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Utilization of indigenous potato (*Solanum tuberosum*) varieties as a source of micronutrient

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ABSTRACT

Potato (*Solanum tuberosum* L.) is the most important non-grain food crop globally. Efforts are being made to breed biofortified potato varieties to mitigate malnutrition. Knowledge about micronutrient content is beneficial from nutritional and health view point. Sixty-three indigenous or *desi* potato varieties were evaluated for micronutrient content in whole tuber and tuber flesh. Mineral content of whole tuber was higher than tuber flesh alone depicting peel contains micronutrients. The zinc, iron, copper and manganese content in whole tuber on dry weight basis varied from 14.66-30.27, 26.82-48.15, 5.29-17.87 and 7.51-28.79 mg/kg or ppm, respectively, while in tuber flesh, the range was 13.67-26.71, 18.11-40.27, 4.48-16.91 and 5.81-21.46 mg/kg, respectively. Moderate correlation observed between iron and zinc content (r=0.483) and manganese and copper content (r=0.354) in tuber flesh implies possibility of simultaneous selection. Significant positive correlation of tuber flesh elemental content to that of whole tuber signifies the higher contribution of tuber flesh to overall nutrient content of whole tuber compared to potato peel deterring the misconception that majority of potato nutrients are found in the peel. NJ 130, Lal Jyoti, Desi No.1, V2 2912, Aruconia, DRR Red, Sathoo and JG-1 were high in individual and combined minerals. This study signifies that potato indigenous or *desi* varieties are potential source of micronutrients particularly zinc. Production of disease free seeds of the varieties particularly by farmers needs to be emphasised. Identified accessions may serve as parental lines in breeding nutrient rich potatoes.

Keywords: *Desi* potato, Micronutrient, Tuber flesh, Whole tuber

Potato (*Solanum tuberosum* L.) is a new world crop that originated and was domesticated in Andes of South America. The introduction of this crop in India dates back to 17th century. The initial introductions were either *Solanum tuberosum* ssp. *andigena* or hybrids of *tuberosum* and *andigena*. Though a non-native crop, in due course of cultivation of these introductions got adapted and further selections mainly by farmers led to the development of indigenous or *desi* varieties (Pal and Pushkarnath 1951). Presently, these collections are being conserved in CPRI potato genebank *in vitro* and *in vivo*. Some of these old varieties are still under commercial cultivation (Gupta *et al*. 2009, Pradela *et al*. 2019) or being used as parental material in breeding programme, eg. Phulwa appears in pedigree of Kufri Safed, Kufri Sheetman, Kufri Chamatkar and Kufri Dewa and clonal selection from Darjeeling Red Round led to development of Kufri Red. Recently, usage of Bareilly Red in the nutrient rich potato breeding has been initiated (Luthra *et al*. 2018). Wang *et al*. (2019) documented cultivation of potato landraces in China due to their taste preference or adaptability, where this crop was introduced in 16th century.

Micronutrient deficiency hampers health and productivity of over half of the world's population. Human body requires 25 mineral elements for proper health and functioning. Iron deficiency primarily causes anaemia. Zinc deficiency in human body leads to hypogonadism, hepatosplenomegaly, geophagia and dwarfism. Symptoms of copper deficiency are skeletal defects, breakdown of nervous system, depigmentation or hypopigmentation. Manganese deficiency manifests as birth defects, skin related issues, glucose intolerance, skeleton disorders and hair discolouration. Low concentration of phytates and high ascorbic acid, b-carotene, organic acids etc. renders potatoes ideal food crop for nutrient biofortification. Potato is the most per capita consumed vegetable of India with projection of rise in production to 125 million tonnes by 2050 at an annual compounded growth rate of 3.20%. The objective of present study was to characterize *desi* potato varieties for their mineral content in view of future use as parental lines or as nutrient rich varieties.

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MATERIALS AND METHODS

Sixty-three *desi* potato varieties were analysed for four micronutrients, viz. zinc, iron, copper and manganese. The morphological descriptions are given in Supplementary Table 1.

