USA were evaluated for nutrient contents. Two Bangladeshi varieties were also included for comparison. Nutritional analyses were performed in the Department of Agricultural Chemistry, BAU during November, 2014 to April, 2015. Considering macro nutrient content, the highest values of N, P, K and S were found in the accession AC 10062 whereas Ca and Mg contents were found highest in Bangladeshi variety Cardinal and USA accessions AC 10073, respectively. In case of micro nutrient, the maximum amounts of Cu, Mn, B and Zn were observed in accession AC 10110, AC 10069, AC 10073 and AC 10109, respectively. Significant positive correlations were observed between N-P, N-K and K-Mn contents while K-Mg, Mn-B and Cu-B contents were negatively correlated. Considering all the parameters studied, the USA accession AC 10062, AC 10069 and AC 10110 were nutritionally superior to Bangladeshi variety Diamant and Cardinal. The accession AC 10062 was found as the best USA accession to produce nutrient rich potato in Bangladesh.

Keyword: USA Potato accession, Nutrient content

Introduction

The word potato may refer to the plant itself as well as the edible tuber. The potato's story begins about 8,000 years ago near Lake Titicaca, which is at 3,800 m above sea level in the Andes mountain range of South America, on the border between Bolivia and Peru (Ahmad, 1977). Potato is an ideal crop grown very well in multiple cropping system prevalent countries having tropical and subtropical agro climatic conditions. It is used as a staple food in many countries of the world, but mainly as a vegetable in Bangladesh (Hussain, 1995). Potato is the 4th most important crop of Bangladesh. It alone contributes to about 63% of the total annual vegetables production in Bangladesh (BBS, 2014). Potato varieties grown in Bangladesh mostly are white fleshed. In 2007, a number of colored potato accession has been introduced from University of Wisconsin, Madison, USA and finally in Germplasm Center of Bangladesh Agricultural University. Their yield potential was very high considering climatic condition of Bangladesh. Nutritional status of those varieties is yet to be studied in Bangladesh.

Potato is a frequent item in the human diet; it is used in a variety of ways. It supplies the necessary daily requirements of various substances including macro and micro elements. Humans require at least 25 mineral elements for their well-being (White and Brown, 2010) and these mineral elements enter the food chain through plants. Potatoes are also an excellent source of these elements. Potatoes are an important source of different dietary minerals. Potato is listed as providing 18% of the RDA of K, 6% of Fe, P and Mg, and 2% Ca and Zn (True *et al.,* 1979). There are significant differences in major and trace mineral contents amongst different genotypes of potato (True *et al.,* 1978). Potassium levels varied the most and manganese the least (Andre *et al.,* 2007). So, the present research was carried out to characterize the USA potato accession in relation to nutrient contents and selecting suitable ones for commercial cultivation under Bangladesh condition.

Materials and Methods

In order to study nutrient contents, twenty two potato accessions of USA and two varieties from Bangladesh were analyzed. The USA accessions were AC 10016, AC 10062, AC 10063, AC 10064, AC 10068, AC 10069, AC 10072, AC 10073, AC 10074, AC 10076, AC 10077, AC 10078, AC 10081, AC 10097, AC 10109, AC 10110, AC 10112, AC 10120, AC 10122, AC 10123, AC 10125 and AC 10190, along with two varieties Diamant and Cardinal from Bangladesh. Potato tuber samples were collected

from Horticulture Farm, Bangladesh Agricultural University, Mymensingh. For chemical analysis, samples were oven dried at 80^{o}C for 72 hours and then ground. Total N was analyzed using Kjeldahl method. For the determination of other nutrients, the samples were digested by using di-acid mixture (HNO_3 : $HClO_4$ = 2:1) as described as Singh *et al*. (1999). Nutrient contents (P, K, Ca, Mg, S, Cu, Mn, Zn and B) of different potato accessions were determined by standard methods of analysis (Page *et al.,* 1982; Ghosh *et al.*, 1983; Tandon, 1995). The data were analyzed using Complete Randomized Design (CRD) and the pair comparisons were performed by DMRT test at 5% level of probability (Gomez and Gomez, 1984).

Results

The mineral nutrients are important potato quality criteria because of their physiological and nutritional value in human food (Högy and Frangmeier, 2009). In this study USA potato accessions and Bangladeshi varieties differed significantly with respect to tuber macro and micro nutrient concentrations.

