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STORABILITY AND ORGANOLEPTIC PERFORMANCE OF INDIGENOUS AND EXOTIC POTATO COLLECTIONS

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ABSTRACT: Sixty two indigenous and exotic potato collections were assessed for three important parameters like storage behaviour at room temperature, tuber dry matter content and cooking quality during consecutive years. The maximum, minimum temperatures and relative humidity during storage period ranged between 28 to 38 ^{0}C, 20-28 ^{0}C and 26 to 78%, respectively. The lesser total weight loss was recorded in 21 collections and top ten were Phulwa Red Splash (7.8%), LahTora (8.3%), Phulwa Red (8.4%), Desla Lal (8.5%), Sisa Pani (8.8%), Burma Special (9.0%), Gulabia (9.0%), Lal Mitti-1 (9.1%), Gartentic (9.1%) and K-22 (9.2%). Higher tuber dry matter percent was observed in 16 collections, top five among them were Lady Rosetta (23.0%), Jeevan Jyoti (22.7%), Desi Aloo (22.1%), DRR-Blue (22.0), Lah saw Khasi (21.9%) and lowest in Variety Nainital (14.6%). Out of 62 potato collections, 19 adjudged as floury, 16 mealy, 26 waxy and one (Assamia Aloo) as soggy. Sprouting percentage at 75 days of storage had highly significant positive correlation with percent physiological weight loss (r=0.51, n=62), percent weight loss due to sprouts (r=0.59**) and percent total weight loss (r=0.59**).**

KEYWORDS: Potato, storage, dry matter, organoleptic properties

INTRODUCTION

Potato (*Solanum tuberosum L.*) is the 4th major food crop in the world after wheat, rice and maize. The total world potato production is estimated at 388 million tonnes in 2017. India ranks second only to China in terms of production with a share of nearly 12.5% in 2017 and third in terms of potato area after China and Russia. India produced 48.6 million tonnes of potatoes (FAO stat, 2019). In future, potato is expected to play important role in food and nutritional security of the world. Per capita consumption of potato in India is comparatively less (24 kg/ annum) than the world (35 kg/annum) but it is integral part of food and traditional cuisines and likely to find more importance in the dietary habit of Indian people. Central Potato Research Institute, Shimla has released more than 65 potato varieties for cultivation in different agro climatic region since 1958 (Luthra *et al*. 2020). Besides these, several other potato clones or local varieties (named locally to unreleased hybrids or exotic varieties) are under cultivation since long. Some of these exotic varieties introduced by the Britishers before independence and a few of them especially processing varieties were brought for commercial interest by industry people. Although, local varieties do not have organized seed potato production programme but they do have their presence in a limited area and scale for one or the other reasons. These varieties are, however, preferred for their special traits like skin and flesh colour, taste, and preparation of other local dishes.

The quality of potato, and its storage life, is reduced by the loss of moisture, decay and physiological breakdown. Suitable and efficient post-harvest technology and marketing of potatoes are vital to the entire production-consumption system because of its bulkiness and semi-perishability. In India

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major portion (90%) of the production comes from the winter crop of sub-tropical plains. The harvesting of potato crop coincides with beginning of summers which force the farmers/ producers to take immediate decision whether to dispose it to the market or to keep the tuber material in cold stores or under ambient condition low cost country stores. Therefore, the knowledge of suitable varieties which can withstand under ambient temperatures at least for 60-75 days is very important so that farmers can periodically sale out their produce. Previous studies on keeping quality (Suchoronczek *et al*., 2016) conducted under ambient condition or under non refrigerated storage like heaps, pits and evaporative cooled potato stores (Mehta *et al*., 2006) were limited to a few varieties or hybrids. Pande *et al*. (2007) conducted a study on sprouting behavior and weight loss of 37 Indian potato varieties under controlled conditions, however, Gupta *et al*. (2015) investigated storage and cooking quality of 44 released potato varieties. The information on storage behavior and organoleptic performance of indigenous and exotic potato collections under ambient conditions or actual farm storage conditions is not available.

Texture is one of the most important quality attributes of potato tubers and it not only affects consumer preference, but it also influences the release of volatile flavor components during chewing (Lucas *et al.* 2002). A mealy potato is dry and granular, while a waxy potato is moist and gummy. Flavor consists of taste (due to nonvolatile compounds), aroma (due to volatile compounds) and texture (mouth feel). All three components interact to produce a flavor response. Flavor is strongly influenced not only by genotypes, but also by production and storage environments (Jansky, 2010). The present study focused on estimation of keeping quality, tuber dry matter content and cooking quality of baked potatoes to identify the variety with better shelf life and high culinary quality.

MATERIALS AND METHODS

The experimental material consisted of 62 potato collections comprising of 50 locally grown indigenous, nine exotic genotypes and three indigenous varieties. The tuber material for the experiment was obtained from the crop for three consecutive harvest of Rabi seasons (2010-12) and 2014-15 at Central Potato Research Institute, Regional Station, Modipuram, Meerut, UP, India (222 m above mean sea level; 29^0 N, 76^0 E). Recommended package of practices were followed to grow the crop. Haulms were cut after 90 days after planting. The crop was harvested 15-20 days after haulm cutting for skin firmness. After harvesting tubers were kept in heap under shade for 15-20 days for proper curing of tuber skin. These skin cured tubers were utilized for studying the storage behavior of potato.