Potato tuber samples were collected from DUS reference collection experimental plot, ICAR-CPRS, Kufri in 2018 to raise the crop. Recommended cultural practices were followed. The soil of the experimental plot was acidic (*p*H 6.1) and the available micronutrients were high. Ten uniform sized tubers with no cuts and cracks were selected for each genotype. Tubers were initially washed under running tap water followed by washing with 0.1N nitric acid and finally with distilled water and oven dried. Peel thickness was approximately less than one mm. Each potato tuber was cut into four equal slices longitudinally and diced into cubes of uniform size. Samples were oven dried at 70ºC in glass petri dishes and ground in a stainless steel grinder. Micronutrient contents in whole and peeled (tuber flesh) tuber were determined by standard methods of analysis after acid digestion in inductively coupled optical spectrometry. The data were analyzed using complete randomized design and pair comparisons were performed by DMRT test at level of $P<0.05$. Correlation coefficients were computed to find inter-relationship amongst the nutrient in whole tuber as well as tuber flesh.

RESULTS AND DISCUSSION

Zinc: The genotypic effect on zinc content in potato tuber flesh and whole tuber was statistically significant (Table 1). The concentration ranged from 13.67-26.71 mg/kg DW in tuber flesh and 14.66-30.27 mg/kg DW in whole tuber. The highest zinc content in tuber flesh on dry weight basis was in NJ-130 (26.71 mg/kg DW) that was statistically at par with Desi No.1 (25.51), JG-1 (25.29), Lal Jyoti (24.92) and Sathoo (24.91), whereas the lower zinc content was found in VK/JG-9 (13.67 mg/kg DW), ON 1645 (14.09), 1591/11 (14.20), NJ-12 (14.28), VK/ JG (14.44), Gulmarg Special (14.90), Lal mitti-2 (15.12) and Deshla (15.52). Zinc content in tuber flesh on dry weight basis of Indian commercial potato varieties has been reported in the range of 12.59 to 22.85 mg/kg (Sharma *et al*. 2017), while tuber flesh of germplasm collection showed wider variations i.e. 2.78-35.40 mg/kg in *tuberosum* accessions (Dalamu *et al*. 2017) and 12.33- 33.87 mg/kg in *andigena* germplasm collection (Singh *et al*. 2020). Native Andean varieties have been reported to have lower zinc content of 8-20 mg/kg in tuber flesh on dry weight basis (Burgos *et al*. 2007) highlighting the better zinc nutrition profile of genotypes like NJ-130 (26.71 mg/kg) for its utilization in breeding programs. Also considering the fact that these initially

