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Influence of source of nutrition on potato (*Solanum tuberosum*) tuber quality in elevated temperature storage

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ABSTRACT

Field experiment was conducted for two years at Central Potato Research Institute Campus, Modipuram to study the effect of organic+homeopathic and inorganic treatments on potato. Potato (*Solanum tuberosum* L.) harvested after curing were stored at elevated temperature (12±0.5ºC) with CIPC, (Isopropyl-N-(3-chlorophenyl carbamate) as per modern technology adopted by farmers. The experiment was laid out in sub-plots with three sources of nutrition (organic+homeopathic nutrition) and inorganic treatments and three cultivars Kufri Bahar, Kufri Sindhuri and Kufri Chipsona-3 in main plots. Results showed that dry matter responded positively to inorganic treatment over organic. Variety Kufri Chipsona 3 recorded maximum dry matter followed by Kufri Sindhuri, while lowest dry matter was reported in Kufri Bahar. Organic and homeopathic nutrition resulted in significantly superior chip colour as compared to inorganic treatment. During both the years, potato chips prepared from cv. Kufri Chipsona 3 tubers with organically treated one had better chip colour. Organic and homeopathic nutrition significantly reduced mean reducing sugars in stored potatoes as compared to inorganic treatment. During both the years of experiment, reducing sugars were low in organically fertilized potatoes in comparison to inorganically fertilized crop. Mean sucrose content in potatoes stored at this temperature was at par in first year, while significantly lower values were observed in second year of experiment in organic+homeopathic treatment. Phenols content were significantly lower in organic and homeopathic treatment over inorganic nutrition across the genotypes in both the years during storage.

Key words: CIPC, Homeopathic, Inorganic, Organic, Potato, Storage, Temperature

Potato (*Solanum tuberosum* L.) is one of the major crops in the world as indicated by the production indices and is valuable source of energy and compounds that are important in human being diet. Potatoes not only supply carbohydrates mainly, but are also relatively rich source of proteins, vitamins, dietary fibre and some minerals. As a part of changing lifestyles in the developed countries, reflected by a pronounced public concern about environmental and personal health issues, organically produced foods are attracting a growing interest both among the scientific community and consumers as well (Hajslova *et al.* 2005). Over the last few decades, consumer demand for healthier food and government policies stressed upon environmentally sustainable agricultural systems and both the issues promoted a rapid expansion of organic farming. Potato represents a major food crop in many countries where the demand for organic products is gradually increasing (Maggio *et al.* 2008). As a widespread belief, organic farming improves the state of the environment, the health of people and increases the quality of food products (Lundegardh and Martensson 2003). A potential advantage of organic agriculture in producing healthy foods is based on more concentrations of beneficial secondary plant substances in organically grown crops as compared to non- organically grown crops and in general, organic foods are considered healthier than conventionally-grown products (Kopke 2005). A clear link between cultivation nutritional value of agricultural products is still missing (Bourn and Prescott 2002). After organic eggs and organic fresh vegetables, organic fresh potatoes, are among the most important fresh products that held a market share of 4.7% in the year 2010 (Willer *et al.* 2012). The quality of fresh fruit and vegetables depend on their quality at harvest, which changes during the storage with the passage of time. In India, nearly ninety percent of the potato is produced especially in sub-tropical Indo-Gangetic plain

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where, the harvest of crop in February and March is followed by the hot summer months. Potato is semi perishable crop as they contain about 80% water and 20% dry matter (Woolfe 1987) and this necessitates the preservation of potato. Potatoes are stored usually from the month of March to November for about >6 months. The common practice for extending availability is cold storage (4ºC). Though the potato can be stored at this temperature with relative humidity 98-100% for few months, but during storage there is problem of sweetening and quality deterioration which is not desirable. Hence, processing and table purpose potatoes are generally stored at 12±0.5ºC temperature with CIPC. The present investigation was undertaken to study the effects of the organic versus inorganic meords of tuber quality during its storage at elevated temperature with CIPC and storage quality of potatoes from the organic treatments has been compared to the crops quality from conventional treatments.

