with high nuclear binding energy. The preponderance of iron (with the highest nuclear binding energy) rich-rocks (seen in the widespread generation ocean floor rocks) since the last 200 Ma is cited as a positive evidence. The transformation inside the Earth continues.

Tassos uses chemistry, physics and mathematics to buttress his point but is candid in his conclusion: "The approach is qualitative but with quantitative constraints, it is based on current knowledge and on reliable observational and experimental data but, at the same time, it is not confined by existing theories and interpretations".

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SCIENTIFIC CORRESPONDENCE

Kufri Chipsona-2: A new high dry matter potato variety for chipping

Most of the potato processing is presently confined to the developed countries, and is still in its infancy in India. The demand for processed products in the country is, however, rising at a fast pace due to increased urbanization, rise in per capita income, increase in number of working women and expanding tourist trade. A large number of processing companies including multinationals have stepped into the field of potato processing. Among processed potato products, chips and French fries are the most popular forms. The potato processing trade needs varieties with above 20% tuber dry matter and low reducing sugars and total phenols, to ensure high recovery of quality processed product. None of the 31 Indian potato varieties released in the country since 1958 meets these standards. Therefore, there has been a tremendous pressure from the processors to import in bulk from USA and Europe, the tuber material of potato varieties suitable for processing.

To meet the demand for a variety suitable for processing, a crash programme of breeding was launched at the Central Potato Research Institute in 1990. The hybrid MP/91-G was developed following identification of suitable parents. It was evaluated along with Kufri Jyoti (the popular variety used presently in processing) for various characters important in processing at the Central Potato Research Station, Morigram (29°N 76°E; 222 m above msl) in North western plains and assessed for various parameters important for processing. This hybrid has been christened as Kufri Chipsona-2 and has been notified now by the Central Sub-committee on Crop Standards, Notification and Release of varieties for Horticultural Crops, Ministry of Agriculture and Co-operation, Govt of India, New Delhi and recommended as a main crop variety.

![Figure 1. Kufri Chipsona-2. a. plant; b. leaf; c. flowers; d. sprout; e. tubers; f-g. chips.](image-url)
Table 1. Per cent tuber dry matter, Modipuram

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<tbody>
<tr>
<td></td>
<td>90 days</td>
<td>90 days</td>
<td>90 days</td>
<td>105 days</td>
<td>100 days</td>
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<tr>
<td>Kufri Chipsona-2</td>
<td>22.4</td>
<td>22.6</td>
<td>22.0</td>
<td>23.0</td>
<td>22.8</td>
</tr>
<tr>
<td>Kufri Jyoti</td>
<td>19.0</td>
<td>20.1</td>
<td>18.0</td>
<td>19.9</td>
<td>18.3</td>
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<td>Average</td>
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*Crop planted on 10 November and harvested on 25 February.

Table 2. Chip colour at Modipuram

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<tr>
<td></td>
<td>100 d</td>
<td>90 d</td>
<td>105 d</td>
</tr>
<tr>
<td>Kufri Chipsona-2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Kufri Jyoti</td>
<td>5</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>
| Chip colour recorded on scale 1–8, where 1 = white and 8 = dark brown colour; d = crop duration in days.
*Crop planted on 10 November and harvested on 25 February.

Table 3. Industrial processing for chips (Uncle Chipps, Noida, 1997)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Per cent reducing sugars*</th>
<th>Per cent dry matter**</th>
<th>Per cent brown chips on frying</th>
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</thead>
<tbody>
<tr>
<td>Kufri Chipsona-2</td>
<td>0.10–0.25</td>
<td>21.2</td>
<td>27.5</td>
</tr>
<tr>
<td>Kufri Jyoti</td>
<td>0.25–0.5</td>
<td>17.5</td>
<td>61.3</td>
</tr>
</tbody>
</table>

*Strip test.
**Estimated through specific gravity test.