Table 1 Micronutrient content of indigenous or *desi* potato varieties

Mineral	Zinc (mg/kg DW)		Iron (mg/kg DW)		Copper (mg/kg DW)		Manganese (mg/kg DW)	
Accession	Tuber Flesh	Whole tuber	Tuber Flesh	Whole tuber	Tuber Flesh	Whole tuber	Tuber Flesh	Whole tuber
AGR-56	21.55^{cd}	24.18^{c-e}	32.47^{d}	40.84^{b-d}	6.98^{g-k}	10.67^{e-g}	6.92^{m}	9.55^{kl}
Alpha	17.86^{g-l}	21.83^{d-f}	23.98^{kl}	28.71^{n}	10.79^{c-e}	14.19^{b-e}	21.15^{a}	23.21^{bc}
Aruconia	24.10^{bc}	24.64^{c-e}	36.78^{ab}	42.89^{b}	6.52^{g-k}	8.94^{h-k}	21.46^{a}	28.79^{a}
Assomia Alu	19.38^{e-h}	22.20^{d-f}	26.06^{hi}	30.39^{k-n}	6.98^{g-k}	8.67^{h-k}	12.95^{f-j}	17.65^{h-j}
Australian White	16.68^{g-l}	17.22^{h-k}	24.31^{i-k}	34.46^{f-i}	4.71^{k}	6.51^{m}	15.17^{d-f}	17.45^{h-j}
Beeta	16.29^{g-l}	17.11^{h-k}	24.89^{i-k}	34.73^{f-i}	9.53^{f-h}	10.64^{e-g}	16.00^{cd}	17.69^{h-j}
Bengal Jyoti	17.20^{g-l}	18.85^{h-k}	21.77^{l}	28.19^{n}	9.97^{f-h}	11.88^{de}	12.20^{h-j}	15.97^{ij}
Bhura Alu	23.65^{bc}	27.93^{ab}	28.22^{f-h}	32.70^{jk}	10.42^{f-h}	12.74^{de}	20.94^{a}	22.42^{c-e}
Brondiar Slave	17.93^{g-l}	18.78^{h-k}	30.45^{de}	39.70^{c-e}	8.01^{g-k}	9.92^{g-i}	8.67^{k-m}	11.11^{kl}
C-9 Patna	18.63^{e-h}	20.69^{fg}	36.32^{cd}	38.27^{ef}	12.20^{c-e}	15.16^{b}	9.64^{j-m}	10.70^{kl}
Clone-I	18.71^{e-h}	26.62^{bc}	34.37^{d}	43.64^{b}	13.50^{bc}	16.92^{a}	19.96^{ab}	23.71^{bc}
Dehati Alu	19.39^{e-h}	22.23^{d-f}	34.87^{cd}	43.17^{b}	11.64^{c-e}	13.20^{de}	14.43^{e-j}	16.61^{h-j}
Deshla	15.52^{kl}	16.35^{k-m}	23.04^{l}	29.61^{k-n}	9.75^{f-h}	11.72^{de}	13.30^{f-j}	18.74^{f-j}
Desi Alu	18.40^{e-h}	21.05^{fg}	24.18^{i-k}	36.03^{fg}	7.64^{g-k}	8.52^{j-l}	15.57^{d-f}	19.46^{f-j}
Desi no.1	25.51^{a-c}	27.08^{ab}	33.56^{d}	44.49^{b}	9.40^{f-h}	13.43^{b-e}	8.10^{k-m}	12.11^{k}
Desi no.2	17.07^{g-l}	21.09^{fg}	27.94^{hi}	40.72^{b-d}	7.61^{g-k}	9.01^{h-k}	18.07^{b-d}	18.75^{f-j}
DRR Blue	16.68^{g-l}	20.25^{g-i}	23.75^{l}	34.33^{f-i}	7.54^{g-k}	10.97^{e-g}	5.81^{m}	7.51^{l}
DRR Red	19.25^{e-h}	22.02^{d-f}	22.17^{l}	27.16^{n}	14.34^{bc}	14.13^{b-e}	20.84^{a}	21.74^{c-e}
Dwarf Culture	18.67^{e-h}	20.07^{g-i}	18.11^{lm}	33.60^{f-i}	8.14^{g-k}	9.33^{h-k}	17.61^{b-d}	20.19^{e-g}
Garlentic	17.52^{g-l}	19.57^{g-i}	22.75^{l}	28.88^{k-n}	12.89^{bc}	14.92^{bc}	14.03^{f-j}	16.57^{h-j}
Gulmarg Special	14.90^{kl}	16.54^{k-m}	29.27^{f-h}	37.92^{ef}	5.76^{k}	7.02^{lm}	17.18^{cd}	20.15^{e-g}
HYB-3	19.20^{e-h}	20.45^{g-i}	27.86^{hi}	29.98^{k-n}	8.43^{g-k}	10.20^{e-g}	10.32^{ij}	15.79^{ij}

Contd.

