

## Studies on Advanced Potato Hybrids for the Preparation of French Fries

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Tubers of seven advanced stage potato hybrids and three control varieties 'Kufri Bahar', 'Kufri Jyoti' and 'Kufri Lauvkar' were evaluated for the preparation of French fries and for important morphological and physico-chemical characteristics, influencing processing. Dry matter contents of the advanced hybrids varied from 17.8–22.5%, as against 18.0–20.5% in control varieties. The reducing sugar contents of the advanced hybrids were lower (104–180 mg/100 g fresh wt) than those of control varieties (216–245 mg/100 g fresh wt). Phenolic compounds and free amino acid contents were also lower in the advanced hybrids. Yield recovery on fresh weight basis ranged from 46.1–59.3% in advanced hybrids, as against 44.7–50.1% in control varieties. Based on colour, texture, flavour and yield of French fries, the advanced hybrids 'MP/90-83' and 'MP/91-G' were considered most suitable for processing into French fries.

**Keywords** : Potato processing, French fries, Potato varieties, Physico-chemical characteristics.

Potato processing is presently confined largely to the developed countries (Young 1981; Holm et al. 1994), whereas, it is still in its infancy in most of the developing countries including India. In India, due to increased urbanization, preference of new generation for easy-to-prepare and fast foods, rising per capita income, increase in the number of working women and expanding tourist trade, production of processed food products is likely to be accelerated. In this context, potato processing is one such area, where a rapid growth is expected. Among processed potato products, chips and French fries are the most popular forms. French fries are served in the restaurants or at fast food outlets and sometimes prepared fresh at home. With the entry of multinational companies in the processing sector, advancement in processing technology and improvement in storage and transportation facilities, the frozen French fries are likely to be introduced shortly in the market.

The yield and texture of the processed potato products are determined by the dry matter content of tubers, besides other factors such as contents of sugars, phenolic compounds and shape, size and colour of tubers (Santerre et al. 1985). The processing quality of French fries is largely determined by the colour after frying, which is closely correlated to reducing sugars, as these combine with free amino acids to cause non-enzymatic browning through Maillard reaction (Fuller and Hughes 1984; Roe et al. 1990). Excessive darkening and development of off-flavours due to high reducing sugar content are unacceptable for processed products (Pritchard and Adam 1994). Phenolic compounds are also important in processing, as they are responsible for

enzymatic discoloration (Schaller and Amberger 1974) and after-cooking darkening in potatoes (Shaw and Booth 1983). Tuber characters influence the yield of French fries as peeling, trimming and cutting losses vary with the shape, size and depth of eyes of tubers, which ultimately influence the yield recovery.

The potato breeding programmes at the Central Potato Research Institute, Shimla was earlier geared to develop high yielding disease-resistant varieties. However, in the recent past, due to increasing demand for varieties suitable for processing, work was also started on developing hybrids suitable for processing purposes. Some of the advance stage hybrids from this programme were evaluated for various physical and chemical characteristics, which influence the processing quality, especially the French fries. Results of this study are presented in this communication.

Seven advanced hybrids viz., 'MP/90-74', 'MP/90-82', 'MP/90-83', 'MP/90-86', 'MP/90-94', 'MP/90-97' and 'MP/91-G' along with 3 control varieties viz., 'Kufri Bahar', 'Kufri Jyoti' and 'Kufri Lauvkar' were grown at the Central Potato Research Station, Modipuram during the period October, 1994 to January 1995 in a randomized block design with four replications. All the standard cultural practices were followed and the crop was harvested after 90 days.

French fries were prepared from large size (100–120 g) tubers in the first week of March and various chemical constituents were also determined simultaneously. Eight to ten tubers of each hybrid/variety were hand-peeled and strips of sizes 1x1 cm were cut using a vegetable cutter (Crystal make). The cut strips were dipped in cold water

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and washed thoroughly, air dried and immediately fried in groundnut oil at 180°C for 4–5 min. The fresh fried French fries were subjectively graded for colour, texture and flavour according to the slightly modified score sheet, used by Holm et al (1994). For determination of dry matter content, tubers were cut into small pieces and oven-dried to a constant weight at 70°C. Reducing sugars were determined according to the procedure of Nelson (1944). Total phenols and free amino acids were determined by the methods of Swain and Hillis (1959) and Moore (1968), respectively. Four replicates for each estimation were taken and the data were statistically analysed.

