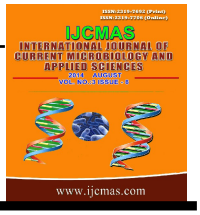
International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 3 Number 8 (2014) pp. 172-177**
http://www.ijcmas.com



Original Research Article

Studies on Indian Potato Genotypes for their Processing and Nutritional Quality Attributes

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A B S T R A C T

Fourteen potato cultivars including 11 Indian genotypes and 3 exotic genotypes were evaluated for processing quality characteristics including specific gravity, dry matter, reducing sugars, starch, protein and ash content. All the quality characteristics were affected by cultivars. 'Kufri-Chipsona-1' among the Indian cultivars and 'FC-3', 'Atlantic' and 'Lady Rosetta' among the exotic cultivars were rated as the best varieties for processing into value added potato products, since these contained the highest amount of specific gravity and dry matter content and lowest among the reducing and total sugars. On the other hand, commonly cultivated varieties such as 'Kufri Pukhraj', 'Kufri Badshah' and 'Kufri Jyoti' were found inferior for processing. The dry matter content of cultivars was positively correlated to specific gravity and starch content.

Keywords

Cultivars, potato, processing, quality, reducing sugars.

Introduction

Potato (*Solanum tuberosum* L.) is one of the principal important tuberous food crops in the world, either for direct consumption or for processing (Ramezani and Aminlari, 2004). Potato is a nutritious vegetable containing significant amount of carbohydrates, superior quality protein, dietary fibre and some minerals. Potato also contains biologically active components including phenolic acids, ascorbic acid and carotenoids which are commonly described as antioxidants (Gumul et al., 2007). Potato production has significantly increased in recent years in India, making it to the position of second largest potato producing country in the world. Potato processing is emerging as a fast growing sector in India. For processing purpose, potato must fulfill certain quality attributes such as low reducing sugars and high dry matter content. Reducing sugars induce a non-enzymatic Millard browning reaction with free amino acids during frying, resulting in desirable color and flavor of fried potato products (Kaur et al., 2012). But their presence in excessive quantities results in formation of unacceptable brown-to-black pigmented products which affect consumer acceptability. High dry matter enhances chip yield, crispness and reduces oil uptake in fried products (Freitas et al., 2012).

In India, fresh potato is available only for 2-3 months in a year and its perishable nature necessitate cold storage for its use in off season. It is well known that potato undergoes many changes during storage including weight loss and accumulation of reducing sugars (Marwaha, 2002). As fresh potato is available only for a short span of time in our country, estimation of desirable processing quality potatoes for potato processing industry is utmost important. Therefore, the aim of this study was to enlighten the industry of widely available varieties in the region and their suitability with respect to processing.

Materials and Methods

Well cured, healthy tubers of fourteen potato genotypes including 11 Indian genotypes ('Kufri Chipsona-1', 'Kufri Chandramukhi', 'Kufri Pukhraj', 'Kufri Chipsona-3', 'Kufri Badshah', '1533', 'Kufri Lauvkar', 'Kufri Jyoti', 'Super', 'Khyati' and 'Pushkar') and 3 exotic genotypes which are commonly cultivated in India ('FC-3', 'Atlantic' and 'Lady Rosetta') were procured from the vegetable farm of Punjab Agricultural University, Ludhiana. Phytochemical analysis of genotypes was carried out in the Food Science and Technology laboratories at Punjab Agricultural University, Ludhiana.

Physico-chemical analysis

Fresh potato tubers were analyzed for dry matter content and ash content by using standard AOAC method (AOAC, 2005). The specific gravity was determined by the standard water displacement method (Raj et al., 2011). Reducing sugars of raw tubers were determined by the Nelson Somogyi Method (Pearson, 1976) and total sugars by phenol sulphuric acid method (Sadasivam and Manickam, 1996).

Starch content was analyzed by the method of Clegg, 1956. Total nitrogen was estimated by the Micro-Kjeldahl Method (Ranganna, 2004) and protein content was calculated using a nitrogen factor of 6.25.

Statistical analysis

All the experiments were conducted in triplicate and the mean and standard deviation were calculated using MS Excel Software. The results were evaluated by one-way analysis of variance (ANOVA) and Tukey's Post hoc tests using SPSS version 16.0 (Systat Statistical Program, USA).

Results and Discussion

Specific gravity

Processing attributes of potato cultivars are presented in Table 1. Specific gravity among different cultivars ranged between 1.040 to 1.096. Cultivar 'Kufri Chipsona-I' displayed highest specific gravity (1.096), followed by 'Kufri Chandramukhi' (1.095), 'Lady Rosetta' (1.095) and 'Atlantic' (1.094) with non-significant difference while 'Kufri Pushkar' and 'Kufri Khyati' showed minimum specific gravity, 1.040 and 1.042, respectively (Table 1).

These differences might be related to genetic variations among different cultivars. Similar observations were reported earlier for different cultivars of potatoes (Dean, 1994, Sandhu and Parhawk, 2002). A high positive correlation (r=0.988) of specific gravity with dry matter content and starch content was noticed in this study (Table 3). Specific gravity and dry matter content reflect the amount of starch present and tubers with high specific gravity (>1.080) are preferred for processing (Abbas et al., 2011).

