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Optimization and screening of potato varieties for microwave baking

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ABSTRACT

The ten potato cultivars viz Kufri Chipsona-2, Atlanta, Kufri Surya, Kufri Pukhraj, Kufri Khayti, Kufri Jyoti, Kufri Pushkar, Kufri Bahar, Kufri Ashoka and J/99-242 were used for different chemical analysis. The moisture content of varieties differed significantly ranging from 78.87 (Atlanta) to 84.53 (Kufri Pushkar) per cent and dry matter content ranged from 15.30 (J/99-242) to 20.93 (Kufri Khayti) per cent. Starch was minimum in J/99-242 (52.55%) and maximum in Kufri Khayti (85.67%). Highest reducing sugars were found in Kufri Pushkar (210.33 mg/100 g) and lowest in Kufri Pukhraj (55.13 mg/100 g). Lowest level of total sugars was found in J/99-242 (216.10 mg/100 g) and Kufri Khayti (216.67 mg/100 g) the two being at par with each other and highest in Kufri jyoti (816.67 mg/100 g). Minimum non-reducing sugars (104.43 mg/100 g) were also found in J/99-242 and maximum (575.00 mg/100 g) in Kufri Chipsona-2. The potatoes weighing 101-140 g baked for 4 min at 100 power density produced well cooked and highly acceptable product with firm texture and less flesh loss. The flesh loss of baked potato ranged between 3.8 (Kufri Pukhraj) to 12.9 (Kufri Jyoti) per cent. There were significant differences in the cultivars with respect to appearance, flavour, taste and overall acceptability. Variety Kufri Jyoti was most preferred with acceptability index (80.89) followed by Kufri Pushkar (78.22) among the microwave baked potatoes. The dry matter was positively correlated with flavour and taste of baked potatoes which could be due to high amount of starch that forms stable complex with flavour compounds during cooking.

Key words: Baking; optimization; screening; variety

INTRODUCTION

Potatoes are the subject of many popular cultural conceptions and misconceptions. At various times in recent history they have had the reputation of being nutritionally both bad and good. During their phase of having a nutritionally bad reputation potatoes were marked as being 'fattening' and contribution to diabetes obesity and its co-morbidities (Burlingame et al 2009). Potato is a high moisture food and thus well suited for microwave treatments (Barba et al 2008). Microwave baking is a complex process which involves many physical, chemical and biochemical changes in food.

In particular during baking the starch gel gets gelatinized inducing palatability, digestibility and softening of the raw starch matrix. It has been reported that baked potatoes produce a complex array of volatile compounds including lipids, Maillard reaction products, sulphur compounds and methoxypyrazines. Pyrazines are considered to be among the most important and characteristic components of baked potato flavor (Oruna-Concha et al 2001). They are produced by the Maillard reaction in which reducing sugars (glucose and fructose) interact with amino acids at high temperature. A strong positive relationship between pyrazine levels and baked potato flavor has been reported (Maga and Holm 1992). Microwave baking is a method of increasing importance for preparing baked potatoes in catering services, fast food and domestic preparations. Keeping these in view an attempt was made to know the acceptability of different tuber varieties for baking and to find out the relation between chemical composition and sensory parameters.

MATERIAL and METHODS

The ten potato cultivars viz Kufri Chipsona-2, Atlanta, Kufri Surya, Kufri Pukhraj, Kufri Khayti, Kufri Jyoti, Kufri Pushkar, Kufri Bahar, Kufri Ashoka and J/99-242 were collected from AICRP on potato, Regional Horticulture Research and Extension Centre, Kumbapur, Dharwad. Tubers were cut, mixed thoroughly and used for different chemical analysis. Total sugar, reducing sugars and non-reducing sugars were estimated by Nelson Somogyi method given by Sadasivam and Manickham (1992), moisture and dry matter content by Anon (1970) and starch by Sadasivam and Manickham (1992). Microwave baking of tubers was optimitized for doneness and known time and power by repeated trials for Kufri Pukhraj (control) and the same was extended to other varieties. The standardized method for microwave baking of potato tubers has been presented in Fig 1. The flesh loss of baked potato was calculated in triplicate and expressed as follows:

$$\text{Flesh loss (\%)} = \frac{\text{Weight of flesh } (g_1)}{\text{Weight of cooked potato } (g_2)} \times 100$$