Macro nutrient contents

Nitrogen

The experimental result showed that N content varied significantly among different accessions. The results have been sown in Table 1. The highest amount of N was found in the accession AC 10062 (2.19%) which had statistical similarity with the second highest accession AC 10069 (2.13%) and the third highest in the accession AC 10110 (1.98%) statistically differed with previous two. The lowest amount of N content was found in the accession AC 10122 (0.89%) which was identical with the accession AC 10109 (1.00%).

Phosphorus

The data on the P content of potato tubers were analyzed and shown in Table 1. The data showed significant variation in P content. Among the accessions it was observed that P content varied within the range of 0.12-0.47%. The highest P content was observed in the accession AC 10062 which was statistically identical with the accession AC 10110 (0.43%), AC 10069 (0.40%), and AC 10125 (0.39%). On the other hand the lowest P content was observed in the accession AC 10016 which was statistically identical with the accession AC 10068(0.18%), AC 10074 (0.19%) and 10097 (0.19%).

Potassium

Potassium content is one of the important parameter to evaluate the nutritional status of potato tuber. The results of K content of different potato accessions have been presented in Table 1. The results showed that K content varied within the range of 1.45-2.58%. The highest amount of K was found in the accession AC 10062 followed by the accession AC 10069 (2.35%) and the accession AC 10110 (2.24%). The lowest amount of K was observed in the accession AC 10112, statistically similar with the accession AC 10072 (1.52%) and AC 10123 (1.55%) respectively.

Sulphur

The S content of potato tubers varied significantly in different accessions or varieties as shown in Table 1. The highest S content was found in the accession AC 10062 (0.39%) which was not significantly higher than the S content of second and third highest accession AC 10069 (0.38%) and Cardinal (0.36%), respectively. The lowest S content was in the accession AC 10076 and AC 10123 (0.07%), the second and third lowest S content were obtained from the accession AC 10109 (0.08%) and AC 10190 (0.09%) were statistically identical.

Calcium

The effect of accession on Ca content in potato tuber was statistically significant (Table 1). The highest Ca content (0.15%) was found in Cardinal which was statistically alike with the accession AC 10125 and AC 10069 (0.14%). The lowest amount of Ca was observed in the accession AC 10016 (0.03%) which was statistically similar to that of the accession AC 10077 (0.04%).

Magnesium

The results presented in Table 1 showed that potato accessions had significant effect on Mg content. The highest Mg content was observed in the accession AC 10073 (0.34%) identically followed by accession AC 10072 and AC 10112 (0.33%). The lowest Mg content was observed in the accession AC 10125 (0.07%) identically followed by the variety Cardinal (0.08%) and the accession AC 10062 (0.10%).

Table 1. Macronutrient contents of some potato accessions of USA and Bangladesh

Sl. no.	Accession	Nutrient content (% dry weight)					
		Nitrogen	Phosphorus	Potassium	Sulphur	Calcium	Magnesium
1	10016	1.57fgh	0.12k	1.86f-i	0.11ijk	0.026k	0.16gh
2	10062	2.19a	0.47a	2.58a	0.39a	0.086fg	0.10lm
3	10063	1.73de	0.37b-e	1.85g-j	0.24c-f	0.12bc	0.13ij
4	10064	1.82cd	0.32c-f	1.93e-h	0.26cde	0.13bc	0.14hi
5	10068	1.04m	0.18ijk	1.67j-m	0.16f-j	0.13bc	0.16g
6	10069	2.13a	0.40abc	2.35b	0.38a	0.14ab	0.12jk
7	10072	1.05m	0.33c-f	1.52mn	0.24def	0.13bc	0.33a
8	10073	1.19l	0.28fgh	1.68i-m	0.19e-i	0.06hi	0.34a
9	10074	1.54gh	0.19ijk	1.75ijk	0.21d-g	0.10f	0.29c
10	10076	1.68efg	0.30efg	2.03def	0.07k	0.05ij	0.27c
11	10077	1.65efg	0.34c-f	1.72i-l	0.19e-i	0.04jk	0.18f
12	10078	1.31jkl	0.13jk	1.69i-m	0.35ab	0.10ef	0.23d
13	10081	1.38ij	0.21hij	1.68i-m	0.20d-h	0.12bc	0.22e
14	10097	1.45hi	0.19ijk	1.71i-l	0.12h-k	0.08fg	0.24d
15	10109	1.00mn	0.32def	1.95efg	0.08jk	0.07gh	0.19f
16	10110	1.98b	0.43ab	2.24bc	0.32abc	0.13bc	0.16g
17	10112	1.21kl	0.30efg	1.45n	0.15ghk	0.12cd	0.33a
18	10120	1.34ijk	0.26f-i	1.60k-n	0.27bcd	0.13bc	0.21e
19	10122	0.89n	0.22ghi	1.77h-k	0.23d-g	0.11cde	0.17fg
20	10123	1.26jkl	0.23ghi	1.55lmn	0.07k	0.10def	0.29c
21	10125	1.90bc	0.39a-d	2.16cd	0.33abc	0.14ab	0.07n
22	10190	1.66efg	0.26f-i	1.67klm	0.09jk	0.12bc	0.31b
23	Cardinal	1.91bc	0.38b-e	2.08cde	0.36a	0.15a	0.08mn
24	Diamant	1.70def	0.34c-f	1.98efg	0.28bcd	0.13bc	0.11kl
$LSD_{0.05}$		0.127	0.073	0.16	0.07	0.02	0.02
CV (%)		5.13	13.88	5.10	3.98	9.61	4.56
SE(±)		0.08	0.02	0.06	0.02	0.007	0.017