MATERIALS AND METHODS

Samples were procured from field experiments conducted at Central Potato Research Institute Campus, Modipuram (29.1º N latitude, 77.92 º E longitude, and an altitude of 300 m above mean sea level) with all the recommended cultural practices during two consecutive years. The treatments consisted of three source of nutrition (organic+homeopathic and inorganic) in sub plots and three cultivars Kufri Bahar (K.Bahar), Kufri Sindhuri (K.Sindhuri) and Kufri Chipsona 3 (K.Chipsona 3) in the main plots. Farm yard manure (FYM) was used on nitrogen (N) basis in case of organic treatment. In case of homeopathic nutrition, the homeo medicines, i.e. Amrit and Sanjivini were used for nutrition, while Rakshak was used for plant protection. For inorganic source of nutrition, chemical fertilizers (Calcium ammonium nitrate, Urea, DAP (diammonium phosphate) and MOP (Muriate of potash) were utilized for nitrogen, phosphorus and potassium (NPK). Crop was harvested 10 days later after skin setting. Well cured potatoes of organic+homeopathic and inorganic treatments were stored in leno bags at 12±0.5ºC (@ 35 ml/tones 50% a.i.) with two CIPC treatments. Quality parameters, viz., dry matter, chip colour, reducing sugars, sucrose and phenols were monitored at harvest and at monthly interval at 30, 60, 90, 120, 150 and 180 days of storage.

Dry matter: Tubers were cut longitudinally into 2 halves and chopped into small pieces and mixed thoroughly. Chopped pieces (10g) were taken per petri-dish and dried in hot air oven at 80ºC for 6 hr and then at 65ºC until constant weight was obtained (Kumar *et al.* 2005).

Potato chip colour: For estimation of chips colour, potatoes were peeled, washed and trimmed to remove defects and cut into 1.5 to 2mm thick slices. Slices were washed. Excess water was removed by dryer from the surface of slices. Potato slices were fried at180°C till the bubbling stopped. Excess oil was removed by draining. Chips were packed in laminated propylene bags. Chip colour score was measured on 1-10 scale of increasing colour using the chip colour cards. Chip colour score up to 3 was considered acceptable, whereas score of 10 (black/ brown) not acceptable (Ezekiel *et al.* 2003).

Reducing sugars: After harvest and storage reducing sugars were analysed by chopping tuber (5 g) samples and thereafter by heating potato cubes in 80% iso-propanol. Content was then heated with alkaline copper tartrate to reduce the copper from cupric to cuprous state resulting in formation of cuprous oxide. Formed cuprous oxide was then treated with arsenomolybdic acid, the reduction of molybdic acid to molybdenum was measured spectrophotometerically at 620 nm (Nelson 1944).

Sucrose: Ten grams of chopped tuber was taken in 50 ml of iso-propanol (80%) in boiling flask. For extraction, content was boiled for two hours and cooled. Content was filtered through Whatman No.1. Concentrated extract was again re-extracted in 30 ml of 80% iso-propanol for one hour and filtered. Alcohol was evaporated on hot plate (70ºC) till 10-15 ml residue volume was made with double distilled water to 100 ml. For analysis, 0.2 ml of extract was taken and volume was made to 1 ml (Van Handel 1968). Potassium hydroxide (30%, 0.1 ml) was added and tubes were then kept in boiling water bath (10 min). After cooling, 3 ml of anthrone was added to each test-tube and after bringing to room temperature, solution was incubated in water bath for 15 min at 40ºC and absorbance was read at 620 nm.

Phenols: To 1 g of potato tissue 10 ml (80%) ethanol was added and ground. Content was centrifuged at 10000 rpm for 20 min. Supernatant was collected and re-extracted again with 80% ethanol and were pooled, evaporated to dryness. Residues were dissolved in 5ml distilled water. To 100 µl aliquot, 0.5 ml Folin-Ciocalteu phenol reagent (1N) was added, vortex mixed and volume was raised to 10 ml with distilled water. After incubation for 3 min 35% (1 ml) sodium carbonate was added and vortex mixed. Samples were incubated and absorbance was read at 630 nm (Malik and Singh 1980).

Statistical analysis: The statistical analyses of experimental data were performed done using 'IRRISTAT' software developed by the International Rice Research Institute (http://www.biometrics@irri.cgiar.org).