Five kilograms clean and uniform size tubers of each genotype were packed separately in Hessian cloth bags, this formed one replication. Three such replications were kept at room temperature during first week of March. Numbers of tubers in each bag were recorded at the beginning of experiment. The bags containing tuber material were stored for 75 days allowing sufficient space of air movement between bags at ambient room temperatures. The maximum and minimum temperatures and relative humidity were recorded every day (**Fig 1 and 2**). Percent sprouting of tubers (as calculated from tubers having one or more sprouts above 2 mm long) and number and weight of healthy and rotted tubers were recorded at 45, 60 and at 75 days of storage. Data on weight of sprouts was recorded at the end of the

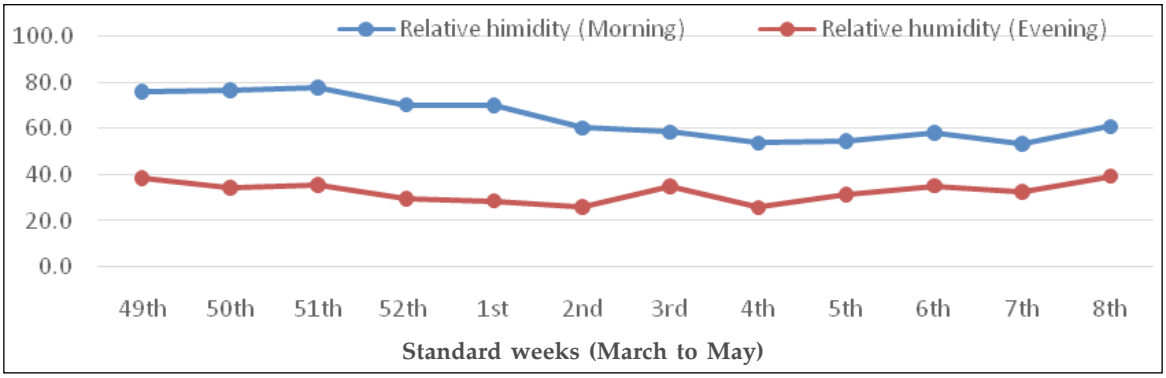

Fig. 1. Mean % relative humidity during storage 2010 to 2012

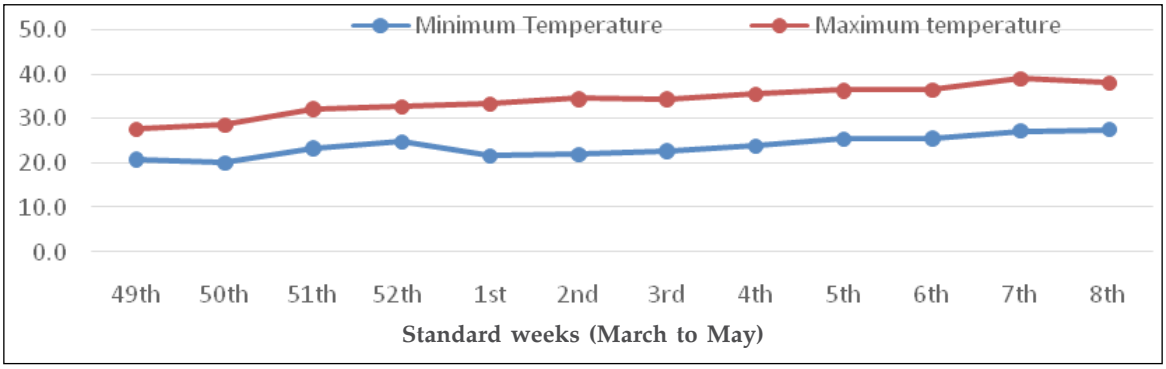

Fig. 2. Mean temperatures during storage 2010 to 2012

storage (75 days) period. Before statistical analyses, the data on % Sprout Weight and % Rottage (weight) were transformed into square roots (×x + 0.5). Data was analyzed as per the statistical methods proposed by Gomez and Gomez (1984).

A sample comprising of 5 randomly drawn tubers from each genotype was used for dry matter estimation. The tubers were chopped into small pieces. The chopped pieces were mixed properly and 50 g sample of each variety in three replications was kept in oven at 80° C for 72 hours. The final dry matter content of the sample was estimated when the weight of the sample reached to a constant level.

A panel of four persons assessed colour, texture and flavour of microwave baked tubers (microwaved for 10-15 minutes) after one month of harvesting during 2014-15. Precaution was taken to rinse the mouth before testing the sample and the final decision about each organoleptic characteristic was taken on consensus. The texture was adjudged in four major categories i.e. a) extremely mealy –floury, b) - medium to slightly mealy/granular-mealy, c) gummy/ pasty- waxy and d) watery or translucent-soggy. Similarly, flavor (a combined feel of taste, texture and aroma) of the baked potatoes was examined on four categories i.e. a) Excellent, b) Very Good, c) Good and d) Average.

RESULTS AND DISCUSSION

The temperature (maximum and minimum) of the experiment site ranged between 28–38°C to 20–28°C during the

period of storage. Relative humidity ranged from 53 to 78 % in the morning and 26 to 39 % in the evening. The results on storage and organoleptic parameters are described below.