The doneness of cooked potato was recorded by placing cooked potato in lengthwise direction and pressing it in between the thumb and index finger. Doneness was expressed as well-cooked and semi-cooked. The ease of hand peeling of skin of cooked potato was recorded as easy to peel or hard to peel. After cooking skin and flesh colour of potato was categorised. Organoleptic evaluation of processed potato and products pressure cooked potato was carried out by 10 trained panellists of Dept of Food Science and Nutrition, University of Agricultural Sciences, Dharwad, Karnataka using nine

point hedonic scale and acceptability index was calculated. Statistical analysis was done to find out the variance between and within the varieties by using complete randomized design (CRD) single factor and significant differences were analysed using 'F' test. The relation between chemical and sensory parameters was verified by correlation using statistical package for social science (SPSS) software. Mean was calculated wherever possible.

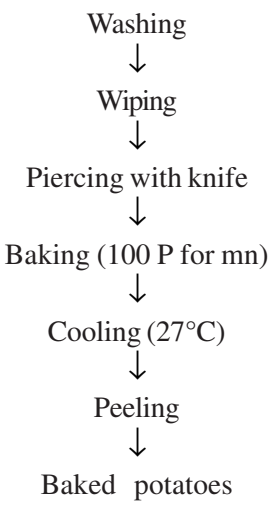

Fig 1. Flow chart for microwave baking of potatoes

RESULTS and DISCUSSION

In the present study moisture content of varieties differed significantly ranging from 78.87 (Atlanta) to 84.53 (Kufri Pushkar) per cent (Table 1). These differences could be attributed to the development and anatomy of the tubers (Reeve et al 1970) who reported similar results with slight variation of moisture content ranging from 81.77 to 84.72 per cent. Dry matter is one of the most important characters determining the end use of potato for processing and production efficiency. High dry matter results in higher yield of processed products or mealiness (Grewal and Uppal 1989). In the present study dry matter content ranged from 15.30 (J/99-242) to 20.93 (Kufri Khayti) per cent. The lower dry matter content of Kufri Pushkar, Kufri Ashoka and Kufri Bahar was statistically at par with that of J/99-242 whereas the higher dry matter content of Atlanta, Kufri Surya and Kufri Chipsona-2 was at par with Kufri Khayti. The differences in dry matter content among the cultivars could be due to variation in hereditary factors, agro-climatic conditions as well as agronomic practices followed for raising the crop (Singh and Ezekiel 2008, Sood et al 2008, Talburt and Smith 1975, Lisinska and Leszczynski 1989, Abong et al 2010, Kumar et al 2003).

Starch content in potatoes varies with the cultivars and plant growth which is calorically most important nutritional component. The physical, chemical and histological characteristics of the starch are not only intimately associated with various parameters involved in the quality of the processed products but these also dictate operational conditions of the processes. Starch is the major constituent of potato tubers and it was minimum in J/99-242