RESULTS AND DISCUSSION

Dry matter

Dry matter was measured after harvest and at regular monthly intervals at (30, 60, 90, 120, 150 and 180 days after storage). A perusal of data in Table 1 revealed that mean tuber dry matter content (%) was found to be higher in inorganic treatments over organic and homeopathic nutrition during both the years in storage of potatoes at 12ºC with CIPC treatment with some exceptions in first year. Among cultivars, Kufri Chipsona 3 recorded maximum dry matter followed by Kufri Sindhuri, while lowest dry matter was reported in Kufri Bahar. In first year, mean values of dry matter content was higher (23.5) in potatoes applied with inorganic nutrition over the potatoes grown with organic source (22.7). Among three varieties, maximum mean dry

Table 1 Effect of organic + homeopathic and inorganic nutrition on tuber dry matter content (%) during storage at 12±0.5°C with CIPC

Variety	Treatment	Days of storage															
		0		30		60		90		120		150		180		Mean	
		Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year
K Bahar	Organic + Homeopathic	19.6	20.9	18.8	21.2	22.5	19.9	22.7	18.4	20.6	20.0	25.7	19.1	22.8	19.1	21.8	20.9
	Inorganic	21.4	20.4	17.4	22.1	26.0	21.3	21.3	26.0	22.7	20.4	22.4	21.3	21.0	19.8	21.5	21.6
	Mean	20.5	20.6	18.1	21.7	23.2	20.6	22.0	22.2	21.6	20.2	24.0	20.2	21.9	19.5	21.6	21.2
K Sindhuri	Organic + Homeopathic	21.3	22.1	20.2	21.9	21.1	21.4	22.4	22.9	25.6	22.5	21.8	21.5	22.6	24.3	22.2	23.3
	Inorganic	23.9	21.8	23.3	23.0	25.0	23.7	25.9	22.0	26.3	23.6	21.6	23.3	24.2	22.7	24.3	23.6
	Mean	22.6	22.0	21.7	22.5	23.1	22.5	24.2	22.5	26.0	25.1	21.7	22.4	23.4	23.5	23.2	22.9
K Chipsona-3	Organic + Homeopathic	22.4	21.1	23.3	18.3	24.7	24.3	24.0	21.9	24.9	22.9	24.8	23.7	24.3	19.8	24.1	23.0
	Inorganic	26.0	22.7	25.6	23.7	24.2	24.1	22.0	24.0	26.8	24.3	23.7	24.4	24.2	22.2	24.6	23.1
	Mean	24.2	22.0	24.5	21.0	24.4	24.2	23.0	23.0	25.8	23.6	24.3	24.1	24.3	20.7	24.4	23.6
Mean	Organic + Homeopathic	21.1	21.3	20.8	20.4	22.7	21.8	23.0	21.0	23.7	21.8	24.1	21.4	23.2	21.0	22.7	22.4
	Inorganic	23.8	21.6	22.1	22.9	24.4	23.0	23.1	24.0	25.3	22.7	22.6	23.0	23.1	21.5	23.5	22.7
	Mean	22.4	21.4	21.4	21.6	23.6	22.4	23.6	22.5	24.5	22.2	23.3	22.2	23.2	21.2	22.8	22.5

LSD (0.05) V= 0.5 V×DOS= 0.4 T= 0.4 T×DOS= 1.0 V×T= 0.7 V×T×DOS= 1.7 DOS = 0.7

LSD (0.05) V= 0.4 V×DOS=1.08 T= 0.3 T×DOS= 0.88 V×T=0.58 V×TDOS=1.5 DOS= 0.6

matter content was recorded by Kufri Chipsona 3 (24.4), followed by Kufri Sindhuri (23.2) and lowest in Kufri Bahar (21.6). Same trend was reported in second year, where, potato crop responded positively for inorganic nutrition. Contrary to this, reverse trend was found regarding accumulation of significantly higher dry matter content in organically grown potatoes in comparison to inorganic one (Schulz 2000). Dry matter is a function of the nutritive and photosynthetic activities of plant. Organic treatment might have provided the balanced needs of the plant after releasing CO_2 from soil and as a result of microbial activities and could be one of the reasons of more dry matter. The greater dry matter accumulation in the potato is likely to be associated with greater availability of nitrogen in the soil allowing its absorption by the plant and tuber growth (Kumar *et al.* 2011). Many authors (Rembialkowska 1998, Magkos *et al.* 2003) indicated that organically grown potato tubers have higher dry matter content than those grown conventionally, our trials provided no such evidence. According to some reports, dry matter content seems to differ between production methods for some produce. In general, the dry matter content of above-ground (leaf) vegetables (studies done on spinach, chard, savoy and white cabbage) was higher in organic crops, whereas, no difference was recorded in the dry matter and starch content of below ground (root and tuber) vegetables (Woese *et al.* 1997). Also, no differences were observed either in dry matter content and sensory properties between organic and conventional fruits in experiments carried out by many researchers (Vetter *et al.* 1983, Woese *et al.* 1997).