Dry matter content

Dry matter content is an important quality determinant in potato processing and its higher content (>20%) allow lesser oil uptake, desirable texture and enhanced yield in the finished products (Marwaha, 1997). Between the cultivars studied, maximum dry matter content was observed in 'Kufri Chipsona-1' and 'Kufri Chandramukhi' (24.30%), followed by 'Lady Rosetta' (24.0%) and 'Atlantic' (23.90%) with non significant differences (Table 1). Minimum value of dry matter content was noticed for cultivar 'Kufri Pushkar' (14.06%). As explained by Abbas et al., 2011, tuber dry matter content is a strongly genetic based characteristic and differs significantly among cultivars. It was observed that cultivars with high specific gravity displayed higher percentage of dry matter content while low dry matter was observed in cultivars with low specific gravity (Table 1). This might be due to a positive correlation of dry matter content with specific gravity (r=0.988) observed in this study (Table 3). A significant relationship between dry matter and specific gravity has been reported earlier (Marwaha, 1997, Abbas et al., 2011)

Reducing sugars

It is desirable that fried potato products such as potato chips and French fries should be of light golden color without any brown over coloring or black spots (Mehta et al., 2011). Excessive darkening and development of bitter flavor due to high reducing sugars is the major quality defect in potato processing. In this study, reducing sugars ranged 0.06-0.54% among different cultivars, with maximum in 'Kufri Pukhraj' (0.54%) followed by 'Kufri Badshah' having 0.30% reducing sugars (Table 1). Minimum reducing sugars were observed in 'Kufri Chipsona-1'and 'Lady Rosette' (0.06%), followed by 'Atlantic' (0.07%) and 'FC-3' (0.08%) with non-significant differences. As explained by Mehta et al., 2011, genetic component has a strong influence upon initial sugar levels in potato tubers. Reducing sugars are also affected by agronomic and environmental factors, storage conditions and processing methods (Abbas et al., 2011). Low reducing sugars (<0.1% on fresh weight basis) is desirable for making light colored finished potato products. The results of the present study revealed that cultivar 'Kufri Chipsona-1', 'Lady Rosetta', 'Atlantic' and 'FC-3' with low reducing sugars can be considered more suitable for making potato chips and French fries. In contrast, commonly cultivated potato varieties 'Kufri Pukhraj', 'Kufri Jyoti' and 'Kufri Badshah' exceeded the prescribed limit for making good quality potato products and are unfit for processing.

Total sugars

Sucrose, glucose and fructose are the major soluble sugars of potato. Sucrose, a non reducing sugar can also play an important role in chip color development through hydrolysis during frying (Illeperuma and Wickramasinghe 2000). Thus, total sugars could also serve as quality index for processing. Large variations in total sugars were observed among different cultivars. Total sugars were found to be maximum in cultivar 'Kufri Pukhraj' (0.77%), followed by 'Kufri Badshah' (0.46%) and minimum in 'Kufri Chipsona-1' and 'Atlantic' (0.12%) (Table 1). Potato tuber sugar content is a heritable character and may be influenced by cultivar, maturity, production site and storage conditions (Abbas et al., 2011). It was observed that total sugars remained well within the prescribed limits (<0.25%) (Abbas et al., 2011) in cultivars 'Kufri Chipsona-1', 'Atlantic', 'FC-3' and 'LR' but exceeded the limit in other cultivars.

Table.1 Processing quality attributes of different potato cultivars

S. No.	Cultivar	Specific gravity	Dry matter (%)	Reducing sugars (%)	Total sugars (%)
1	'Kufri Chipsona-1'	1.096^{b}±0.005	24.31^{a}±0.90	0.06^{d}±0.003	0.12^{d}±0.02
2	'Kufri Chandramukhi'	1.095^{b}±0.005	24.30^{a}±0.80	0.18^{cd}±0.05	0.30^{c}±0.03
3	'Kufri Pukhraj'	1.052^{b}±0.002	15.31^{d}±0.50	0.54^{a}±0.08	0.77^{a}±0.04
4	'Kufri Chipsona-3'	1.097^{b}±0.004	22.30^{b}±0.06	0.18^{cd}±0.05	0.32^{c}±0.02
5	'Kufri Badshah'	1.066^{b}±0.003	18.30^{c}±0.16	0.38^{b}±0.03	0.46^{b}±0.05
6	'1533'	1.082^{b}±0.004	21.20^{b}±0.25	0.20^{c}±0.08	0.30^{c}±0.04
7	'Kufri Lauvkar'	1.080^{b}±0.004	21.10^{b}±0.11	0.22^{c}±0.02	0.32^{c}±0.02
8	'Kufri Jyoti'	1.066^{b}±0.003	18.20^{c}±0.06	0.38^{b}±0.02	0.41^{bc}±0.07
9	'Super'	1.045^{b}±0.002	14.70^{d}±0.10	0.28^{bc}±0.05	0.43^{bc}±0.06
10	'Kufri Khyati'	1.042^{b}±0.002	14.30^{d}±0.18	0.30^{bc}±0.04	0.50^{d}±0.05
11	'Kufri Pushkar'	1.040^{a}±0.003	14.06^{d}±0.11	0.30^{bc}±0.06	0.40^{bc}±0.02
12	'FC-3'	1.085^{b}±0.003	21.93^{b}±0.25	0.08^{d}±0.002	0.16^{d}±0.08
13	'Atlantic'	1.094^{b}±0.005	23.90^{a}±0.03	0.07^{b}±0.003	0.12^{d}±0.05
14	'Lady Rosetta'	1.095^{b}±0.005	24.00^{a}±0.12	0.06^{d}±0.002	0.14^{d}±0.06