Table 1. Chemical composition of different potato varieties

Variety[#]	Total sugars[¥]	Reducing sugars[¥]	Non-reducing sugars	Moisture	Dry matter	Starch[¥]
Kufri Chipsona-2	686.67±0.58^{g}	111.67±11.55^{g}	575.00±11.27^{g}	79.47±0.12^{a}	20.57±0.06^{a}	72.30±0.52^{c}
Atlanta	500.00±0.58^{d}	90.33±10.00^{e}	409.67±10.50^{d}	78.87±0.58^{a}	20.70±0.17^{ab}	73.32±1.87^{d}
Kufri Surya	520.00±0.64^{e}	60.73±8.66^{b}	459.27±8.99^{e}	79.33±0.12^{a}	20.67±0.12^{ab}	62.70±1.04^{d}
Kufri Pukhraj	506.67±0.64^{de}	55.13±2.89^{a}	451.53±2.63^{e}	80.67±1.15^{b}	19.77±0.32^{c}	64.96±1.62^{d}
Kufri Khayti	216.67±1.15^{a}	75.90±5.77^{c}	140.77±6.90^{b}	79.00±0.20^{a}	20.93±0.12^{a}	85.67±1.57^{a}
Kufri Jyoti	816.67±0.64^{h}	104.77±15.28^{f}	711.90±15.17^{h}	82.00±0.00^{c}	18.00± 0.00^{d}	65.98±2.68^{d}
Kufri Pushkar	398.07±1.33^{c}	210.33±16.05^{h}	187.73±15.43^{c}	84.53±0.92^{d}	15.63±0.25^{f}	68.37±2.82^{c}
Kufri Bahar	305.53±1.27^{b}	104.03±5.55^{f}	201.50±4.49^{c}	83.93±0.12^{d}	16.07±0.12^{e}	71.43±3.44^{c}
Kufri Ashoka	569.40±2.54^{f}	87.33±12.73^{d}	482.07±12.50^{f}	84.33±0.23^{d}	15.67±0.12^{f}	65.70±1.56^{c}
J/99-242	216.10±0.58^{a}	111.67±2.42^{g}	104.43±2.76^{a}	84.07±0.81^{d}	15.30± 0.10^{g}	52.55±2.06^{e}
F	30*	55*	65*	40*	69*	53*
SEm±	5.89	0.67	5.85	0.33	0.09	1.19
$CD_{0.01}$	17.37	1.97	17.24	0.98	0.89	3.51

[#] Mean of 3 replications, *Significant at 0.01 level, [¥]dry weight basis, Different superscripts within a column indicate significant difference at 0.05 level by DMRT

Table 2. Preliminary trials for optimization of microwave baking of potatoes

Variable		Descriptive characteristic
Weight (g)	Time (min)	
101-120	3	Semi cooked
101-120	4	Well cooked, soft texture
101-120	5	Over cooked, texture became too dry
121-140	3	Semi cooked, hard texture in centre
121-140	4	Well cooked, soft texture
121-140	5	Over cooked, too dry and hard
141-160	3	Semi cooked, hard texture
141-160	4	Semi cooked, hard texture in centre
141-160	5	Well cooked, soft texture

Table 3. Quality parameters of microwave baked potatoes of different varieties

Variety[#]	Flesh loss[$]	Colour		Doneness	Peelability
		Skin	Flesh		
Kufri Chipsona-2	6.20[b]	Brown	Yellow	Well cooked	Easy to peel
Atlanta	7.10[c]	Yellowish brown	Cream	Well cooked	Easy to peel
Kufri Surya	5.80[b]	Brownish yellow	Yellow	Semi cooked	Easy to peel
Kufri Pukhraj	3.80[a]	Creamish brown	Cream	Well cooked	Easy to peel
Kufri Khayti	6.70[c]	Brown	Yellowish cream	Well cooked	Easy to peel
Kufri Jyoti	12.9[g]	Brown	Yellowish cream	Semi cooked	Hard to peel
Kufri Pushkar	8.20[e]	Light brown	Yellowish cream	Well cooked	Easy to peel
Kufri Bahar	10.4[f]	Brown	Cream	Well cooked	Easy to peel
Kufri Ashoka	5.90[b]	Brown	Yellowish cream	Well cooked	Easy to peel
J/99-242	7.70[d]	Brownish brown	White	Well cooked	Easy to peel

[#]Mean of 3 replications, [$]Different superscripts within a column indicate significant difference at 0.05 level by DMRT