Micro nutrient contents

Copper

The results of Cu content of different potato accessions or varieties have been presented in Table 2. The results showed that Cu content varied within the range of 10.14 - 35.77 µg g^{-1}. The highest amount of Cu was found in the accession AC 10110 followed by the accession AC 10069 (35.57 µg g^{-1}) and AC 10062 (34.07 µg g^{-1}) were the second and third highest, respectively. The lowest amount of Cu was observed in the accession AC 10076 statistically similar with the accession AC 10097 (11.08 µg g^{-1}) and AC 10073 (11.68 µg g^{-1}), respectively.

Manganese

The Mn content of potato tubers varied significantly in different accessions as shown in Table 2. The highest Mn content was found in the accession AC 10069 (50.61 µg g^{-1}) which was not significantly higher than the second and third highest the accession AC 10062 (49.19 µg g^{-1}) and AC 10110 (48.27 µg g^{-1}), respectively. The lowest Mn content was in the accession AC 10097 (7.43 µg g^{-1}), which was statistically identical with the second lowest accession AC 10109 (9.35 µg g^{-1}) and AC 10073 (11.60 µg g^{-1}) was statistically differed with previous two.

Boron

The effect of accession or varieties on the B content in potato tuber was statistically significant (Table 2). The highest B content (15.78 µg g^{-1}) was found in the accession AC 10073 which was statistically alike with the accession AC 10190, AC 10078, AC 10072 and AC 10120. The lowest amount of B content was observed in the accession AC 10062 (3.67 µg g^{-1}) which was statistically similar to that of accession AC 10069, AC 10110, variety Cardinal and AC 10125.

Zinc

The results have been presented in Table 2 showed that accessions had significant effect on Zn content. The range of Zn content varied between 21.80 to 45.80 µg g^{-1}. The highest amount of Zn content was observed in Cardinal closely followed by accession AC 10125 (44.63 µg g^{-1}) and variety Diamant (44.57 µg g^{-1}). The lowest Zn content was observed in the accession AC 10109 (21.80 µg g^{-1}) closely followed by the accession AC 10120 (23.33 µg g^{-1}) and 10072 (23.77 µg g^{-1}).