Table 1. (*Concluded*)

Mineral	Zinc (mg/kg DW)		Iron (mg/kg DW)		Copper (mg/kg DW)		Manganese (mg/kg DW)	
Accession	Tuber Flesh	Whole tuber	Tuber Flesh	Whole tuber	Tuber Flesh	Whole tuber	Tuber Flesh	Whole tuber
JG-1	25.29^{a-c}	26.31^{bc}	29.65^{f-h}	32.92^{h-j}	11.20^{c-e}	17.87^{a}	21.41^{a}	23.25^{bc}
JG-2	19.52^{e-h}	22.91^{d-f}	36.46^{a-c}	43.20^{b}	11.36^{c-e}	14.46^{bc}	7.27^{lm}	9.52^{kl}
JG-22	21.47 ^{cd}	24.59^{c-e}	39.05^{a}	41.61^{b-d}	9.50^{f-h}	12.50^{de}	17.97^{b-d}	18.91^{f-j}
JG-25	23.67^{bc}	24.65^{c-e}	28.92^{f-h}	31.72^{jk}	7.40^{g-k}	10.32^{e-g}	11.15^{h-j}	14.52^{ij}
JG-27	18.39^{e-h}	19.47^{g-i}	24.33^{i-k}	36.42^{fg}	6.65^{g-k}	7.84^{j-l}	9.63^{j-m}	10.87^{kl}
JG-56	19.78^{c-e}	20.63^{g-i}	24.97^{i-k}	29.00^{k-n}	12.43^{c-e}	14.72^{bc}	18.27^{b-d}	23.23^{bc}
JN-2303	18.41^{e-h}	21.18^{fg}	24.58^{i-k}	32.41^{jk}	11.36^{c-e}	15.50^{b}	20.15^{a}	23.35^{bc}
Kacha Bhutia	17.79^{g-l}	19.29^{g-i}	28.71^{f-h}	31.13^{jk}	9.68^{f-h}	12.61^{de}	8.04^{k-m}	11.47^{kl}
Kanpuria Safed	18.17^{e-h}	20.13^{g-i}	24.91^{i-k}	27.64^{n}	13.85^{bc}	15.68 ^{b}	16.86^{cd}	19.77^{e-g}
Kranti	22.63^{bc}	28.04^{ab}	25.02^{i-k}	30.81^{k-n}	7.80^{g-k}	8.96^{h-k}	14.77^{e-j}	23.35^{bc}
Lah Polin	20.34^{cd}	24.68^{c-e}	27.74^{hi}	30.76^{k-n}	13.93^{bc}	14.33^{b-e}	14.71^{e-j}	17.66^{h-j}
Lah Smit	17.76^{g-l}	18.48^{h-k}	25.08 $^{i-k}$	27.52^{n}	14.37^{bc}	13.71^{b-e}	19.35^{b}	22.88^{bc}
Lah Arpor	21.01^{cd}	22.18^{d-f}	26.46^{hi}	30.92^{jk}	11.84^{c-e}	7.81^{j-l}	13.72^{f-j}	19.83^{e-g}
Lal Ankh	18.16^{e-h}	20.02^{g-i}	29.66^{f-h}	33.67^{f-i}	7.74^{g-k}	9.38^{h-k}	16.75^{cd}	20.34^{e-g}
Lal Gulab	22.07 ^{cd}	23.16^{d-f}	27.10^{hi}	27.69^{n}	13.32^{bc}	14.06^{b-e}	19.58^{b}	20.87^{c-e}
Lal Jyoti	24.92^{a-c}	29.23^{a}	40.27^{a}	48.15^{a}	11.45^{c-e}	15.90^{b}	20.57^{a}	26.96^{a}
Lal mitti-1	22.83^{bc}	23.53^{c-e}	36.10^{cd}	46.23^{a}	12.94^{bc}	14.32 $^{b-e}$	18.74^{b-d}	19.81^{e-g}
Lal mitti-2	15.12^{kl}	17.18^{h-k}	25.26^{i-k}	32.93^{f-i}	5.02^{k}	5.29^{m}	17.49^{cd}	20.87^{c-e}
NJ-12	14.28^{kl}	17.21^{h-k}	23.61^{l}	32.83^{h-j}	5.16^{k}	7.94^{j-l}	10.97^{ij}	12.72^{k}
NJ-23	17.44^{g-l}	18.65^{h-k}	32.06^{de}	40.73^{b-d}	7.17^{g-k}	9.78^{h-k}	12.88^{f-j}	16.47^{ij}