(52.55%) and maximum in Kufri Khayti (85.67%). The values fall within the range reported by Sood et al (2008). The differences in starch content and its components among the cultivars may be due to differences in morphology of tubers and internal distribution of nutrients (Kroner and Volksen 1950, Talburt and Smith 1975) their differential root absorption pattern and translocation to aerial parts and finally distribution to potato tubers for their various metabolic activities (Sood et al 2008). Reducing sugar content of potato tubers is of considerable importance in relation to processing especially for fried products. Highest reducing sugars were found in Kufri Pushkar (210.33 mg/100 g) and lowest in Kufri Pukhraj (55.13 mg/100 g). Among the varieties Kufri Pukhraj had lowest reducing sugars (55.13 mg/100g) and thus ranked first. Sood et al (2008) however reported 83.28 mg/100g and 158.6 mg/100 g reducing sugars for Kufri Chipsona-2 and Kufri Pukhraj respectively. In the present study the reducing sugars in Kufri Chipsona-2 and Kufri Pukhraj were 111.67 mg/100 g and 55.13 mg/100 g respectively. These differences may be attributed to environmental factors, different growing seasons and fertilizers used (Talburt and Smith 1975, Lisinska and Leszczenski 1989). The concentration of total sugars and non-reducing sugars significantly differed among the cultivars in the present research. Similarly the varieties differed in total and non-reducing sugars. Lowest level of total sugars was found in J/99-242 (216.10 mg/100 g) and Kufri Khayti (216.67 mg/100 g) the two being at par with each other and highest in Kufri jyoti (816.67 mg/100 g). Minimum non-reducing sugars (104.43 mg/100 g) were also found in J/99-242 and maximum (575.00 mg/100 g) in Kufri Chipsona-2. The variation in sugar content in the present study could be due to size differences, changes in weather conditions during growth, differences in the rate of plant maturity or fluctuations of nutrients in plant system (Sood et al 2008, Singh and Ezekiel 2008, Abong et al 2010, Talburt and Smith 1975, Lisinska and Leszczenski 1989).

In the trials on baking of potatoes in microwave (Table 2) it was found that when potatoes weighing 101-120 g were baked for 3 min at 100 power density the potatoes were semi-cooked. As the weight of potatoes increased time of baking increased concurrently which yielded acceptable baked potatoes. Potatoes weighing 141-160 g baked at 3 min were semi-cooked having hard texture, at 4 min semi-cooked having hard texture in centre and at 5 min well cooked having soft texture. Thus potatoes weighing 101-140 g baked for 4 min at 100 power density produced well cooked and highly acceptable product with firm texture and less flesh loss.

Flesh loss, peel loss and yield of potatoes are of economical importance to the consumer (King et al 1962). In the present study flesh loss of baked potato ranged between 3.8 (Kufri Pukhraj) to 12.9

Table 4. Sensory profile of pressure cooked potatoes of different varieties

Variety[#]	Appearance	Texture	Flavour	Taste	Overall acceptability
Kufri Chipsona-2	7.7±1.25^{ab}	6.2±0.92^{b}	5.1±1.45^{bc}	5.7±1.25^{ab}	6.7±1.06^{ab}
Atlanta	6.2±2.04^{c}	6.2±1.62^{b}	6.1±1.45^{abc}	5.9±1.29^{ab}	6.2±1.32^{abc}
Kufri Surya	6.7±1.16^{abc}	6.2±1.32^{b}	4.6±2.12^{c}	3.6±1.84^{c}	4.6±1.51^{d}
Kufri Pukhraj	7.1±0.99^{abc}	6.5±0.71^{ab}	5.5±2.17^{bc}	5.0±2.26^{bc}	5.7±1.57^{bcd}
Kufri Khayti	6.4±1.43^{c}	6.2±1.62^{b}	5.7±1.95^{abc}	5.5±2.07^{ab}	5.2±1.69^{cd}
Kufri Jyoti	7.2±1.32^{abc}	7.5±1.08^{a}	7.2±1.31^{a}	7.1±1.37^{a}	7.4±1.17^{a}
Kufri Pushkar	7.9±0.88^{a}	7.6±0.97^{a}	6.2±1.31^{abc}	6.4±1.17^{ab}	7.1±0.88^{a}
Kufri Bahar	6.5±0.85^{bc}	5.9±1.52^{b}	6.4±1.35^{ab}	6.8±1.32^{a}	6.3±1.16^{abc}
Kufri Ashoka	7.2±1.62^{abc}	6.7±1.64^{ab}	6.6±1.96^{ab}	6.8±1.99^{a}	6.9±1.79^{ab}
J/99-242	6.0±0.47^{c}	6.2±1.32^{b}	6.6±0.70^{ab}	6.3±0.67^{ab}	6.5±0.85^{abc}
F	2.4*	NS	2.3*	4.2*	4.3*
SEm±	0.4	0.41	0.52	0.5	0.42
$CD_{0.01}$	1.13	1.16	1.45	1.42	1.12