Table 2. Micronutrient contents of some potato accessions of USA and Bangladesh

Sl. no.	Accession	Nutrient Content (µg g^{-1} dry weight)			
		Copper	Manganese	Boron	Zinc
1	10016	24.27cd	38.31cd	10.52bc	25.13h-k
2	10062	34.07a	49.19a	3.670i	36.07bc
3	10063	23.47cd	28.94h	7.147efg	32.97de
4	10064	25.10c	35.15ef	7.233efg	38.33b
5	10068	13.48g	14.13lm	10.93bc	32.43cde
6	10069	35.57a	50.61a	4.71hi	44.27a
7	10072	15.98f	15.47kl	14.68a	23.77ijk
8	10073	11.68gh	11.60mn	15.78a	42.43a
9	10074	21.99de	32.08g	9.83cd	26.10hij
10	10076	10.14h	32.42fg	8.00ef	30.57efg
11	10077	30.47b	43.01b	8.37de	35.90bc
12	10078	17.46	18.12k	14.96a	31.57def
13	10081	16.71f	17.80k	11.43bc	25.37h-k
14	10097	11.08gh	7.43o	10.93bc	25.23h-k
15	10109	22.36de	9.35no	7.14efg	21.80k
16	10110	35.77a	48.27a	4.85hi	38.57b
17	10112	17.77f	21.86j	10.06cd	35.33bcd
18	10120	18.09f	24.19ij	14.50a	23.33jk
19	10122	20.89e	35.94de	12.07b	28.17fgh
20	10123	18.49f	26.91hi	11.73bc	27.63ghi
21	10125	33.50a	44.83b	5.403ghi	44.63a
22	10190	13.18g	12.35m	15.59a	34.70bcd
23	Cardinal	28.60b	39.56c	5.193hi	45.80a
24	Diamant	30.80b	44.87b	6.30fgh	44.57a
$LSD_{0.05}$		2.31	2.76	1.68	3.60
CV (%)		6.38	5.76	10.69	6.64
SE(±)		1.63	2.83	0.76	1.55

Correlation among different parameters

Different correlation among N, P, K and Mn (N-P, N-K and K-Mn) contents in potato tuber indicate significant positive correlation at 1% level of probability with each other (Fig.2). The value of correlation of coefficient (r) was 0.61**, 0.78** and 0.71**, respectively with the regression line y = 0.160x + 0.046; y = 0.597x + 0.942 and y = 35.79x - 37.06. On the other hand significant negative relationship was observed among K-Mg, Mn-B and Cu-B contents at 1% level of probability with each other (Fig.2). The value of correlation of coefficient (r) was - 0.72**, - 0.76** and - 0.78**, respectively with the regression line y = - 0.219x + 0.607; y = - 0.199x + 15.46 and y = - 0.364x + 17.67.