NJ-42	20.25^{cd}	23.89^{c-e}	30.73^{de}	43.14^{b}	5.12^{k}	7.27^{j-l}	6.54^{m}	10.47^{kl}
NJ-62	18.16^{e-h}	20.79^{fg}	27.70^{hi}	35.06^{fg}	7.45^{g-k}	10.39^{e-g}	5.91^{m}	8.07^{l}
NJ-75	20.66^{cd}	23.02^{d-f}	31.46^{de}	38.27^{ef}	8.19^{g-k}	11.43^{e-g}	6.97^{lm}	7.80^{l}
NJ-78	16.93^{g-l}	17.64^{h-k}	25.87^{i-k}	36.10^{fg}	4.48^{k}	6.51^{m}	18.02^{b-d}	21.31^{c-e}
NJ-130	26.71^{a}	27.70^{ab}	34.54^{cd}	41.80^{b-d}	9.87^{f-h}	11.13^{e-g}	9.34^{k-m}	10.40^{kl}
ON-1645	14.09^{kl}	15.01^{k-m}	26.84^{hi}	40.87^{b-d}	4.89^{k}	5.29^{m}	11.93^{h-j}	13.88^{i-k}
Phulwa White	16.43^{g-l}	19.22^{g-i}	27.88^{hi}	34.33^{f-i}	9.17^{f-h}	11.74^{de}	6.56^{m}	9.81^{kl}
PR/RC-292	17.46^{g-l}	19.68^{g-i}	28.80^{f-h}	32.54^{jk}	7.20^{g-k}	9.29^{h-k}	14.63^{e-j}	17.15^{h-j}
PHC/11	20.02^{c-e}	21.60^{d-f}	23.64^{l}	26.82^{n}	10.23^{f-h}	12.93^{de}	19.27^{b}	22.77^{c-e}
PSK-76	23.27^{bc}	27.15^{ab}	27.11^{hi}	34.95^{fg}	7.97^{g-k}	9.27^{h-k}	11.94^{h-j}	13.15^{k}
Rajendra-2	17.08^{g-l}	19.60^{g-i}	27.58^{hi}	36.13^{fg}	10.43^{f-h}	11.25^{e-g}	8.45^{k-m}	9.37^{l}
Rangpuria	16.13^{g-l}	19.07^{h-j}	24.82^{i-k}	29.76^{k-n}	6.49^{g-k}	9.07^{h-k}	13.01^{f-j}	17.11^{h-j}
Sathoo	24.91^{a-c}	30.27^{a}	31.72^{de}	41.49^{b-d}	6.89^{g-k}	9.62^{h-k}	6.80^{m}	8.86^{l}
V2-2912	19.09^{e-h}	20.30^{g-i}	23.24^{l}	28.89^{k-n}	16.91^{a}	17.74^{a}	20.11^{a}	22.82^{bc}
VB-8	18.37^{e-h}	19.41^{g-i}	22.37^{l}	27.76^{n}	11.11^{c-e}	12.36^{de}	19.11^{b-d}	20.28^{e-g}
VK/JG	14.44^{kl}	15.44^{k-m}	29.05^{f-h}	36.44^{fg}	6.75^{g-k}	9.48^{h-k}	12.48^{h-j}	14.66^{ij}
VK/JG-1	20.80 ^{cd}	22.10^{d-f}	34.34^{d}	38.76^{ef}	8.50^{f-h}	11.32^{e-g}	10.45^{ij}	13.36^{k}
VK/JG-2	18.99^{e-h}	21.52^{d-f}	24.66^{i-k}	40.50^{b-d}	7.07^{g-k}	9.11^{h-k}	16.78^{cd}	18.68^{f-j}
VK/JG 9	13.67^{kl}	14.66^{k-m}	27.58^{hi}	40.61^{b-d}	9.63^{f-h}	10.52^{e-g}	16.19^{cd}	18.74^{f-j}
1001	21.08^{cd}	24.12^{c-e}	25.02^{i-k}	27.66^{n}	11.92^{c-e}	12.74^{de}	18.12^{b-d}	21.62^{c-e}
1591/11	14.20^{kl}	16.65^{k-m}	24.34^{i-k}	31.10^{jk}	5.71^{k}	6.56^{m}	19.77^{ab}	20.78^{c-e}
Mean	19.14	21.38	28.04	35.11	9.25	11.22	14.33	17.20
Range	13.67-26.71	14.66-30.27	18.11-40.27	26.82-48.15	4.48-16.91	5.29-17.87	5.81-21.46	7.51-28.79
SD	3.07	3.59	4.64	5.57	2.83	3.02	4.75	5.15
SE	0.45	0.39	0.58	0.70	0.36	0.38	0.60	0.65