Sprouting behavior and dormancy period

Large variation was observed with respect to sprouting behavior (0-100% after 75 days of storage) and dormancy period (>45 to >75 days). Weather conditions i.e. temperature and relative humidity are known to be the important factors affecting the sprouting and dormancy period. The results on sprouting behaviour (**Table 1**) revealed that 14 collections namely Bareilly Red, Desla Lal, DRR, DRR-Blue, DRR-Red, Gulabia, Jeevan Jyoti, Lah Saw Khasi, Lah Tora, Lal Mitti-1, Lal Mitti-2, Phulwa Red, Phulwa Red Splash and Sisa Pani did not sprout till 45 days of storage. Potato variety namely Dwarf Culture, Kufri Jyoti, Gartentic, Lady Rosetta showed less than 1% sprouting, on the other hand high sprouting was observed in Assamia

Table. 1 Mean storability attributes and tuber dry matter content in local and exotic potato genotypes (three year mean)

S. No	Genotypes	Sprouting (%) after days of storage			Dormancy (days)	Weight loss (%) at 75 Days				Tuber dry matter
		45 days	60 days	75 days		Rottage*	Physiological	Sprout*	Total	
1	1001	6.59	69.15	95.66	>60	1.93 (1.29)	7.30	0.16 (0.86)	9.39	16.19
2	1007	3.38	32.17	39.40	>75	2.02 (1.53)	8.23	0.04 (0.66)	10.30	16.04
3	Assamia Aloo	78.53	100.00	100.00	>45	3.05 (1.91)	16.53	1.44 (1.68)	21.02	17.53
4	Bareilly Red	0.00	0.00	33.33	>75	0.30 (0.68)	11.78	0.26 (0.80)	12.34	16.33
5	Bengal Jyoti	20.25	97.84	97.84	>45	0.44(0.87)	10.22	0.17 (0.90)	10.83	17.96
6	Bhoora Aloo	17.64	99.44	99.44	>45	1.74 (1.26)	7.91	0.12 (0.84)	9.77	18.82
7	Burma Special	6.89	68.79	69.10	>75	0.19 (0.64)	8.62	0.17 (0.88)	8.98	21.28
8	C-9 Patna	4.81	46.94	46.94	>75	0.47 (0.95)	10.54	0.15 (0.83)	11.16	20.90
9	Champaran Lal	41.86	100.00	100.00	>45	2.40 (1.49)	12.47	0.45 (1.15)	15.31	17.38
10	Craig Defience	49.87	98.15	98.15	>45	1.95 (1.31)	12.37	0.22 (0.89)	14.54	20.04
11	Desi Aloo	20.23	99.85	99.85	>45	5.03 (2.47)	14.50	0.50 (1.16)	20.03	22.12
12	Desla Lal	0.00	0.00	1.10	>75	0.30 (0.76)	8.18	0.00 (0.53)	8.48	21.20
13	DRR	0.00	5.49	33.33	>75	0.86 (1.00)	8.78	0.02 (0.59)	9.66	20.22
14	DRR-Blue	0.00	6.72	8.50	>75	1.77 (1.33)	8.76	0.05 (0.66)	10.58	22.01
15	DRR-Red	0.00	0.00	0.00	>75	1.19 (1.27)	8.21	0.00 (0.54)	9.40	19.71
16	Dwarf Culture	0.37	8.29	10.66	>75	0.74 (0.89)	9.46	0.06 (0.67)	10.26	19.72
17	G-4	2.96	35.93	38.28	>75	0.09 (0.60)	9.40	0.11 (0.75)	9.61	19.68
18	Gartentic	0.46	9.96	11.60	>75	1.06 (1.09)	8.02	0.04 (0.66)	9.12	18.28
19	Great Scot	17.65	100.00	100.00	>75	5.31 (1.90)	7.93	0.28 (1.01)	13.52	15.57
20	Gulabia	0.00	0.00	0.00	>75	0.63 (0.96)	8.37	0.00 (0.55)	9.02	21.79
21	Gulmarg Special	37.77	78.53	79.39	>75	1.00 (1.12)	10.90	0.19 (0.87)	12.08	19.82
22	Hamraj Hatti	10.81	50.88	51.26	>75	1.67 (1.33)	9.13	0.09 (0.74)	10.89	17.89
23	Jalandhar	56.04	100.00	100.00	>45	1.85 (1.26)	11.72	0.47 (1.15)	14.04	18.73
24	Jeevan Jyoti	0.00	33.33	36.45	>75	0.00 (0.50)	9.28	0.07 (0.70)	9.36	22.74
25	K-22	1.95	31.40	98.60	>60	0.00 (0.50)	8.97	0.18 (0.90)	9.16	19.07
26	Kachha Bhutia	15.10	100.00	100.00	>45	1.04 (1.07)	10.31	0.40 (1.06)	11.74	21.19