**Morphological characters :** Morphological characters such as shape and eye depth of the tubers of 7 hybrids along with 3 control varieties are given in Table 1. Hybrid 'MP/90-74' had oval shape and red skin colour, whereas, the remaining hybrids were oblong in shape and white skinned. All the hybrids, except 'MP/90-86' had fleet eyes. Since tubers of long oval or oblong shapes and shallow or fleet eyes are preferred (Sukumaran and Verma 1993) so as to produce fries of desirable length (6–7 cm) with minimum processing losses, all the hybrids except 'MP/90-74' and 'MP/90-86' were found suitable for the preparation of French fries.

**Dry matter content of tuber and texture of French fries :** The dry matter contents of tubers of the hybrids varied between 17.8% and 22.5%, as against the control varieties, which showed dry matter in the range of 18.0% to 20.5% (Table 2). Hybrids 'MP/90-74', 'MP/90-83' and 'MP/91-G' recorded more than 22% tuber dry matter, which was significantly higher than that (20.5%) observed in the best control variety 'Kufri Lauvkar'. Variations

TABLE 1. MORPHOLOGICAL CHARACTERS OF THE TUBERS OF SOME ADVANCED POTATO HYBRIDS USED FOR FRENCH FRIES

Cultivar	Shape of the tuber	Type of tuber eye	Colour of tuber skin
'MP/90-74'	Oval	Fleet	Red
'MP/90-82'	Oblong	Fleet	White
'MP/90-83'	Oblong	Fleet	White
'MP/90-86'	Oblong	Medium deep	White
'MP/90-94'	Oblong	Fleet	White
'MP/90-97'	Oblong	Fleet	White
'MP/91-G'	Oblong	Fleet	White
'Kufri Bahar'	Oval	Medium deep	White
'Kufri Jyoti'	Oval	Fleet	White
'Kufri Lauvkar'	Round	Medium deep	White

TABLE 2. IMPORTANT PHYSICO-CHEMICAL CHARACTERS OF THE TUBERS OF ADVANCED POTATO HYBRIDS USED FOR FRENCH FRIES

Cultivar	Dry matter, %	Reducing sugars*	Free amino acids**	Total phenols*
'MP/90-74'	22.2	122	56.1	31.9
'MP/90-82'	18.9	124	86.7	37.2
'MP/90-83'	22.1	108	82.8	30.1
'MP/90-86'	18.4	180	84.1	32.6
'MP/90-94'	21.5	104	70.2	25.6
'MP/90-97'	17.8	136	83.7	34.1
'MP/91-G'	22.5	112	66.9	27.1
'Kufri Bahar'	19.4	216	94.3	38.9
'Kufri Jyoti'	18.0	245	91.8	45.2
'Kufri Lauvkar'	20.5	228	89.2	40.2
CD (0.05)	1.2	11	2.4	1.6

\* mg/100 g fresh weight

\*\* mg N/100 g fresh weight

in tuber dry matter contents of varieties are also reported earlier (Marwaha and Raj Kumar 1987; Marwaha and Kang 1994). Potatoes having high dry matter contents are considered suitable for the preparation of French fries and chips. High tuber dry matter is also associated with mealiness, crispness, and reduced oil uptake in French fries (Brody 1969; Kirkpatrick et al. 1956). In the present investigation also, six advanced hybrids having dry matter contents above 18% produced fries of acceptable mealy to crispy texture, whereas, the hybrid 'MP/90-97' having low tuber dry matter (17.8%) produced greasy textured unacceptable fries (Tables 2 and 3).

**Reducing sugars and free amino acids :** Reducing sugar contents of potato tubers are of considerable importance in relation to processing, especially for fried products. Potatoes containing more than 0.5% reducing sugars on fresh weight basis are not considered suitable for french fries (Burton and Wilson 1978). All the advanced hybrids and the controls contained lower levels of reducing sugars than the prescribed limit. Hybrid 'MP/90-94' had the lowest level of reducing sugars (104 mg/100 g fresh wt), which is at par with 'MP/90-83' (108 mg/100 g fresh wt) and 'MP/91-G' (112 mg/100 g fresh wt). The lowest level of free amino acids was recorded in hybrid 'MP/90-74' (56.1 mg N/100 g fresh wt) followed by 'MP/91-G' (66.9 mg N/100 g fresh wt), 'MP/90-94' (70.2 mg N/100 g fresh wt) and 'MP/90-83' (82.8 mg N/100 g fresh wt). Among controls, the variety 'Kufri Lauvkar' had the lowest level (89.2 mg N/100 g fresh wt) of free amino acids.

