STARCH FRACTIONS OF COOKED POTATOES AT LOW TEMPERATURE

Pinky Raigond¹, R Ezekiel¹ and Bhawna Kaundal¹

ABSTRACT: Consumption of boiled potatoes stored for one or two days in a refrigerator is a common practice. This study was carried out to measure the potential of three Indian potato cultivars for resistant starch (RS) formation during domestic cooking and storage. Hence, the effect of cooking (boiled, microwave cooked, pressure cooked) followed by low temperature storage (4 and 12°C) for different durations (12 and 48 hour) on content of starch fractions was studied. The study showed that decrease in starch content in cooked potato tubers was accompanied by an increase in reducing sugars and sucrose contents. Cooling of cooked tubers at 4°C for 48 hour resulted in 7% reduction in starch content, 63% increase in RS content and 7% reduction in rapidly digestible starch content, but 35% increase in reducing sugars and 40% increase in sucrose contents. Low temperature storage can be beneficial in increasing the RS content considerably but the increase in reducing sugars and sucrose contents can offset this benefit. The increase in RS content after cooling was higher in boiled tubers as compared to microwave and pressure cooked tubers. Cultivar Kufri Bahar has higher tendency to form RS in boiled and cooled tubers compared to Kufri Jyoti and Kufri Sindhuri.

KEYWORDS: Amylose, cooking, potato cultivars, resistant starch, storage

INTRODUCTION

Potato production in Asia accounts for a great share of global output by introduction of new technologies, improvement in production and post-harvest infrastructures and government policies as well (Scott and Suarez, 2012). It contributes in two different ways to the lively-hoods of the poor i.e., it contributes directly to hunger reduction (as a staple food) and principally to poverty reduction by increased income or by creating employment (Thiele et al., 2010). Potato is one of the world’s major agricultural crops and is most important and versatile foods.

Potatoes are cooked in different ways viz. boiled, fried, microwave cooked (Sharmishtha et al., 2012) and pressure cooked for consumption. Cooking affects composition as well as nutritional value of potatoes. All commonly used cooking methods for preparation of potato for consumption help in providing high level of digestible starch as high water content of potato allows good gelatinization of the starch (Garcia-Alonso and Goni, 2000). Potatoes have high starch content but all the starch present is not digestible. There are three types of starches viz. rapidly digestible starch (RDS), slowly digestible starch (SDS) and resistant starch (RS). Out of these SDS and RS have attracted the attention of nutritionists due to their effect on the glycemic index of foods. A small proportion of starch that escapes digestion in the small intestine and ferments in the large intestine with the production of short chain fatty acids is termed as “Resistant Starch”, and it is further classified into four types namely RSI, RSII, RSIII and RSIV (Topping et al., 2003). Out of these RSIII is the most common form of resistant starch formed during cooking of starchy foods in presence of water and its formation is associated with retrogradation of amylose. Factors such as amylose content, temperature during cooking and storage can affect the content of RSIII (Ozturk et al., 2009).

¹Central Potato Research Institute, Shimla-171 001, Himachal Pradesh, India.
Email: jariapink@gmail.com
Potatoes are considered a high glycemic food (Ek et al., 2012). Hence, any factor that helps in increasing the resistant starch content can help in lowering the glycemic index of potato and potato products. Content of resistant starch in food mainly depends on the method of cooking. It also depends on the degree of gelatinization and retrogradation during cooling of the cooked foods (Garcia-Alonso and Goni, 2000). Information on increase in RS content in cool storing of cooked potatoes is already available in literature (Garcia-Alonso and Goni, 2000; Mishra et al. 2008; Monro et al., 2009), but the information on the tendency of Indian potato cultivars for RS formation is limited. Hence, the aim of this study was to determine changes in starch fractions in Indian potato cultivars cooked by different methods followed by storage at low temperatures, in order to see whether these treatments can increase the resistant starch content considerably and lower the glycemic index.

MATERIALS AND METHODS

Sample preparation

Medium sized tubers of cvs. Kufri Bahar, Kufri Jyoti and Kufri Sindhuri were used in the experiments. Each method of cooking and processing consisted of three replications and each replication consisted of ten tubers. Manually washed and peeled tubers were cut into two equal halves. The core region was removed and cylindrical pieces were taken out from each half with the aid of a cork borer (diameter 1 cm). These cylindrical pieces were trimmed to 1 cm length. Three cooking methods used were those which are normally used in India, i.e. boiling, pressure cooking and microwave cooking as described by Ezekiel and Singh (2007). Boiling was done by cooking 70 g of tuber pieces (1x1 cm) in 400 ml of double distilled water. Microwave cooking was carried out by cooking 70 g of tuber pieces without water in a microwave oven for 5 min at 1,350 W. Pressure cooking was done by cooking 1 kg of intact washed and unpeeled tubers in 400 ml of water under 15 psi for 10 min, and 1x1 cm cylindrical pieces were prepared after pressure cooking, as described above. After cooking the pieces were brought to room temperature. Raw, boiled, microwave cooked and pressure cooked pieces before storage (0 hour) were treated as control. Raw and cooked samples were stored at 4°C (Walk-in-chamber) and 12°C (Walk-in-chamber) for 12 and 48 hour. Tuber samples were freeze dried in lyophilizer (-56°C, 4.0 mbar), grounded and stored at room temperature until analysis.