introduced material were non-tuberosum or hybrids of tuberosum in origin, usage of these genetic resources would broaden the genetic base of commonly cultivated potatoes, i.e. *Solanum tuberosum* ssp. *tuberosum*. The trend of zinc content in whole tuber was similar to that in tuber flesh with highest performing genotypes being Sathoo (30.27 mg/kg DW), Lal Jyoti (29.23), Kranti (28.04), Bhura Alu (27.93), NJ-130 (27.70), PSK-76 (27.15) and Desi No. 1 (27.08).

Iron: Along with zinc, iron is the most important nutrient element for human nutrition. The highest iron content in tuber flesh was observed in Lal Jyoti (40.27 mg/kg DW) followed by JG-22 (39.05), Aruconia (36.78) and JG-2 (36.45). Genotypes containing lower iron concentration were Dwarf Culture (18.11 mg/kg DW) that was statistically similar in content to Bengal Jyoti (21.77), DRR Red (22.17), VB-8 (22.37), Garlentic (22.75), Deshla (23.04), V2-2912 (23.24), NJ-12 (23.61), PHC/11 (23.64) and DRR Blue (23.75). The iron concentration in tuber flesh of Indian potato varieties ranged between 19.96 to 49.51 mg/kg (Sharma *et al*. 2017) which was higher than present genotypes while lower range of iron content in tuber flesh of Andean potato varieties (9-37 mg/kg) was reported (Burgos *et al*. 2007). Singh *et al*. (2020) found iron concentrations of 18.03-45.97 mg/kg in tuber flesh of *andigena* germplasm while *tuberosum* germplasm have much higher content of 14.90-67.13 mg/kg DW (Dalamu *et al*. 2017). The whole tuber iron content was in range of 26.82-48.15 mg/kg DW. The genotypes having high iron content in whole tuber were Lal Jyoti (48.15 mg/kg DW) that was statistically similar to Lal mitti-1 (46.23) followed by Desi No. 1 (44.49) that was statistically lower than previous two accessions. The trend of iron content in tuber flesh was not much similar to that in whole tuber as compared to those of zinc content in tuber flesh and whole tuber that may be due to chances of soil contaminations (Burgos *et al*. 2007).

Copper: Copper content also showed a great degree of variation (>3 times) amongst varieties both in tuber flesh and whole tuber. The copper content in tuber flesh was highest in V-2 2912 (16.91 mg/kg DW), which was significantly higher than the second highest content genotype Lah Smit (14.37). The lowest amount of copper in tuber flesh was observed in NJ 78 (4.48 mg/kg DW), Australian White (4.71), ON 1645 (4.89), Lal mitti-2 (5.02), NJ- 42 (5.12), NJ-12 (5.16), 1591/11 (5.71) and Gulmarg Special (5.76). In Indian potato varieties the copper content of tuber flesh ranged from 5.13- 21.06 mg/kg dry weight basis (Sharma *et al*. 2017) signifying present set of germplasm as moderate source of copper. Singh *et al*. (2020) reported that *andigena* germplasm also have higher copper content in tuber flesh (4.43-22.47 mg/kg). In whole tuber, the copper content was in the range of 5.29-17.87 mg/kg DW. The highest concentration of copper in whole tuber was found in accession JG-1 (17.87 mg/kg DW) statistically similar to second highest genotype V2 2912 (17.74) and Clone-I (16.92). On the other hand, lowest copper concentration in whole tuber was found in Lal Mitti-2 and ON 1645 (5.29 mg/kg DW each) followed by NJ-78 and Australian White (6.51 each) and 1591/11 (6.56). Like iron, the trend of copper content in tuber flesh and whole tuber was not similar.