S. No	Genotypes	Sprouting (%) after days of storage			Dormancy (days)	Weight loss (%) at 75 Days				Tuber dry matter
		45 days	60 days	75 days		Rottage*	Physiological	Sprout*	Total	
27	Kanpuria Safed	1.67	95.23	100.00	>45	1.80 (1.47)	11.69	0.23 (0.90)	13.71	19.13
28	KP/PC-292	16.09	63.47	63.47	>75	0.14 (0.67)	10.50	0.20 (0.86)	10.84	20.78
29	Krantz	4.97	68.75	68.75	>75	0.87 (0.92)	9.03	0.19 (0.93)	10.09	20.56
30	Lady Rosetta	0.65	17.35	17.77	>75	0.00 (0.50)	12.26	0.05 (0.68)	12.31	22.99
31	Lah Ipon	71.11	100.00	100.00	>45	0.37 (0.70)	13.61	0.97 (1.48)	14.95	21.56
32	Lah Polin	78.09	100.00	100.00	>45	0.37 (0.78)	14.63	0.93 (1.46)	15.92	20.29
33	Lah Sarkari	65.39	100.00	100.00	>45	0.39 (0.79)	14.44	0.60 (1.26)	15.42	18.64
34	Lah Saw	15.19	100.00	100.00	>45	0.00 (0.50)	11.30	0.36 (1.07)	11.66	21.61
35	Lah Saw Khasi	0.00	34.43	35.52	>75	0.67 (0.88)	8.94	0.16 (0.78)	9.77	21.89
36	Lah Saw Smit	18.47	100.00	100.00	>45	0.00 (0.50)	12.76	0.35 (1.07)	13.11	21.57
37	Lah Syientew	1.57	71.99	72.86	>75	0.41 (0.80)	9.07	0.25 (0.99)	9.72	19.51
38	Lah Tora	0.00	0.00	10.62	>75	1.08(1.10)	7.18	0.04 (0.62)	8.30	18.29
39	Lal Gulab	19.76	100.00	100.00	>45	0.93 (1.05)	12.13	0.54 (1.23)	13.59	19.62
40	Lal Jyoti	24.23	99.26	99.26	>45	1.94 (1.28)	9.35	0.15 (0.87)	11.44	18.11
41	Lal Lauvkar	53.22	100.00	100.00	>45	0.67 (0.88)	19.65	0.45 (1.16)	20.76	18.06
42	Lal Mitti-1	0.00	3.42	3.42	>75	0.37 (0.78)	8.70	0.02 (0.58)	9.09	21.19
43	Lal Mitti-2	0.00	0.00	0.00	>75	0.80 (0.97)	9.52	0.00 (0.50)	10.32	20.48
44	Magnum Bonum	4.78	46.75	49.21	>75	0.15 (0.68)	12.23	0.21 (0.89)	12.58	19.91
45	Nainital	14.10	66.67	67.10	>75	0.17 (0.64)	11.97	0.21 (0.87)	12.34	14.56
46	ON-1645	23.43	100.00	100.00	>45	2.80 (1.46)	12.86	0.37 (1.05)	16.02	20.22
47	Phulwa Red Splash	0.00	0.00	0.00	>75	0.00 (0.50)	7.83	0.00 (0.50)	7.83	21.04
48	Phulwa Red	0.00	0.00	0.00	>75	0.00 (0.50)	8.41	0.00 (0.60)	8.44	21.78
49	Phulwa White	5.12	39.18	64.99	>75	0.99 (1.13)	9.27	0.08 (0.73)	10.33	16.24
50	Pimpernnel	0.16	78.49	84.04	>60	2.62 (1.41)	7.50	0.17 (0.90)	10.29	20.11
51	PS-4904	44.05	96.67	100.00	>45	0.43 (0.72)	10.49	0.27 (1.02)	11.19	20.06
52	Rangpuria	15.63	76.91	99.66	>60	3.05 (1.67)	10.69	0.25 (0.97)	14.00	19.14
53	Rajendra-1	49.14	80.47	100.00	>45	1.45 (1.46)	11.30	0.21 (0.95)	12.96	19.95
54	Rajendra-2	14.78	75.55	99.75	>60	2.41 (1.38)	12.52	0.23 (0.96)	15.16	18.51
55	Rajendra-3	5.40	66.67	100.00	>60	0.19 (0.64)	9.05	0.17 (0.89)	9.41	17.35
56	Sisa Pani	0.00	0.00	0.89	>75	0.37 (0.79)	8.42	0.01 (0.55)	8.79	19.49
57	Ultimus	5.93	42.75	76.08	>75	1.00 (0.94)	13.34	0.18 (0.88)	14.52	20.69
58	Up-to-date	5.38	66.67	100.00	>60	0.00 (0.50)	10.74	0.21 (0.92)	10.94	20.85
59	VB-8	77.84	94.54	100.00	>45	1.39 (1.14)	12.69	0.52 (1.20)	14.60	20.90
60	Kufri Bahar	54.49	100.00	100.00	>45	1.19 (1.09)	10.26	0.54 (1.21)	11.99	19.05
61	Kufri Jyoti	0.44	10.03	24.91	>75	0.72 (0.85)	8.57	0.24 (0.96)	9.54	18.54
62	Kufri Chipsona-1	36.96	95.69	99.84	>75	0.29 (0.80)	9.31	0.16 (0.88)	9.76	21.14
	Mean	18.08	59.11	65.98		1.01	10.48	0.89	11.81	19.61
	C.V.	74.72	40.15	33.40		68.91	22.30	16.86	25.08	6.24
	C.D. 5%	12.52	21.98	20.41		0.65	2.17	0.14	2.74	1.13

*Data in parenthesis are square root transformed means

Aloo (78.53%) followed by Lah Polin (78.09), VB-8 (77.84), Lah Ipon (71.11%), Lah Sarkari (65.39%), Jalandhar (56.04%), Kufri Bahar (54.49%) and Lal Lauvkar (53.22%) under study.

