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Studies on productivity and quality of tuber for processing of potato in alluvial zone of West Bengal

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ABSTRA CT

Seven potato cultivars (MP/98-172, MP/99-322, MP/99-406, Kufri Chipson-1, Kufri Chipsona-2, Atlantic and Kufri Jyoti) were evaluated for processing on the basis of yield and chemical composition at Block Seed Farm, Adisaptagram, Hooghly, West Bengal during winter season of 2005-06 and 2006-07. The experiment was carried out in Randomized Block Design with three replications. The highest number of tubers per plant was recorded from Kufri Chipsona-1 (9.33) and MP/98-172 (7.66), but the highest average tuber weight (89.2 g) per plant was obtained from MP/99-406. MP/98-172, Kufri Chipsona-1, Kufri Chipsona-2 and Atlantic produced more than 25 t/ha tuber yield and the highest tuber yield (27.53 t/ha) was obtained from MP/98-172. MP/98-172, Atlantic, Kufri Chipsona-2 and Kufri Chipsona-1 (yielded 27.53, 25.95, 25.76 and 25.68 t/ha, respectively) showed an increase of 27.63, 20.3, 19.43, 19.05% yield over indigenous cultivar Kufri Jyoti (control). These cultivars recorded low reducing sugar (<100 mg/100g fresh weight basis) and high dry matter content (>20%) except Atlantic which recorded low but very close to 20% dry matter, possessed all other desirable attributes for processing. Among the cultivars, MP/98-172 produced the maximum dry matter content (21.24%) but low reducing sugar was obtained from Atlantic (75.6 mg/100g fresh weight). The highest Specific gravity was recorded from Kufri Chipsona- 2 (1.080). MP/99-322 scored the minimum peeling loss of tubers (9.9%) followed by Kufri Chipsona-1 (11.75 %). Kufri Chipsona-1 and MP/98-172 showed minimum physiological loss in weight (13.88% and 15.25%) and rotting of tubers (11.1% and 12.1%) after 90 days of storage.

Key words: Potato cultivars, productivity and processing traits

Potato processing is essential to sustain the present increasing rate of production in India. Most of the potato processing is presently confined to the developed countries and is only in its infancy in most of the developing countries with the exception of China (20 %), DPR Korea (6 %) and Mexico (8 %) In Netherlands and the USA, processing industry absorbs about 55 and 60 %, respectively of the annual potato production (Marwaha and Sadhu, 1999). However, fast growth in potato processing is expected to occur in India due to increased urbanization, preferences for easy-to-prepare and fast foods, rise in per capita income, increase in number of working women and expanding tourist trade. Processing provides an effective means of utilizing surplus potatoes especially during glut in some years as it reduces wastage and helps in decreasing the demand for refrigerated storage space, the capacity of which is hardly 45 % of the total production both in India and West Bengal. Keeping this in view the experiment was carried out in order to identify suitable high yielding potato varieties for processing with better keeping quality for the Gangetic Alluvial Plains of West Bengal

MATERIALS AND METHODS

The experiment was carried out during winter season of 2005-06 and 2006-07 at Block Seed Farm, Adisaptagram, Hooghly, West Bengal to study productivity, morphological and biochemical attributes for processing of seven potato cultivars (one exotic cultivar Atlantic and six Indian potato cultivars, namely MP/98-172, MP/99-322, MP/99-406, Kufri, Chipsona-1, Kufri Chipsona-2 and Kufri Jyoti). The cv. Kufri Jyoti commonly used for processing in the country (India) was used as control. The farm is situated at approximately 22° 57′ N latitude and 88° 20′ E longitude with an average altitude of 9.75 m above mean sea level. The soil of the experimental field was sandy loam in texture having pH 6.6, organic carbon 0.85%, available nitrogen 310.18 kg, available P_2O_5 14.90 kg and available K_2O 218.40 kg /ha. Well sprouted healthy whole seed tubers weighing about 25 g each approximately were planted at a spacing of 60 cm × 20 cm in Randomized Block Design with a gross plot size of 4.8 m x 4.0 m following the recommended fertilizer schedule of the region (180 kg N, 150 kg P_2O_5 and 150 kg K_2O/ha). The crop was planted on 26.11.05 and 20.11.2006 and dehaulmed at 90 days after planting in 2005-06 and 2006-07), respectively. Harvesting was done 15 days after dehaulming. Half of nitrogen and full doses of P_2O_5 and K_2O were applied in furrows and thoroughly mixed with soil before plating of seed potato tubers. The rest half of nitrogen was top dressed at 30 days after planting.