Chip colour

*E*ffect of organic treatment and storage on chip colour score indicates that significantly superior chip colour was found in organic nutrition as compared to inorganic one among all the cultivars. Chips made from cv. Kufri Chipsona 3 tubers and that too with organic one had better chip colour and was markedly superior over table purpose genotypes during both the years (Table 2). Organically cultivated potatoes indicated consistent and better chip-colour during storage in Kufri Chipsona 3. In first and second year mean chip colour values of storage were 4.3 and 5.8, respectively; which were statistically superior over inorganic nutrition (4.4 and 6.4, respectively). Potato chips colour results are in tune with the studies, who found less taste defects, less flesh darkening, best quality tubers and more pleasant aroma in organic potatoes (Varis *et al.* 1996). Organically cultivated potatoes indicated consistent and better chip-colour during storage in Kufri Chipsona 3. Same results has been reported when potatoes were subjected at different temperatures (Bandana *et al.* 2016a).

Reducing sugars

Significantly lower mean reducing sugars (mg/100 g fresh tuber weight) were recorded in organic+homeopathic nutrition when compared with inorganic treatment during both the year of study (Table 3). In first year of experiment, reducing sugars were less in organically fertilized potatoes

Table 2 Effect of organic + homeopathic and inorganic nutrition on potato chip colour score during storage at 12±0.5ºC with CIPC

Variety	Treatment	Days of storage (On a scale of 1-10, where 1 is white and 10 is black/ brown, and a score up to 3 is acceptable)															
		0		30		60		90		120		150		180		Mean	
		Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year
K Bahar	Organic + Homeopathic	4.9	5.5	3.8	8.6	6.0	7.6	5.3	7.6	4.8	7.0	5.2	6.4	6.5	7.2	5.2	7.1
	Inorganic	5.3	6.0	3.5	8.0	6.0	8.0	5.2	7.5	5.1	6.5	5.6	8.1	6.0	7.2	5.3	7.3
	Mean	5.1	5.7	3.6	8.3	6.0	7.8	5.3	7.5	5.0	6.7	5.4	7.2	6.3	7.2	5.2	7.2
K Sindhuri	Organic + Homeopathic	3.5	5.0	5.3	7.1	5.3	6.5	5.2	6.7	5.1	5.5	4.1	6.8	5.7	6.2	4.9	6.2
	Inorganic	4.0	5.3	4.8	7.4	5.3	7.1	5.8	7.5	5.2	7.6	4.1	8.0	5.6	7.8	5.0	7.2
	Mean	3.4	5.1	5.1	7.2	5.3	6.8	5.5	7.1	5.2	6.5	4.1	7.4	5.6	7.0	4.9	6.7
K Chipsona-3	Organic + Homeopathic	2.0	3.0	1.1	5.6	3.0	2.6	2.5	4.2	3.0	3.2	3.1	4.6	3.8	5.6	2.7	4.1
	Inorganic	2.7	2.0	1.9	2.3	3.4	5.8	2.9	5.3	2.5	6.0	3.0	7.0	4.0	5.0	2.9	4.7
	Mean	2.4	2.5	1.5	3.9	3.2	4.2	2.7	4.7	2.7	4.6	3.1	5.8	3.9	5.3	2.8	4.4
Mean	Organic + Homeopathic	3.5	4.5	3.4	7.1	4.8	5.5	4.3	6.1	4.3	5.2	4.2	5.9	5.3	6.3	4.3	5.8
	Inorganic	4.0	4.4	3.4	5.9	4.9	6.9	4.6	6.7	4.3	6.7	4.3	7.7	5.2	6.6	4.4	6.4
	Mean	3.7	4.4	3.4	6.5	4.8	6.2	4.5	6.4	4.3	5.9	4.2	6.8	5.3	6.4	5.3	6.0

LSD (0.05) V= 0.1 V×DOS= 0.3 T= 0.1 T×DOS= 0.3 V×T=NS V×T×DOS= 0.4 DOS= 0.2
LSD (0.05) V=0.03 V×DOS=0.07 T=0.02 T×DOS= 0.58 V×T=0.04 V×T×DOS=0.01 DOS=0.04