Analysis methods

Reducing sugars: Sugar content was determined by the method developed by Somogyi (1952). Samples (200 mg) were made protein free by using lead acetate and potassium oxalate. The sample was filtered and volume was raised to 20 ml with distilled water, and 100 μl of extract was mixed with 900 μl of distilled water. After adding 1ml Nelson alkaline reagent the samples were boiled for 20 min and cooled in chilled water to stop the reaction. Nelson’s Arsenomolybedate reagent (1 ml) was added and vortex mixed. To these samples 7 ml of distilled water was added and optical density was measured at 620 nm. Reducing sugars were calculated from the standard curve using the equation:

\[
\text{Concentration of sugars in Sample} = \frac{(\text{Absorbance of sample} - 0.006)}{5.72}
\]

Sucrose: Sucrose content was measured by the addition of 100 μl of 30% potassium hydroxide to the samples (100 μl extract + 900 μl distilled water). The samples were boiled for 10 min and cooled in chilled water. After bringing the samples to room temperature 3 ml of 0.15% anthrone solution prepared in
76% sulphuric acid was added. The samples were incubated at 40°C for 15 min and optical density was measured at 620 nm. Sucrose was calculated from the standard curve using the equation:

\[
\text{Concentration of sucrose in Sample} = \frac{(\text{Absorbance of sample} + 0.109)}{10.08}
\]

**Total starch:** Starch content was determined according to the modified method of McCready et al. (1958). The samples (100 mg) were suspended in 6.5 ml of 52% perchloric acid and 5 ml of distilled water. The samples were incubated for 24 hour at room temperature (25°C). After incubation, the samples were centrifuged and residue was extracted with 6.5 ml of 52% perchloric acid and centrifuged again. Both the supernatants were combined and final volume was raised to 50 ml with distilled water. For colour development 50 μl of sample and 950 μl of distilled water was boiled in presence of 2 ml of anthrone-sulphuric acid reagent (200 mg anthrone in 100 ml chilled conc. sulphuric acid). Boiling was done for 8 minutes and samples were cooled to room temperature. Absorbance was recorded at 620 nm. Total starch was calculated from the standard curve using the following equation:

\[
\text{Concentration of starch in Sample} = \frac{[(\text{Absorbance of sample} - 0.026)]}{12.23} \times 0.9
\]

**Resistant starch:** RS content was analysed in raw and cooked tubers (before and after low temperature storage) using the methodology described by Goni et al. (1996) with slight modifications. Main steps involved were the sample (100 mg) incubation with pepsin (40°C, 60 min, pepsin in KCl-HCl buffer pH 1.5) to make the sample protein free, incubation with \(\alpha\)-amylase (37°C, 16 hour, \(\alpha\)-amylase in Tris-maleate buffer pH 6.9) to hydrolyze digestible starch, incubation of residues with amyloglucosidase (60°C, 45 min) to hydrolyze RS. The glucose was determined using glucose-peroxidase Assay Kit (Sigma Chemicals). RS was calculated as glucose × 0.9.

**Rapidly digestible starch:** RDS was estimated by the modified method of Englyst et al. (1999). The sample (100 mg) was incubated at 37°C for 30 min in presence of 10 ml of freshly prepared pepsin-guar gum solution. After addition of 5 ml of 0.5 mol sodium acetate buffer (pH 5.2) the samples were gently shaken and equilibrated at 37°C. At 1 min interval enzyme mixture (pancreatin, amylglucosidase and invertase) was added to each tube. After exactly 20 min of enzyme addition 0.2 ml of aliquot was collected. Absolute ethanol (4 ml) was added to the aliquot and vortex mixed. This was the G20 portion. The glucose content of G20 portion was determined using glucose-peroxidase Assay Kit (Sigma Chemicals). RDS content was calculated from G20 portion and free sugar glucose (FSG) by using the formula \((\text{G}_{20} - \text{FSG}) \times 0.9\).

**Amylose:** The amylose content was determined in raw and processed samples by using Amylose/Amylopectin Assay Kit (Megazyme).

**Statistical analysis:** A completely randomized design was followed with each treatment having three replications. The means were separated by Tukey’s honestly significant difference test.