Data on tuber number/plant, average tuber weight, grade wise tuber production on the basis of

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number and weight and total tuber yield were recorded just after harvesting of tubers. Dry weight of tubers, specific gravity, reducing sugar and peeling loss of tubers were recorded after 7-10 days of harvesting. Physiological weight loss and rotting of tubers were recorded 90 days after storing in room temperature. The data were recorded as per standard methods (A.O.A.C. 1984) and analyzed statistically (Gomez and Gomez, 1983). Peeling loss of tubers of potato cultivars was computed by using general kitchen peeler.

RESULTS AND DISCUSSION

Morphological characters

The shape of tubers of all the cultivars were found to be suitable for processing particularly for chips because shape of tubers were either round to oval or oval with fleet or shallow eyes (Table 1).

The highest average tuber weight per plant was recorded from MP/99-406 (89.2 g) while the lowest average tuber weight per plant was recorded from Kufri Jyoti (43.1) (Table 2).

Percentage of number of large sized tubers (>60g) ranged between 17.5-38.0 %, medium sized tubers (30-60g) between 33.0-45.5% and small size tubers (<30g) between 26.5-40.0% among different cultivars during both the years of study. Pooled data shows that the maximum percentage (by number) of large sized tubers was recorded in MP/99-406 (38.0 %), closely followed by exotic cultivar Atlantic (34.0 %), while maximum percentage (by number) of medium sized tubers was obtained in MP/98-172 (45.5%) closely followed by Kufri Chipsona-1, Kufri Jyoti, Kufri Chipona-2. The percentage in number of tuber containing small sized tubers (<30g) was highest in Kufri Jyoti (40.0 %), closely followed by MP/98-172 (37.0 %).

Percentage of large sized tubers on weight basis (>60g) ranged between 39.5-68.5%, medium sized tubers (30-60g) between 24.5-45.5% and small sized tubers (<30g) between 7.0-15.5% among different cultivars. Similar differences in different grades of tubers among these cultivars were reported by Gaur *et al.* (1999) from Modipuram in northeastern plains and Chettri *et al.* (2001) and Ray and Mukhopadhyay, (2004) from Hooghly in West Bengal. Pooled data showed that the maximum yield from large sized tubers (>60 g) was recorded from MP/99-406 (68.5%), while maximum yield of medium sized tubers was obtained from MP/98-172 (45.5%), closely followed by Kufri Jyoti (45.0 %), Kufri Chipsona-2 (41.0 %) and Kufri Chipsona-1 (40.5%). The percentage of tuber yield containing small sized tubers (<30g) was highest in Kufri Jyoti (15.5%), closely followed by MP/98-172 (14.0 %).

From the results, it is evident that the cultivars MP/99-322, MP/99-406 and Atlantic produced more than 89% of the total yield comprising large and medium sized tubers. Hence, these varieties have potential for large-scale cultivation in West Bengal.