At 60 days of storage, sprouting in 29 collections remained below critical level of 80% sprouting and interestingly 9 collections namely Bareilly Red, Desla Lal, DRR-Red, Gulabia, Lah Tora, Lal Mitti-2, Phulwa Red, Phulwa Red Splash and Sisa Pani remained un-sprouted. Whereas 24 collections crossed the 80% limit of sprouting at 60 days of storage. Thirteen collections attained 100% sprouting at 60 days of storage. At 75 days of storage, five collections like DRR-Red, Gulabia, Lal Mitti-2, Phulwa Red Splash and Phulwa Red remained un-sprouted, however another 26 collections were below the critical level of 80% sprouting. Remaining 31 collections showed sprouting ranging between 80-100%.

At harvest tubers are in a dormant state and after harvesting, tuber dormancy is released progressively. This release is accompanied by numerous physiological and biochemical changes, such as carbohydrate hydrolysis and the accumulation of saccharides. Endogenous hormones are thought to play a significant role in the regulation of tuber dormancy and in the onset of sprouting. Dormancy is considered to be the varietal character that might get influenced by the soil and environmental conditions during crop growth and storage environment (Ezekiel and Singh, 2003). Among various factors temperature is considered to be most important physical factor affecting dormancy and it is reported that tubers stored at lower temperature (3–20°C) have a longer period of innate dormancy than those stored at higher temperatures (Wiltshire and Cobb, 1996).

In the present investigation, none of the collection showed short dormancy period (<6 weeks), however dormancy period varied from >45 days (22 collections), > 60 days (7 collections) and more than 75 days (33 collections). As five genotypes namely DRR-Red, Gulabia, Lal Mitti-2 Phulwa Red Splash and Phulwa Red did not sprout till 75 days of storage, they seems to possess extremely longer tuber dormancy period. Lesser the number of days to sprout indicates short and higher the number of days indicates long dormancy. Indian potato varieties have been found to have dormancy period of 6-8 weeks at ambient temperatures. They were grouped into three categories, short (< 6 weeks) as in Kufri Bahar, medium dormancy (6-8 weeks) as in Kufri Jyoti and long dormancy (>8 weeks) as in Kufri Sindhuri. However, Ezekiel and Singh (2003) reported dormancy period 126 days in Kufri Jyoti (from the date of haulm cutting). Gupta *et al*. (2015) also reported that days to sprouting (dormancy) followed similar trend in potato varieties. Pande *et al*. (2007) however, categorized the dormancy period under controlled condition as short (<71 days), medium (71-80 days) and long (> 80 days) in 37 Indian varieties.

Physiological weight loss and weight loss due to sprouts

Physiological weight loss is known as reduction in weight of tubers due to evaporation process from the tuber surface (Gupta *et al.* 2015). Excessive evaporative losses not only reduce weight but also cause shrinkage on the tuber skin and consequently affect the market value of tubers. Physiological weight loss ranged from 7.18% in Lah Tora to 19.65% in Lal Lauvkar. As many as 6 genotypes namely Lah Tora, 1001, Pimpernnel, Phulwa Red Splash, Bhoora Aloo and Great Scot were noted for very low (7-8%) physiological weight loss. However, 14 varieties namely Gartentic, Desla Lal, DRR-Red, 1007, Gulabia, Phulwa Red, Sisa Pani, Kufri Jyoti, Burma Special, Lal Mitti-1,

DRR-Blue, DRR, Lah Saw Khasi and K-22 exhibited low (8-9%) mean physiological weight loss.

Varieties with longer dormancy period are known to perform better under non-refrigerated storage conditions as the magnitude of sprout growth determines the weight loss in potatoes. Sprouted potatoes loose much more weight than un-sprouted potatoes (Van Es and Hartmans, 1987). In present investigation, weight loss due to sprouts was in higher range in varieties Assamia aloo (14.4 g/Kg tuber at 75 days of storage), Lah Ipon (9.7g), Lah Polin (9.3 g), Lah Sarkari (6.0 g), Kufri Bahar (5.4 g), Lal Gulab (5.4 g), VB-8 (5.2 g), Desi Aloo (5.0 g), Jalandhar (4.7 g), Champaran Lal (4.5 g) and Lal Lauvkar (4.5 g) which might have contributed to high physiological weight loss (**Table 1**). In general genotypes with no or very low sprout weight loss also had low physiological weight loss. Ezekiel *et al*. (2004) reported that weight loss in potato varieties during storage is related with the periderm thickness, number of cell layers in the periderm and also with the number of lenticels on the tuber surface. In the present investigation, Phulwa Red Splash, Desla Lal, DRR-Red, Gulabia, Phulwa Red and Lal Mitti-2 had least weight loss due to sprout and evaporative losses as these did not sprout till 75 days thereby ruling out the chances of weight losses.