Table 3 Effect of organic + homeopathic and inorganic nutrition on reducing sugars (mg/100 g fresh tuber weight) during storage at 12±0.5ºC with CIPC

Variety	Treatment	Days of storage															
		0		30		60		90		120		150		180		Mean	
		Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year
K Bahar	Organic+homeopathic	184.2	116.4	101.2	155.2	103.0	274.7	109.2	276.9	80.8	419.6	64.5	254.7	162.6	509.9	115.9	286.7
	Inorganic	157.1	157.9	192.1	153.8	109.6	342.7	115.6	86.0	162.6	242.3	338.9	253.9	183.8	510.3	180.0	249.5
	Mean	170.6	137.1	146.7	154.5	106.3	308.7	112.4	181.4	124.7	330.9	201.7	254.3	173.2	510.1	148.0	268.1
K Sindhuri	Organic+Homeopathic	105.9	143.9	243.9	152.4	58.9	403.1	64.5	174.9	61.3	282.4	339.0	201.9	182.9	312.1	150.9	238.6
	Inorganic	124.4	161.7	274.1	152.0	91.9	581.7	33.5	279.0	45.2	425.9	254.2	255.4	175.3	494.6	142.7	335.7
	Mean	115.2	152.8	259.0	152.2	75.4	492.4	49.0	226.9	53.2	354.1	296.6	228.6	179.1	403.3	146.8	287.1
K Chipsona-3	Organic+Homeopathic	83.2	66.3	29.7	153.3	17.2	117.5	19.5	64.9	9.8	27.7	249.1	30.6	116.3	53.7	75.0	73.4
	Inorganic	47.6	49.0	26.4	49.5	14.4	80.1	15.1	72.6	8.2	67.2	262.8	117.7	52.3	127.4	61.0	80.5
	Mean	65.4	57.6	28.0	101.4	15.8	98.8	17.3	68.7	9.0	47.4	256.0	74.1	84.3	90.5	68.0	76.9
Mean	Organic+Homeopathic	124.4	108.8	124.9	153.6	59.7	265.1	64.4	172.2	52.6	243.2	217.5	162.4	154.0	291.9	113.9	199.6
	Inorganic	109.7	122.8	164.2	118.8	72.0	334.8	54.7	145.8	72.0	245.1	285.3	209.0	137.1	377.4	127.9	221.9
	Mean	117.1	115.8	144.6	136.0	65.8	229.9	59.6	159.0	62.3	224.1	251.4	185.7	145.6	334.6	120.3	197.8

LSD (0.05) V= 8.0 V×DOS=21.2 T= 6.7 T×DOS=17.3 V×T= 11.4 V×T×DOS=30.0 DOS= 12.0
LSD (0.05) V= 8.5 V×DOS=22.4 T=6.9 T×DOS=18.3 V×T=12.0 V×TDOS=11.6 DOS= 12.9

(113.9) as compared to inorganically fertilized crop (127.9). Organic +homeopathic treatment had significantly lower reducing sugars (199.6) over inorganic nutrition (221.9) during second year. As for genotypes, Kufri Chipsona 3 recorded lowest values (80.5) and was significantly better over Kufri Bahar (268.1) and Kufri Sindhuri (287.1). Kufri Chipsona 3 and Kufri Sindhuri recorded significantly lower values in organic+homeopathic treatment over inorganic nutrition, while opposite trend was recorded for Cv. Kufri Bahar. Mean reducing sugars were significantly lower during 60-120 days of storage, but it was higher at 30 and 150-180 days when compared with harvest values. K. Chipsona 3 was having significantly lower values from 30 to 120 days in comparison to harvest time values, but the increase was sharp afterwards. Values did not follow a consistent pattern at different stages of storage in both seasons. Similar results have been reported (Kumpulainen 2001) where, no clear cut differences were found for organic acids and sugars accumulation pattern. Likewise, no differences for both for the proportion of monosaccharides in total sugar content was found (Woese *et al.* 1997). However, contradictory results were reported (Warman and Harvard 1998) in retaining higher glucose and fructose from organic produce on a dry weight basis. Moreover, reducing sugars in potato tubers may differ depending upon the composition of processing and non-processing cultivars (Bandana *et al.* 2016b).