Peeling losses in the cultivars varied between 9.9 (MP/98-172) and 15.3% (Kufri Jyoti). MP/98-172, Kufri Chipsona-1, Kufri Chipsona-2 and Atlantic recorded peeling loss less than 13% while MP/99-406 and Kufri Jyoti recorded more than 14.0 % peeling loss. Differences in peeling losses of tubers of Indian cultivars were also observed by Marwaha *et al.* (2007). The tubers having shallow eyes might have contributed to lower peeling losses in the cultivars. Relatively thin skin of MP/99-322 recorded lesser peeling losses in the cultivar than Kufri Chipsona-1 and Kufri Chipsona-2. Tuber characters influence the yield of processed products as peeling, trimming and cutting losses vary with the shape, size and depth of eyes of tubers, which ultimately influence the yield recovery (Gaur *et al.*, 1998). It can, therefore, be concluded that recovery percentage of finished products of the cultivar MP/98-172 would be higher in comparison to Kufri Jyoti and other cultivars

Number of tubers per plant and tuber yield

The maximum number of tubers per plant was recorded from Kufri Chipsona-1 (9.33), MP/98-172 (7.66) and Kufri Chipsona-2 (6.67). The minimum number of tubers per plant was recorded from MP/99-406 (3.89) and Atlantic (5.14). Kufri Chipsona-1 and MP/98-172 produced 32.34% and 8.65% more tubers than Kufri Jyoti (7.05).

A significant variation in tuber yield was observed among the cultivars (Table 2). MP/98-172 cultivar produced the maximum yield of tubers (27.53 t/ha). The lowest yield of tuber was recorded from Kufri Jyoti (21.57 t/ha) and MP/99-406 (21.85 t/ha). MP/98-172 (27.53 t/ha), Kufri Chipsona-1 (25.68 t/ha), Kufri Chipsona-2 (25.76) and Atlantic (25.95 t/ha) showed an increase of 27.63, 19.05, 19.43 and 20.3% yield over indigenous cultivar Kufri Jyoti (control). Ray and Mukhopadhyay (2004) reported that Kufri Chipsona-1 gave 4.48% higher yield over Kufri Jyoti.

Tuber quality

Only three cultivars, namely MP/98-172, Kufri Chipsona-1 and Kufri Chipsona-2 recorded more than 20% dry matter content (21.2, 21.0 and 20.5%, respectively) (Table 3). Atlantic recorded below but very close to 20% dry matter. Kufri Jyoti recorded lowest dry matter content (18.0 %). Singh *et al.* (2005) recorded dry matter content of 21.2% and 22% from the varieties Kufri Chipsona-1 and Kufri Chipsona-2, respectively. MP/98-172, Kufri Chipsona-1, Kufri Chipsona-2 and Atlantic having around and more than 20% dry matter can be considered ideal for processing in Gangetic alluvial plains of West Bengal as proposed by Brody (1969).

Table 1: Morphological characters of tubers of potato cultivars after harvest

Potato cultivars	Shape	Skin type /colour	Eyes	Flesh	Peeling loss (%)
MP/98-172	Round to oval	White	Fleet	White	12.84
MP/99-322	Round to oval	White	Fleet	White	9.9
MP/99-406	Round to oval	White	Shallow	White	14.35
Kufri Chipsona-1	Oval to oblong	Smooth/White Cream	Fleet	Cream	11.75
Kufri Chipsona-2	Round to oval	Smooth/Cream	Fleet	Yellow	12.82
Atlantic	Round to round oval	White	Shallow	Yellow	12.8
Kufri Jyoti	Oval	Smooth/White	Shallow	Dull white	15.3
S.Em (±)					**0.67**
LSD (0.05)					**2.31**

Table 2: Yield components and tuber yield of potato cultivars (pooled over two years)