Tuber rottage

Rotted tubers are unfit for consumption and also induce the infection in the adjacent tubers kept for storage generally due to soft rot. The duration of storage also affects losses (Burton *et al*., 1992). The weight loss due to rottage varied from nil (0%) in Phulwa Red Splash, Phulwa Red, Lady Rosetta, Jeevan Jyoti, K-22, Up-to-date, Lah Saw Smit and Lah Saw to 5.03% in Desi Aloo and 5.31 % in Great Scot. The mean percent rottage (by weight) in 45 collections remained below 0.09 to <2%, however, 1007 (2.02%), Champaran Lal (2.40%), Rajendra-2 (2.41%), Pimpernel (2.62%), ON-1645 (2.80%), Rangpuria (3.05%), Assamia Aloo (3.05%), Desi Aloo (5.03%) and Great Scot (5.31%) showed >2% weight loss due to rottage. Mehta *et al*. (2006) in experiments under room temperature found variable rottage % in different genotypes over different storage period.

Total weight loss

Total weight loss (including evaporative and respiratory weight loss of tubers and sprouts; and weight loss due to rottage) at 75 days of storage showed large variation between genotypes (**Table 1**). The total weight loss ranged from 7.83% in Phulwa Red Splash to 21.02% in Assamia Aloo. Low total weight loss was recorded in 21 samples namely Phulwa Red Splash (7.83%), Lah Tora (8.3%), Phulwa Red (8.44%), Desla Lal (8.48%), Sisa Pani (8.79%), Burma Special (8.98%), Gulabia (9.02%), Lal Mitti-1 (9.09%), Gartentic (9.12%), K-22 (9.16%), Jeevan Jyoti (9.36%), 1001 (9.39%), DRR-Red (9.4%), Rajendra-3 (9.41%), Kufri Jyoti (9.54%), G-4 (9.61%), DRR (9.66%), Lah Syientew (9.72%), Kufri Chipsona-1(9.76%), Bhoora Aloo and Lah Saw Khasi (9.77%). Whereas, genotypes namely Assamia Aloo (21.02%), Lal Lauvkar (20.76%), Desi Aloo (20.03%), ON-1645 (16.02%), Lah Polin (15.92%), Lah Sarkari, (15.42%), Champaran Lal (15.31%) and Rajendra-2 (15.16%) exhibited higher mean total weight loss in comparison to other varieties under study. Mehta *et al*. (2006), Kang *et al*. (2007) and Gupta *et al.* (2015) also grouped Indian potato varieties for storage behaviour. The information on total weight loss in Kufri Bahar, Kufri Jyoti and Kufri Chipsona-1 was also in confirmation with the above findings, though there are no reports on investigation of local collections.

The keeping quality of indigenous and exotic potato collections based on total weight loss observed in this study, can be grouped as excellent (<10% total weight loss), very good (>10 to ≤12%), good (>12 to ≤15%), average (>15 to ≤20%) and poor keeper (>20% weight loss). Based on the results 21 collections namely, Phulwa Red Splesh, Lah Tora, Phulwa Red, Desla Lal, Sisa Pani, Burma Special, Gulabia, Lal Mitti-1, Gartentic, K-22, Jeevan Jyoti, 1001, DRR-Red, Rajendra-3, Kufri Jyoti, G-4, DRR, Lah Syientew, Kufri Chipsona-1, Bhoora Aloo and Lah Saw Khasi were found to be excellent keeper (<10% total weight loss). Seventeen potato collections namely Krantz, Dwarf Culture, Pimpernel, 1007, Lal Mitti-2, Phulwa White, DRR-Blue, Bengal Jyoti, KP/PC-292, Hamraj Hatti, Up-to-date, C-9 Patna, PS-4904, Lal Jyoti, Lah Saw, Kachha Bhutia and Kufri Bahar found to be very good keeper (>10 to ≤12% total weight loss). However, 16 genotypes namely Gulmarg Special, Lady Rosseta, Bareilly Red, Nainital, Magnum Bonum, Rajendra-1, Lah Saw Smit, Great Scot, Lal Gulab, Kanpuria Safed, Rangpuria, Jalandhar, Ultimus, Craig Defience, VB-8 and Lah Ipon **(Table 1)** were found to be good keeper (>12 to ≤15% total weight loss). Five genotypes namely, Rajendra-2, Champaran Lal, Lah Sarkari, Lah Polin, ON-1645 were average keeper (15-20% total weight loss) and three namely Desi Aloo, Lal Lauvkar and Assamia Aloo were poor in keeping quality with total weight loss of >20%. These results indicates the reason of wide spread popularity of variety Kufri Jyoti across the country and other local collections are also finding place in the heart of traditional farmers and consumers due to their low weight losses under traditional storage methods for own consumption or meeting demand of local markets.