Manganese: Like copper large variations (>3 times) were also observed in manganese content of tuber flesh as well as whole tuber. Aruconia (21.46 mg/kg DW), JG-1 (21.41), Alpha (21.15), Bhura Alu (20.94) and DRR Red (20.84) had higher tuber flesh manganese content, while DRR Blue (5.81 mg/kg DW) followed by NJ-62 (5.91), NJ-42 (6.54), Phulwa White (6.56), Sathoo (6.80), AGR-56 (6.92), NJ-75 (6.97) and JG-2 (7.27) had lower manganese content. Manganese content in tuber flesh of Indian potato varieties varied from 14.19 to 29.86 mg/kg (Sharma *et al*. 2017) and in *andigena* potato germplasm from 7.27 to 29.80 mg/kg (Singh *et al*. 2020). Manganese concentration in whole tuber ranged from 7.51-28.79 mg/kg DW. Genotypes Aruconia (28.79 mg/kg DW) and Lal Jyoti (26.96) had high manganese content, whereas DRR Blue (7.51 mg/kg DW), NJ-75 (7.80), NJ-62 (8.07), Sathoo (8.86) and Rajendra-2 (9.37) had low manganese content in whole tuber.

Correlation between different traits: Correlation coefficients were computed to find relationships between micronutrients (Data not presented). Moderate correlation was observed between iron and zinc content in tuber flesh (r=0.483) and iron content in tuber flesh and zinc content of whole tuber (r=0.478) at 5% level of probability with regression y=0.7301x+14.06l and y=0.618x+14.81, respectively. Positive significant correlations between iron and zinc concentrations irrespective of locations were also reported by Burgos *et al*. (2007), Dalamu *et al*. (2017) and Subramanian *et al*. (2017). Zinc content in tuber flesh and whole tuber also had positive and significant correlations with copper content of whole tuber, 0.362 & 0.374, respectively, and regression equation of y=0.355x+4.41; y=0.314x+4.50. Manganese content in tuber flesh and whole tuber also had positive association with copper content of flesh (r=0.354; 0.312) and regressions line of y=0.595x+8.82 and y=0.568x+11.94. These results are in accordance to those obtained by Subramanian *et al*. (2017).

Micronutrient content of tuber flesh and whole tuber showed significant positive association. Highest correlation was observed in case of manganese (r=0.950) followed by zinc (r=0.922), copper (r=0.882) and iron (r= 0.780) with regression line of y=1.03x+2.43, y=1.077x+0.758, y=0.940x+2.51 and y=0.932x+8.95, respectively (Fig 1).

This suggests that though potato peels have significant nutrient content but as peel contributed only 6–8% of whole tuber thus potato flesh is chief source of potato nutrient. Similar results of poor correlation between micronutrient content of tuber flesh and peel were obtained in Indian potato varieties (Sharma *et al*. 2017). Beals (2019) also documented prevalence of major portion of nutrient including micronutrient in potato tuber flesh.