Sucrose

Mean sucrose content (mg/100 g fresh tuber weight) was at par during first year, while significantly lower values were observed in second year in organic and homeopathic nutrition in comparison to inorganic treatment during potato storage. In first year, highest mean value of sucrose was obtained in K. Bahar (299.5), while the values for K. Sindhuri (267.9) and K. Chipsona 3 (274.6) were statistically at par. Variety K. Chipsona-3 (173.5) maintained lowest sucrose and remained at par with K. Sindhuri (184.2) and significantly lower than K. Bahar (228.1) in the second year. The highest mean value was noticed in Kufri Bahar followed by Kufri Sindhuri and then Kufri Chipsona 3. In first year, sucrose content was more or less stable up to 120 days and increased sharply afterwards, whereas in second season, initially the values were higher and declined later. Similar trend was followed by processing variety Kufri Chipsona 3 (Table 4). Mean sucrose content was at par during first year, while significantly lower values were observed in second year in organic and homeopathic nutrition in comparison to inorganic treatment during potato storage. The sucrose analysis results are in agreement with the results (Warman and Harvard 1998) where, conventional potatoes had a higher content of sucrose than organic one.

Phenols

Phenolic compounds are of great importance in terms of nutritional and commercial properties of agricultural products, in relation to potato sensory properties. Data in Table 5 revealed that mean phenol value (mg/100 g fresh

Table 4 Effect of organic + homeopathic and inorganic nutrition on sucrose (mg/100 g fresh tuber weight) during storage at 12±0.5ºC with CIPC

Variety	Treatment	Days of storage															
		0		30		60		90		120		150		180		Mean	
		Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Istyear	2nd year	Istyear	2nd year	Ist year	2nd year
K Bahar	Organic+Homeopathic	190.8	295.2	149.9	242.5	129.2	283.1	148.1	98.2	331.7	123.3	419.3	197.9	802.7	205.7	310.2	206.5
	Inorganic	192.3	349.0	190.5	305.6	146.7	390.1	147.5	71.2	229.4	111.7	445.8	311.1	668.8	209.9	288.7	249.8
	Mean	191.6	322.1	170.2	274.0	137.9	336.6	147.8	84.7	280.5	117.5	432.5	254.5	735.8	207.8	299.5	228.1
K Sindhuri	Organic+Homeopathic	181.4	332.5	268.4	215.7	125.3	233.6	131.9	72.3	100.2	92.0	394.2	172.3	754.1	157.8	279.4	182.3
	Inorganic	163.1	288.4	146.4	267.5	155.2	255.5	148.4	74.3	106.3	95.6	340.6	157.1	734.6	165.5	256.4	186.2
	Mean	172.2	310.4	207.4	240.8	140.2	244.6	140.2	73.3	103.3	93.8	367.4	164.7	744.3	161.7	267.9	184.2
K Chipsona-3	Organic+Homeopathic	161.3	264.8	209.1	233.6	150.2	202.8	141.7	101.6	108.8	82.7	223.9	144.3	862.9	115.9	265.4	163.6
	Inorganic	220.8	271.6	211.5	307.9	172.2	216.0	153.0	71.2	189.7	100.3	311.3	179.5	728.6	137.9	283.9	183.4
	Mean	191.1	268.2	210.3	270.7	161.2	209.4	147.3	86.4	149.3	91.5	267.6	161.9	795.8	126.9	274.6	173.5
Mean	Organic+homeopathic	177.8	297.5	209.1	230.6	134.9	239.8	140.6	90.7	180.2	99.3	345.8	171.5	806.6	159.8	285.0	184.1
	Inorganic	192.1	303.0	182.8	293.7	158.0	287.2	149.6	72.2	175.2	102.5	365.9	215.9	710.7	171.1	276.3	206.5
	Mean	184.9	300.3	196.0	261.9	146.5	263.5	145.1	81.5	177.7	100.9	355.8	193.7	758.6	165.5	275.5	195.2

LSD (0.05) V= 23.4 V×DOS=62.0 T= NS T×DOS=50.0 V×T= NS V×T×DOS=NS DOS= 35.8

LSD (0.05) V=12.6 V×DOS=33.4 T=10.3 T×DOS=27.3 V×T=17.8 V×T×DOS=47.2 DOS=19.3

Table 5 Treatment effect of organic + homeopathic and inorganic nutrition on phenols (mg/100 g fresh tuber weight) of tubers during storage at 12±0.5°C with CIPC