Tuber dry matter content

Tuber dry matter content ranged from 14.56% in Nainital to 22.99% in Lady Rosetta at 90 days of harvest. Potato varieties with relatively low to moderate dry matter content namely, Nainital (14.56%), Great Scot (15.57%) followed by 1007 (16.04%), 1001 (16.19%), Phulwa White (16.24%) and Bareilly Red (16.33%) are being grown traditionally for table purposes. Twenty eight collections possessed tuber dry matter between >17 to ≤20 and varieties namely Craig Defience, PS-4904, Pimpernnel, DRR, ON-1645, Lah Polin, Lal Mitti-2, Krantz, Ultimus, KP/PC-292, Up-to-date, C-9 Patna and VB-8 possessed tuber dry matter between >20 to ≤21. The maximum and significant tuber dry matter content (**Table 1**) was observed in 16 collections including Lady Rosetta (22.99%) followed by Jeevan Jyoti (22.74%), Desi Aloo (22.12%), DRR-Blue (22.01), Lah saw Khasi (21.89%), Gulabia (21.79%), Phulwa Red (21.78%), Lah Saw (21.61%), Lah Saw Smit (21.57%), Lah Ipon (21.56%), Burma Special (21.28%), Desla Lal (21.2%), Lal Mitti-1 (21.19%), Kachha Bhutia (21.19%), Kufri Chipsona-1 (21.14%) and Phulwa Red Splash (21.04%). Potato varieties like Lady Rosetta and Kufri Chipsona-1 possessed comparatively high dry matter and are under cultivation for processing purposes. The high tuber dry matter content is indication of suitability for processing purposes subject to prevalence of low reducing sugars in local collections. Luthra *et al*. (2018) also found variation for tuber dry matter in 23 potato genotypes.

Organoleptic test

Organoleptic test or mouth feel of boiled or baked potatoes provide information on flavor, texture and acceptability for consumption. The grouping based on flesh colour after peeling revealed wide variation for cream (40 collections), light yellow (6 collections), yellow (3 collections), white (12 collections) and red purple (Bareilly Red). The flesh colour remained same even after

baking of the samples under investigation. In present investigation, out of 62 collections, 19 were adjudged as floury, 16 mealy, 26 waxy and one (Assamia Aloo) as soggy (**Table 2**). The 19 floury (extremely mealy) varieties possessed average tuber dry matter content 20.49% with a range of 16.24% (Phulwa White) to 22.99% (Lady Rosetta). Jansky (2008), Van Dijk *et al*. (2002) and Mosely and Chase (1993) also found that mealiness is associated with high tuber dry matter. Similarly, average dry matter of mealy textured varieties was 18.44% and ranged from 16.19 (1001) to 20.9% (C-9 Patna). However, average dry matter of waxy

Table 2 Cooking quality of local and exotic potato genotypes

S. No	Genotypes	Internal colour after peeling	Texture	Flavor	S. No	Genotypes	Internal colour after peeling	Texture	Flavor
1	1001	Yellow	Mealy	Good	32	Lah Polin	white	Floury	Good
2	1007	Cream	Mealy	Good	33	Lah Sarkari	white	Waxy	Good
3	Assamia Aloo	Cream	Soggy	Average	34	Lah Saw	white	Floury	Good
4	Bareilly Red	Purple cream	Waxy	Very good	35	Lah saw Khasi	Cream	Waxy	Very good
5	Bengal Jyoti	Cream	Mealy	Good	36	Lah Saw Smit	Cream	Floury	Average
6	Bhoora Aloo	Cream	Floury	Very good	37	Lah Syientew	Cream	Floury	Good
7	Burma Special	white	Floury	Good	38	LahTora	white	Waxy	Excellent
8	C-9 Patna	light Yellow	Mealy	Good	39	Lal Gulab	Cream	Mealy	Good
9	Champaran Lal	white	Waxy	Excellent	40	Lal Jyoti	Cream	Waxy	Very good
10	Craig Defience	Cream	Floury	Good	41	Lal Lauvkar	Cream	Waxy	Very good
11	Desi Aloo	light Yellow	Floury	Average	42	Lal Mitti-1	Cream	Waxy	Good
12	Desla Lal	Cream	Waxy	Very good	43	Lal Mitti-2	Light Yellow	Floury	Very good
13	DRR	light Yellow	Waxy	Very good	44	Magnum Bonum	white	Mealy	Very good
14	DRR-Blue	Cream	Waxy	Excellent	45	Nainital	Cream	Mealy	Good
15	DRR-Red	Cream	Waxy	Very good	46	ON-1645	Cream	Floury	Very good
16	Dwarf Culture	Cream	Waxy	Very good	47	Phulwa Red Splash	Yellow	Waxy	Good
17	G-4	Cream	Waxy	Good	48	Phulwa Red	Light Yellow	Waxy	Very good
18	Gartentic	Yellow	Mealy	Average	49	Phulwa White	Cream	Floury	Excellent
19	Great Scot	white	Mealy	Excellent	50	Pimpernnel	Cream	Waxy	Very good
20	Gulabia	light Yellow	Waxy	Very good	51	PS-4904	white	Mealy	Very good
21	Gulmarg Special	Cream	Mealy	Good	52	Rangpuria	Cream	Waxy	Good
22	Hamraj Hatti	Cream	Mealy	Good	53	Rajendra-1	Cream	Floury	Excellent
23	Jalandhar	Cream	Waxy	Good	54	Rajendra-2	Cream	Waxy	Average
24	Jeevan Jyoti	Cream	Floury	Good	55	Rajendra-3	Cream	Floury	Average
25	K-22	Cream	Mealy	Very good	56	Sisa Pani	Cream	Mealy	Good
26	Kachha Bhutia	Cream	Waxy	Very good	57	Ultimus	Cream	Mealy	Good
27	KanpuriaSafed	Cream	Mealy	Average	58	Up-to-date	Cream	Floury	Very good
28	KP/PC-292	white	Waxy	Very good	59	VB-8	Cream	Waxy	Good
29	Krantz	Cream	Floury	Very good	60	Kufri Bahar	white	Mealy	Very good
30	Lady Rosetta	Cream	Floury	Very good	61	Kufri Jyoti	Cream	Waxy	Good
31	Lah Ipon	white	Floury	Good	62	Kufri Chipsona-1	Cream	Floury	Very good