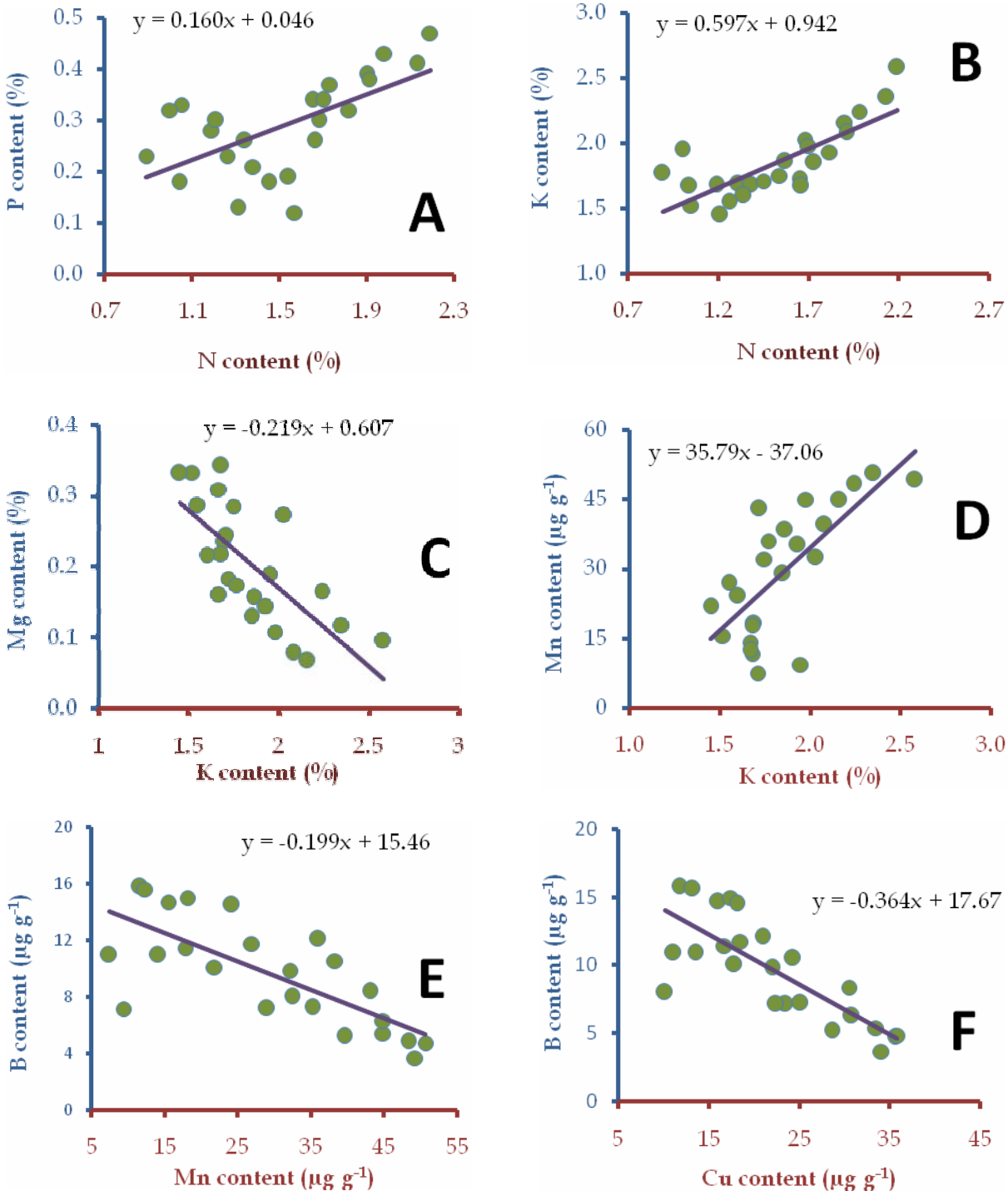

Fig. 2. Correlation between N and P content (A), N and K content (B), K and Mg content (C), K and Mn content (D), Mn and B content (E), Cu and B content (F) of different potato accessions of USA and Bangladesh

Discussion

A wide range of mineral elements occurs in fruits and vegetables, which are primary dietary source. The importance of optimal mineral intake to maintain good health is widely recognized (Avioli, 1988). Potatoes are an important source of different dietary minerals. Potato is listed as providing 18% of the Reference Daily Intake (RDA) of potassium, phosphorus and magnesium, and 2% calcium and zinc (True *et al.*, 1979). Potatoes rank highest for K content among 20 most frequently consumed cereals including rice and wheat, raw vegetables and fruits. (Casanas *et al.,* 2002; Rivero *et al.,* 2003: Sanchez-Castillo. 1998). The K content in potato is as even higher amount than in banana, a food often recommended by dieticians to people who need to supplement potassium consumption (Lisinka and Leszczynski, 1989).

In this study the P, K, Ca and Mg content are in agreement with the study of Ekin (2011). In general, the contents of N, P, K, S, Ca and Mg are similar to those, reported by other authors working on potatoes (Rivero *et al*., 2003; Tekaling and Hammes, 2005; Andre *et al.,* 2007; DiGiacamo *et al.,* 2007). The present study also showed that the N, P, K and S content of accession AC 10062, AC10069 and AC10110 were higher than the Bangladeshi variety Diamant and Cardinal, which are also high yielding (Kabir 2014).The levels of Cu, Mn, and Zn in this study are alike with those reported by Haynes *et al.* (2012). They observed average Mn, Cu, and Zn contents were 10.2, 9.9, and 20.0 mg kg^{-1} of FW, respectively and concluded that genetic variation had significant influence on micronutrient contents of potato. In general, the contents in Cu, Mn, B and Zn are also similar to those reported by others (Andre *et al.,* 2007; Rivero *et al.,* 2003, Dugo *et al.,* 2004). B content of most of the tested USA accession are very high than Bangladeshi varieties Diamant and Cardinal.

The differences in macro and micro nutrient concentrations of potato tuber could be explained by several factors. First and foremost is the potato cultivar characteristic. Indeed, the tuber mineral concentrations may vary among genotypes of cultivated potatoes. There is evidence that potato genotypes, grown under identical conditions, have been shown to differ in tuber macro and micro nutrient concentrations (Tekalign and Hammes, 2005; White et al., 2009) and systematic differences in tuber K, Mg, Fe, Zn, Mn and Cu concentrations have been observed between commercial potato cultivars (Rivero *et al*., 2003; DiGiacomo *et al*., 2007).

Conclusion

Nutrient contents of different potato accessions of USA and Bangladesh differed significantly. Among the twenty four accessions under trial the accession AC 10062 was superior to other accessions acknowledging nutrient content. Therefore, accession AC 10062 can be suggested to cultivate in Bangladesh to produce nutritionally superior potato.

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