Variety	Treatment	Days of storage 0		30		60		90		120		150		180		Mean	
		Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year
K Bahar	Organic+Homeopathic	114.2	37.6	47.0	66.7	129.3	50.3	60.4	40.6	73.2	57.6	71.3	78.5	181.3	81.0	96.7	58.9
	Inorganic	101.8	55.4	59.8	28.7	128.2	58.9	67.0	25.8	61.2	104.6	124.1	84.9	229.0	75.1	110.2	61.9
	Mean	108.0	46.5	53.4	47.7	128.7	54.6	63.7	33.2	67.2	81.1	97.7	81.7	205.1	78.0	103.4	60.4
K Sindhuri	Organic+Homeopathic	77.6	44.9	50.1	44.6	111.5	34.2	62.0	26.6	58.8	62.1	74.1	39.3	172.6	59.2	86.7	44.4
	Inorganic	99.2	41.3	75.8	66.6	121.7	39.3	84.8	34.4	73.0	63.7	63.4	107.7	142.0	72.7	94.3	60.8
	Mean	88.4	41.1	63.0	55.6	116.6	36.7	73.4	30.5	65.9	62.9	68.8	73.5	157.3	65.9	90.5	52.6
K Chipsona 3	Organic+Homeopathic	76.6	58.7	53.8	65.2	107.8	27.5	43.7	30.1	58.0	44.2	58.3	57.7	121.4	68.4	74.2	50.2
	Inorganic	65.2	54.5	55.7	80.7	79.2	47.9	78.5	33.3	56.3	54.6	62.2	82.4	158.2	119.7	79.3	67.5
	Mean	70.9	56.6	54.8	72.8	93.5	37.5	61.1	31.7	57.2	49.4	60.3	70.0	139.8	94.0	76.8	58.8
Mean	Organic+Homeopathic	89.5	47.0	50.3	58.8	116.2	37.3	55.4	32.4	63.3	54.6	67.9	58.5	158.4	69.5	85.9	51.1
	Inorganic	88.7	50.4	63.8	58.6	109.7	48.7	76.7	31.1	63.5	74.3	83.3	91.6	176.4	89.1	94.6	63.4
	Mean	89.1	48.7	57.0	58.7	112.9	43.0	66.1	31.7	63.4	64.4	75.6	75.0	167.4	79.3	96.40	57.2
LSD (0.05)	V= 5.3	V×DOS=14.2		T=4.4	T×DOS=11.6	V×T=NS	V×T×DOS=20.0	DOS = 8.2									
LSD (0.05)	V=3.3	V×DOS=8.7		T=2.7	T×DOS=7.1	V×T=4.7	V×T×DOS=12.4	DOS=5.10									

tuber weight) was found to be significantly lower in organic and homeopathic treatment in comparison to inorganic nutrition across the genotypes and phenol content remained stable in storage. During both the years, Kufri Chipsona 3 had lowest phenol content among cultivars. Mean value for treatments was higher in inorganically fertilized potato (94.6) as compared to organically fertilized ones (85.9) during first year. Similarly in second year, organic and homeopathic products had significantly lower phenol content (51.1) in comparison to inorganic nutrition (63.4) and similar pattern was observed among the cultivars. Different cassava varieties gave different levels of antioxidant compounds including phenols with different organic and mineral-based fertilizers and it was mentioned phenol content too depends upon the climatic conditions and cultural practices (Bok *et al.* 2006). Organic treatments gave higher phenolic content in cassava varieties as compared to inorganic one (Omar *et al.* 2012), whereas in our study we, found reverse trend, where, inorganic treatments resulted in high phenols as compared to organic one.

The findings of study suggested that the chip colour score was comparable between both the sources of nutrition, i.e. organic and inorganic. Mean tuber dry matter content was higher in inorganic treatments over organic and homeopathic nutrition during storage at 12±0.5ºC Organic and homeopathic nutrition reduced reducing sugars content and phenol than inorganic ones while opposite trend was observed for sucrose accumulation in potato tubers. More investigations are still needed to provide better understanding of the potato nutrients composition influenced by organic, inorganic treatments and storage behaviour of varieties. Beside this studies based on meta-analyses can be used to estimate how much health benefit may be obtained by using this system high level of nutritional and organoleptic quality.

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