varieties was little higher than mealy (19.80%) and ranged from 16.33 (Bareilly Red) to 22.01 (DRR-Blue). This shows that dry matter content is not always associated with the mealiness. As in the present study ON 1645 (20.22% dry matter) categorized as floury and DRR (22.22% dry matter) was adjudged as waxy. These findings are in corroboration with results of Brittin and Trevino (1980), True and Work (1981), Gupta *et al*. (2015) and Unrau and Nylund (1957), who have found that potatoes within a variety which differ in specific gravity differ in mealiness and potatoes of different varieties but identical in specific gravity may also differ in mealiness depending on the varieties being compared. Texture is also influenced by genotypes having varying cell wall density and the degree of solubilization of the middle lamella and cell walls (van Marle *et al*., 1997). With regards to flavor, 6 collections (Champaran Lal, DRR-Blue, Great Scot, Lah Tora, Phulwa White, Rajendra-1) were adjudged as excellent whereas 24 collections possessed very good flavor (Bareilly Red, Bhoora Aloo, Desla Lal, DRR, DRR-Red, Dwarf Culture, Gulabia, K-22, Kachha Bhutia, KP/PC-292, Krantz, Lady Rosseta, Lah saw Khasi, Lal Jyoti, Lal Lauvkar, Lal Mitti-2, Magnum Bonum, ON-1645, Phulwa Red, Pimpernnel, PS-4904, Up-to-date, Kufri Bahar, Kufri Chipsona-1). Remaining 25 were graded as good and 7 collections were found to have average flavor on the basis of consensus of panelists. Plant genotype, production environment and storage environment influence the levels of sugars, amino acids, RNA, and lipids and the enzymes that react with them to produce flavor compounds (Jansky, 2010).

Correlation between different attributes of potato storage parameters

The weight loss increases with sprout growth, since sprout growth adds to the surface area of the tuber and high permeability of sprout wall to water vapour leads to greater water loss. It has been reported that the surface area of sprouts equivalent to 1% of that of tuber could double the potential rate of evaporation (Singh and Ezekiel, 2003). In this study also sprouting percentage at 75 days of storage had highly significant positive correlation (**Table 3**) with percent physiological weight loss (r=0.51**, n=62), percent weight loss due to sprouts (r=0.59**) and percent total weight loss (r=0.59**). Percent rottage by weight in varieties was highly significant, it had positive correlation with total weight loss (r= 0.49**) and negative correlation with percent tuber dry matter (r= -0.30**). Gupta *et al.* (2015) reported similar negative association between weight loss due to rottage and tuber dry matter in Indian potato varieties. Physiological weight loss had positive association with % weight loss due to sprouts (r= 0.71**) and total weight loss (r= 0.92**). The positive and high associations of total weight loss between, sprouting,

Table 3 Character association between storage parameters

Sl No	Parameters	R%	PWL%	SWL%	TWL%	DM%
1	Spr %	0.33**	0.51**	0.59**	0.59**	-0.22
2	R%		0.11	0.24	0.49**	-0.30*
3	PWL%			0.71**	0.92**	0.01
4	SWL%				0.76**	-0.08
5	TWL%					-0.11

Spr % =Sprouting % at 75 days, R% =Rottage % (by weight), PWL%=Physiological weight loss % at 75 days, SWL%=Weight loss due to sprouts (%), TWL%=Total weight loss % at 75 days and DM%= Tuber Dry matter %

rottage, physiological weight loss, and sprout weight loss indicative of due care to be taken while selecting for use as parental line or commercial cultivation.

Correlation coefficients (n=62) between tuber dry matter and texture (r=0.41*) was significant and positive which indicate that potato varieties with high tuber dry matter possess floury texture which endorsed the findings of Mosely and Chase (1993). Although starch is tasteless, it influences texture and can interact with flavor compounds during cooking (Jitsuyama *et al*., 2009; Solms and Wyler, 1979). Briant *et al*. (1945) found a correlation between starch granule size and texture of cooked potatoes. Barrios *et al*. (1963) found that the mealy potatoes had higher specific gravities, starch and amylose contents as well as a higher percentage of large starch granules (diameter>50 µm) than the waxy cultivars.

CONCLUSION

Besides high yield, the storage and cooking quality of potatoes are the most important features that insure high income to producer but at the same time it provides security to the traders and consumers for deriving assured benefits. A number of local collections have traditionally been popular for various uses in different parts of India. Based on the results on storage and organoleptic test, potato collections namely, Phulwa Red Splash, Lah Tora, Phulwa Red, Desla Lal, Sisa Pani, Burma Special, Gulabia, Lal Mitti-1 with low storage losses (<9.12%), medium to high tuber dry matter (18.29 to 21.79%), good to excellent flavor and with texture of floury to waxy were identified. The information generated in this study would enhance the knowledge of stakeholders with regard to shelf life and organoleptic attributes of locally grown collections and utility of these collections in future breeding programmes.

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