[#]9 Point Hedonic Scale, NS= not significant, *Significant at 0.01 level, Different superscripts within a column indicate significant difference at 0.05 level by DMRT

Table 5. Acceptability indices of baked potato varieties

Varieties	Total score (max 45)	Acceptability index (%)	Rank
Kufri chipsona-2	31.40	69.78	VI
Atlanta	30.60	68.00	VII
Kufri Surya	25.70	57.11	X
Kufri Pukhraj	29.80	66.22	VIII
Kufri Khayti	29.00	64.44	IX
Kufri Jyoti	36.40	80.89	I
Kufri Pushkar	35.20	78.22	II
Kufri Bahar	31.90	70.89	IV
Kufri Ashoka	34.20	76.00	III
J/99-242	31.60	70.22	V

Table 6. Correlation (r) between chemical composition (%) of raw potatoes and sensory profile of pressure cooked potatoes

Parameter	Total sugars (mg)	Reducing sugars (mg)	Non-reducing sugars (mg)	Dry matter (g)	Starch (g)	Moisture (g)
Appearance	0.569^{NS}	0.509^{NS}	0.440^{NS}	-0.094^{NS}	0.289^{NS}	0.182^{NS}
Texture	0.438^{NS}	0.598^{NS}	0.290^{NS}	0.640^{NS}	0.65^{NS}	-0.570^{NS}
Flavour	0.028^{NS}	0.335^{NS}	-0.044^{NS}	0.688*	0.061^{NS}	0.600^{NS}
Taste	0.071^{NS}	0.521^{NS}	-0.035^{NS}	0.675*	0.248^{NS}	-0.31^{NS}
Overall acceptability	0.384^{NS}	0.631^{NS}	0.235^{NS}	-0.613^{NS}	0.057^{NS}	0.612^{NS}

*Significant at 0.01 level, ^{NS}Not Significant

(Kufri Jyoti) per cent (Table 3). The differences in flesh loss among the various cultivars could be due to variation in rate of loss of moisture or degree of attachment of flesh to skin after baking. There is higher rate of loss of water in microwave baking in which tuber temperature goes up to 100°C within few minutes. Except for Kufri Jyoti the skin of the rest of the tuber varieties was easy to peel. Absence of moisture in baked potato delayed removal of skin. The dry matter content of potato incredibly is an important parameter of potato quality as it influences the effect of cooking on sensory attributes in general and texture in particular (Taylor et al 2007). Gopal and Khurana (2006) also reported that dry matter is generally correlated with texture.

In present investigations there was a significant difference among the varieties for all sensory parameters with exception for texture (Table 4). There were significant differences in the cultivars with respect to appearance (range 6.0 to 7.7), flavour (range 4.6 to 7.2), taste (range 3.6 to 7.1) and overall acceptability (range 4.6 to 7.4). These differences can be attributed to variation in starch, flavour component, sugar and amount of non-starch polysaccharides contents.

Variety Kufri Jyoti was most preferred with acceptability index (80.89) followed by Kufri Pushkar (78.22) among the microwave baked potatoes (Table 5). Kufri Surya was not appreciated which could be due to astringent taste sensed by judges during organoleptic evaluation.

The results revealed that dry matter was positively correlated with flavour and taste of baked potatoes (Table 6) which could be due to high amount of starch that forms stable complex with flavour compounds during cooking (Solms and Wyler 1979).

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