TABLE 3. LOSSES DURING PREPARATION OF FRENCH FRIES, PROCESSING QUALITY AND YIELD OF FRIES PREPARED FROM ADVANCED POTATO HYBRIDS

Cultivar	Peeling loss, %	Trimming and cutting loss, %	Total losses during processing, %	Colour	Texture	Flavour	Yield of French fries, %
'MP/90-74'	12.7	2.1	14.8	VL	Mealy	Typical	53.3
'MP/90-82'	7.2	1.3	8.5	L	Mealy	Typical	55.7
'MP/90-83'	9.0	2.3	11.3	L	Mealy	Typical	59.3
'MP/90-86'	10.7	2.1	12.8	LB	Mealy	Typical	46.1
'MP/90-94'	7.3	2.1	9.4	VL	Crispy	Typical	54.0
'MP/90-97'	8.5	2.5	11.0	L	Greasy	Typical	55.6
'MP/91-G'	8.4	1.7	10.3	L	Crispy	Typical	58.3
'Kufri Bahar'	7.1	3.0	10.1	L	Mealy	Typical	50.1
'Kufri Jyoti'	10.4	3.5	13.9	I	Mealy	Bitter	44.7
'Kufri Lauvkar'	9.2	5.9	15.1	L	Mealy	Typical	49.7
CD (0.05)	0.8	0.3	1.1	-	-	-	3.2

VL = Very light; L = Light; LB = Light brown; I = Inconsistent

Peeling loss is the weight of skin removed during peeling

Trimming loss includes the weight of residual skin, eyes and discoloured area removed from peeled potatoes

Cutting loss includes the weight of slivers (thin slices) and nubbins (short or broken pieces) separated from the product after cutting of french fry strips

**Total phenols :** Phenolic compounds have been associated with enzymic discoloration, which occurs due to the oxidation of these compounds by polyphenoloxidase (Schaller and Amberger 1974). Levels of total phenols in all the advanced hybrids were significantly lower than those in the best control variety 'Kufri Bahar'. None of the hybrids showed enzymic discoloration during processing. The lowest level of phenols was recorded in 'MP/90-94' (25.6 mg/100 g fresh wt) followed by 'MP/91-G' (27.1 mg/100 g fresh wt), and 'MP/90-83' (30.1 mg/100 g fresh wt). The highest total phenols content was recorded in the variety 'Kufri Jyoti' (45.2 mg/100 g fresh wt), which also showed enzymic discoloration in the strips prior to frying.

**Losses during processing for French fries :** Peeling losses in the advanced hybrids varied between 7.2% and 12.7%, whereas, the losses in control varieties were between 7.1% and 10.4% (Table 3). Among advanced hybrids, 'MP/90-97' showed maximum trimming and cutting loss (2.5%), which was significantly lower than all the control varieties. The minimum total losses during processing were recorded for the hybrids 'MP/90-82' and 'MP/90-94'. The hybrids 'MP/91-G' and 'MP/90-83' also showed significantly lower total losses than the popular processing varieties 'Kufri Jyoti' and 'Kufri Lauvkar'.

**Colour, flavour and yield of French fries :** The colour of French fries prepared from all the advanced hybrids varied from very light, light to light brown,

all within acceptable range with typical pleasing flavour (Table 3). Among control varieties, 'Kufri Jyoti' produced fries of inconsistent colour with bitter flavour, which were unacceptable. None of the cultivars produced dark coloured fries. All the hybrids except 'MP/90-86' gave significantly higher yield of French fries than the best control variety 'Kufri Bahar'. Yield recovery of French fries on fresh weight basis ranged from 44.7 to 59.3% being the highest in 'MP/90-83' (59.3%), followed by 'MP/91-G' (58.3%). Hybrid 'MP/90-97', although, produced high yield of French fries (55.6%), the quality was not acceptable due to greasy texture.

The above results suggested the suitability of 5 advanced hybrids viz., 'MP/90-74', 'MP/90-82', 'MP/90-83', 'MP/90-94' and 'MP/91-G' for processing into French fries. However, based on tuber morphological characters, tuber dry matter content and colour, texture, flavour and yield of French fries, 2 advanced hybrids viz., 'MP/90-83' and 'MP/91-G' were most suitable for processing into French fries.

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