Genotypic effect is one of the most important factors for variations in nutrient content. Biofortification mainly focusses on this aspect. Considering billions of people mostly in developing nations suffer from micronutrient malnutrition, food-based approach may help in the reduction in number of

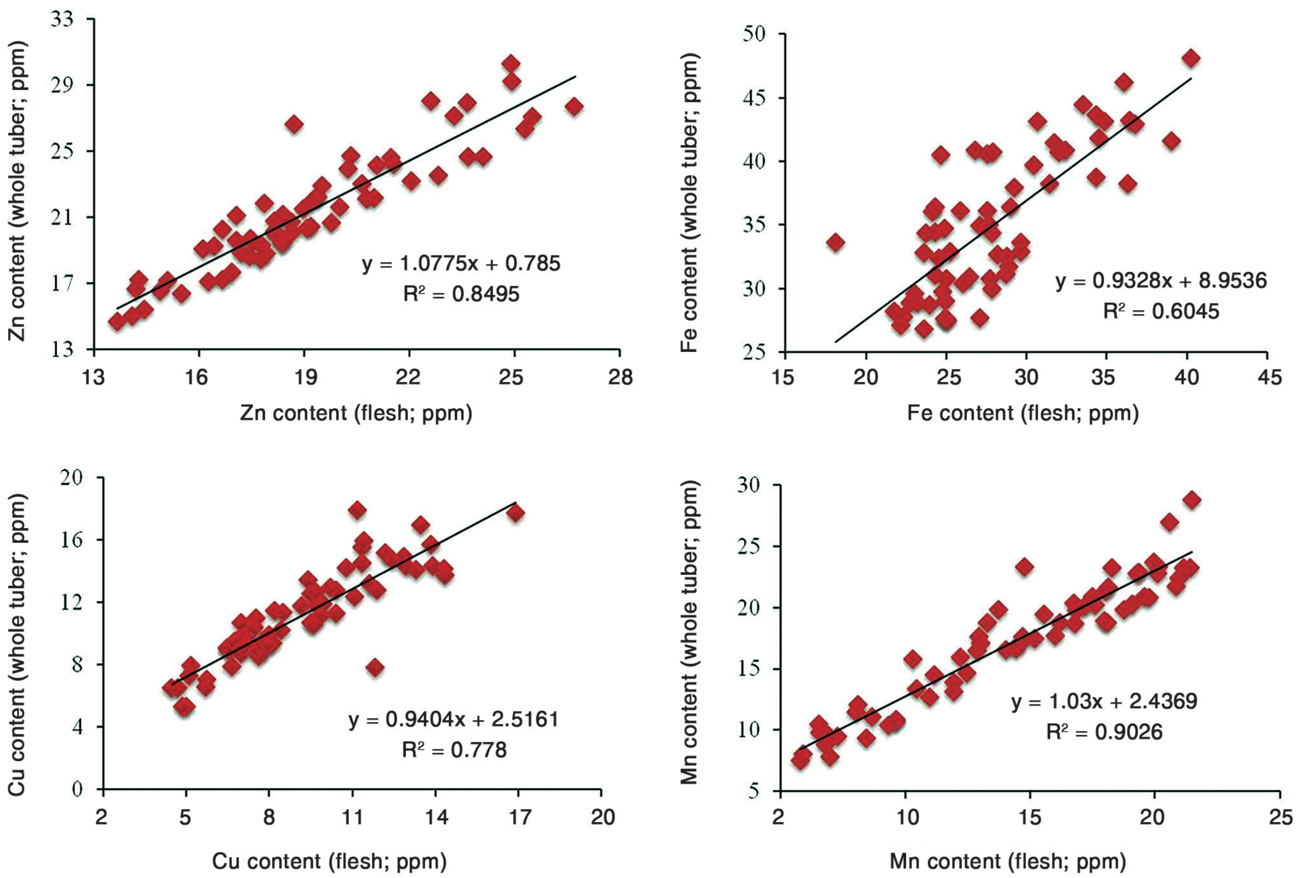

Fig 1 Correlation between whole tuber and tuber flesh for zinc, iron, copper and manganese content in potato varieties.

micronutrient malnourished people to a greater extent. The range of micronutrient variability obtained in present study would help in strengthening the Indian potato biofortification program. Genotypes like NJ 130, Lal Jyoti, Desi No.1, V2 2912, Aruconia, DRR Red, Sathoo and JG-1 may be used as donor in nutrient rich potato breeding.

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