due to oxidation of these compounds by polyphenol oxidase. In trials conducted at Modipuram during 1993–94 to 1997–98 crop seasons, the tuber dry matter in the variety Kufri Chipsona-2 ranged from 22 to 23% as against 18–20.1% in the control variety Kufri Jyoti (Table 1). At other locations, its tuber dry matter varied from 21.2 to 25.6% as compared to 18.4 to 20.8% in Kufri Jyoti (Figure 2). Thus Kufri Chipsona-2 has consistently given higher tuber dry matter at all the locations. The tuber dry matter is known to influence oil uptake during frying as with its increase the oil uptake decreases. The use of this variety will thus economize on oil consumption and improve the quality of product which will be less greasy and of low calories. The analysis of tuber material for reducing sugars, total phenols and free amino acids (Figure 3) showed Kufri Chipsona-2 to have lower values of these characters than Kufri Jyoti.

Chip colour is the most important criterion for marketing of the finished product. The chipping industry accepts chip colour in the range of 1 to 3 on a

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Figure 2. Tuber dry matter of Kufri Chipsona-2 and Kufri Jyoti at various locations.

Figure 3. Total phenols (TP), free amino acids (FAA) measured as mg N and reducing sugars (RS) per 100 g fresh tuber weight in Kufri Chipsona-2 and Kufri Jyoti. (Modipuram, 1995–96).

Figure 4. Chip colour of Kufri Chipsona-2 and Kufri Jyoti at various locations (1997–98).
scale of 1–8 (I being the lightest and 8 the darkest). The chip colour of Kufri Chipsona-2 at Modipuram during the years 1994–95 to 1997–98 ranged between 1 and 3 (Table 2). It gave light colour chips in the range of 1 to 3 at all the locations, viz. North western, North central and eastern plains, and plateau region. In contrast, the popular processing variety Kufri Jyoti produced chips in the colour range of 4.5 to 6 (Figure 4). The results of trials conducted at Modipuram in 1997–98 crop season have shown that Kufri Chipsona-2 can be harvested at any time starting from 90 days onwards to give acceptable light colour chips (Figure 5). The variety was also tested for chips under factory conditions at M/s Uncle Chips, Noida. The results showed a much lower percentage of brown chips in Kufri Chipsona-2 as compared to Kufri Jyoti (Table 3).

In trials conducted at Modipuram during 1993–94 to 1997–98 and at other locations (Table 4) Kufri Chipsona-2 produced about the same yield as Kufri Jyoti. The variety also possesses resistance to late blight and appears to have potential in kharif crop season in Karnataka. During 1996–97, severe frost occurred during the potato crop season in the North western plains. This variety also showed high tolerance to frost.

The major potato processing industries are located in North western plains of India. However, generally the potatoes grown in cooler North western plains contain relatively less dry matter and more reducing sugars, hence the region is not considered good for procuring potatoes for processing. As we move towards the warmer regions of North eastern plains and peninsular India, the dry matter content in potatoes increases and reducing sugar decreases. The industry presently procures most of the raw material from central plains of Uttar Pradesh and Malwa region of Madhya Pradesh. With the introduction of this variety, it will be possible to produce potatoes of desirable chipping quality even in North western region, thereby saving on the large transportation cost. The development of Kufri Chipsona-2 will eliminate the need to import bulk quantities of potatoes with attendant risk of importing exotic diseases and pests which could wipe out the potato industry in the country. The variety will also help in saving valuable foreign exchange and open up opportunities for our farmers to get better returns on their investment of time and energy. It will also improve the quality of chips available to the consumers and will help in improving export of this value-added potato product.


ACKNOWLEDGEMENTS. We thank Dr G. S. Shekhawat, Director, Central Potato Research Institute, Shimla, Dr S. M. Paul Khurana, Project Coordinator, All India Coordinated Potato Improvement Project (ICAR) and Dr Jagpal Singh, Joint Director, Central Potato Research Station, Modipuram for providing facilities and to M/s Uncle Chips for help in industrial evaluation of the variety.

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![Table 4. Tuber yield (q/ha) at various locations](Image)