Potato cultivars	No. of tubers/plant	Av. weight of tuber (g)	Grades of tubers						Tuber yield ($t.ha^{-1}$)
			% on number basis			% on weight basis			
			>60g	30-60g	<30g	>60g	30-60g	<30g	
MP/98-172	7.66	50.1	17.5 (24.73)	45.5 (42.42)	37.0 (37.47)	40.5	45.5	14.0	27.53
MP/99-322	6.84	56.1	28.0 (31.95)	39.5 (38.94)	32.5 (34.94)	57.0	32.5	10.5	22.35
MP/99-406	3.89	89.2	38.0 (38.06)	33.0 (35.06)	29.0 (32.58)	68.5	24.5	7.0	21.85
Kufri Chipsona-1	9.33	50.5	22.0 (27.97)	42.5 (40.69)	35.5 (35.67)	46.5	40.5	12.5	25.68
Kufri Chipsona-2	7.21	47.9	23.0 (28.66)	42.0 (40.40)	35.5 (36.57)	46.0	41.0	13.0	25.76
Atlantic	5.14	63.7	34.0 (35.67)	39.5 (38.94)	26.5 (30.98)	58.5	32.0	9.5	25.95
Kufri Jyoti	7.05	43.1	17.5 (24.73)	42.5 (40.69)	40.0 (39.23)	39.5	45.0	15.5	21.57
S.Em (±)	**0.85**	**4.55**	**1.60**	**1.97**	**1.93**	**1.84**	**1.56**	**1.22**	**0.96**
LSD (0.05)	**2.61**	**15.54**	**5.52**	**6.80**	**6.66**	**6.39**	**5.38**	**4.21**	**2.95**

Figures in the parentheses are angular transformed values

Table 3: Tuber quality of potato cultivars (pooled over two years)

Potato cultivars	Dry matter (%)	Specific gravity	Reducing sugar (% fresh wt.)	Total weight loss (%)	Rotting (%)
MP/98-172	21.24	1.076	90.85	15.25	12.1
MP/99-322	18.23	1.072	92.79	34.29	33.3
MP/99-406	18.47	1.071	87.37	68.75	62.5
Kufri Chipsona 1	20.95	1.076	88.95	13.88	11.1
Kufri Chipsona 2	20.5	1.080	78.1	45.25	41.2
Atlantic	19.6	1.073	75.6	44.0	42.1
Kufri Jyoti	18.02	1.068	163.5	50.25	43.9
S.Em (±)	**0.47**	**0.002**	**2.10**	-	-
LSD (0.05)	**1.62**	**0.006**	**7.27**	-	-

Potato cultivars Kufri Chipsona-2 exhibited highest specific gravity (1.080) closely followed by MP/98-172 and Kufri Chipsona-1 (1.076). Kufri Jyoti attained the lowest value of 1.068. The observation showed a positive correlation between specific gravity and dry matter content of tubers which were reported by Marwaha and Kumar (1997). Pandey *et al.* (2006) reported that potato having specific gravity more than 1.070 could be utilized for processing of chips. Based on this observation all the potato cultivar except Kufri Jyoti can be utilized for processing of chips. Only Kufri Jyoti having specific gravity < 1.070 was found not suitable for processing for chips.

Reducing sugar content in tubers ranged between 75.6-163.5 mg/100 g on fresh weight basis. All the cultivars except Kufri Jyoti recorded reducing sugar content less than 150 mg/100 g fresh weight and therefore, found to be ideal for processing as proposed by Paul Khurana (2002). Kufri Jyoti (163.5 mg/100 g fresh weight) recorded higher value of reducing sugar than desired level (150 mg/100 g fresh weight) for processing.

Regarding keeping quality, Kufri Chipsona-1, MP/98-172 showed minimum physiological loss in weight (13.88% and 15.25%, respectively) and rotting of tubers (11.1%, 12.1% respectively) after 90 days of storage.

From the investigation it has been revealed that Kufri Chipsona-1, Kufri-Chipsona-2, MP/198-172 and Atlantic met the required processing traits of having tubers of round to oval shape and fleet or shallow eyes, high (20 % or more) dry matter content, low (less than 150 mg/100 g fresh weight) reducing sugar and better keeping quality under new alluvial zone of West Bengal. Besides, it was observed that the potato cultivars had higher yield potential and ability to produce higher percentage of processing grade tubers as compared to the other cultivars tested in this investigation including Kufri Jyoti which was used as control.

Kufri-Chipsona-1, Kufri Chipsona-2 and Atlantic have already been introduced for processing purpose in West Bengal. The experiment also revealed that potato cultivar MP/98-172 had desirable quality traits for processing (particularly for chips because of its round shaped tubers). However, the tolerance of the cultivar to late blight should be tested before introduction in West Bengal

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