Values are mean± standard deviation, *n*=3. Values with same superscript within the column do not differ significantly.

Table.2 Nutritional attributes of different potato cultivars

S. No.	Cultivar	Starch (%)	Protein (%)	Ash (%)
1	'Kufri Chipsona-1'	18.50^{a} ± 0.21	5.20^{a} ± 0.20	1.12^{c} ± 0.10
2	'Kufri Chandramukhi'	18.10^{a}± 0.25	4.50^{b} ± 0.25	2.09^{a}± 0.21
3	'Kufri Pukhraj'	12.00^{gh} ± 0.18	3.53^{c} ± 0.30	1.73^{b}± 0.09
4	'Kufri Chipsona-3'	15.20^{c}± 0.20	2.80^{d}± 0.05	0.70^{d}± 0.02
5	'Kufri Badshah'	13.20^{ef} ± 0.12	1.40^{f}± 0.04	0.98^{c}± 0.10
6	'1533'	13.90^{de} ± 0.08	2.85^{d}± 0.11	1.01^{c}± 0.10
7	'Kufri Lauvkar'	14.20^{d}± 0.10	2.00^{e}± 0.15	0.98^{c} ± 0.05
8	'Kufri Jyoti'	12.80^{fg} ± 0.13	$1.82e^{f}$± 0.09	0.95^{cd} ± 0.02
9	'Super'	11.81^{h} ± 0.15	1.82^{ef} ± 0.07	1.12^{c} ± 0.10
10	'Kufri Khyati'	12.80^{fg} ± 0.16	1.61^{fg} ± 0.09	1.08^{c} ± 0.08
11	'Kufri Pushkar'	12.31^{gh} ± 0.20	1.34^{f} ± 0.05	0.98^{c} ± 0.11
12	'FC-3'	14.50^{d} ± 0.25	2.80^{d} ± 0.11	0.89^{cd} ± 0.05
13	'Atlantic'	15.90^{bc} ± 0.09	2.90^{d} ± 0.13	1.12^{c} ± 0.08
14	'Lady Rosetta'	16.00^{b} ± 0.16	1.81^{ef} ± 0.09	0.70^{d}± 0.05

Values are mean± standard deviation, *n*=3. Values with same superscript within the column do not differ significantly

Table.3 Correlation between antioxidant activity, total phenolic content and ascorbic acid Content

	SG	DM	RS	TS
DM	0.988889			
RS	-0.74857	-0.78376		
TS	-0.76296	-0.81216	0.959767	
S	0.85781	0.893187	-0.75009	-0.73934

SG-Specific gravity, DM-Dry matter, RS- Reducing sugars, TS-Total sugars, S-Starch

Starch content

Starch, comprising 65-80% of the dry matter content, is considered to be the main constituent of potato (Kadam et al., 1991). Results for starch content indicated that highest starch content was obtained in 'Kufri Chipsona-1' (18.50%), followed by 'Kufri Chandramukhi' (18.10%), both being at par (Table 2). Lowest starch content was noticed in 'Super' (11.81%) and 'Kufri Pukhraj' (12.0%). This difference in starch content might be due to difference in dry matter content among various cultivars as starch and dry matter contents of potato are directly related to each other. A strong positive correlation (r=0.893) of starch content with dry matter content and specific gravity was seen in the present study (Table 3).

Protein and ash content

The protein and ash content among different cultivars ranged 1.40-5.40% and 0.70-1.73%, respectively (Table 2). In previous studies on different potato cultivars, the protein content was reported to be in the range of 0.70-4.60% (Singh and Kaur, 2009, Abbas et al., 2011). Higher values observed in the present study might relate to varietal characteristics. Data for ash content is in line with those reported by Sandhu and Parhawk for different potato cultivars.

Potato processing industry in India is on the threshold of rapid growth. Therefore, screening of suitable potato cultivars for processing is important. The present study concludes that all the three exotic cultivars *viz*. 'FC-3', 'Atlantic' and 'Lady Rosetta' and one Indian cultivar 'Kufri-Chipsona-1' could be considered best for processing due to presence of dry matter and low reducing and total sugars. Whereas cultivar 'Kufri Pukhraj' had the poorest quality for processing due to high sugar content and low dry matter. Cultivation of processing quality potatoes can not only solve the problem of potato industry but can also improve the socio-economic conditions of farmers as these cultivars fetch higher prices in market.

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