**RESULTS AND DISCUSSION**

**Changes in sugars and starch under various cooking methods**

Changes in reducing sugars, sucrose and starch contents due to cooking are given in Tables 1 and 2. In raw tubers, the reducing sugars content was significantly higher in Kufri Bahar and lower in Kufri Sindhuri, while the sucrose content was significantly higher in Kufri Jyoti. Kufri Bahar is reported to contain
Starch fractions of cooked potatoes at low temperature

higher levels of reducing sugars than Kufri Jyoti (Ezekiel et al., 2011) both before and after storage at 4 and 12°C. After boiling, the reducing sugars and sucrose contents showed an increase in Kufri Bahar and Kufri Jyoti. The increase in reducing sugars and sucrose contents in boiled tubers was not proportional to the decrease in starch content. This could be due to loss of sugars due to leaching during boiling. Among the different cooking methods, the contents of reducing sugars was maximum in pressure cooked tubers in Kufri Bahar and Kufri Jyoti, and in microwave cooked tubers in Kufri Sindhuri. The sucrose content was the maximum in pressure cooked tubers in Kufri Bahar and Kufri Sindhuri, and in boiled tubers in the case of Kufri Jyoti.

The starch content was 72, 70 and 68 g/100 g dry weight in raw tubers of Kufri Jyoti, Kufri Bahar and Kufri Sindhuri, respectively (Table 2). Kufri Jyoti is reported to have higher dry matter and therefore, higher starch content than Kufri Bahar (Ezekiel et al., 2005). The starch content decreased in tubers cooked by all the three methods, in all the three cultivars. Though cooking methods resulted in significantly lower starch values, the extent

Table 1. Changes in reducing sugars and sucrose content in potato tubers cooked by different methods and stored at different temperatures.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Cultivar</th>
<th>Reducing Sugars (mg/100g dry weight)</th>
<th>Sucrose (mg/100g dry weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C 12h 48h</td>
<td>C 12h 48h</td>
</tr>
<tr>
<td>4°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>Kufri Bahar</td>
<td>2689c 4492d 4643b 1754i 1820j 7532k 384m 484n 534o</td>
<td>329kl 355ijk 392p 791q 428r 1102s 339t 477u 636v</td>
</tr>
<tr>
<td>B</td>
<td>Kufri Jyoti</td>
<td>2878e 3167f 3897g 3140h 3607i 4192j 384m 484n 534o</td>
<td>3557hi 4742a 2138b 4359c 5544d 852e 1301f 1353g</td>
</tr>
<tr>
<td>M</td>
<td>Kufri Sindhuri</td>
<td>3306k 3557hi 4742a 2138b 4359c 5544d 852e 1301f 1353g</td>
<td>477f 550i 594j 1357l 1410m 1548n 445p 459q 424r</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>3790f 4292d 4693b 4192d 3056b 3173c 727d 2739e 3590f</td>
<td>657c 488f 371i 1579k 1304l 2279m 869n 742o 700p</td>
</tr>
<tr>
<td>12°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>Kufri Bahar</td>
<td>2522o 3507p 1503q 2472r 409s 418t</td>
<td>329kl 355ijk 392p 791q 428r 1102s 339t 477u 636v</td>
</tr>
<tr>
<td>B</td>
<td>Kufri Jyoti</td>
<td>2839ar 3184d 3090b 3834e 334f 418g</td>
<td>3557hi 4742a 2138b 4359c 5544d 852e 1301f 1353g</td>
</tr>
<tr>
<td>M</td>
<td>Kufri Sindhuri</td>
<td>3424j 3607m 4225d 3790p 985r 919s</td>
<td>477f 550i 594j 1357l 1410m 1548n 445p 459q 424r</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>4025d 4492d 2989m 3073n 1253d 618e</td>
<td>657c 488f 371i 1579k 1304l 2279m 869n 742o 700p</td>
</tr>
</tbody>
</table>

R: Raw; B: Boiled; M: Microwave cooked; P: Pressure cooked
Different letters indicate significant statistical differences
Table 2. Changes in starch and resistant starch content in potato tubers cooked by different methods and stored at different temperatures.

<table>
<thead>
<tr>
<th>Starch content (g/100g dry weight)</th>
<th>Kufri Bahar</th>
<th>Kufri Jyoti</th>
<th>Kufri Sindhuri</th>
</tr>
</thead>
<tbody>
<tr>
<td>4°C</td>
<td>C 12h 48h</td>
<td>C 12h 48h</td>
<td>C 12h 48h</td>
</tr>
<tr>
<td>R</td>
<td>70^b</td>
<td>69^ab</td>
<td>65^c</td>
</tr>
<tr>
<td>B</td>
<td>60^ab</td>
<td>56^ab</td>
<td>56^ab</td>
</tr>
<tr>
<td>M</td>
<td>56^ab</td>
<td>55^ab</td>
<td>51^c</td>
</tr>
<tr>
<td>P</td>
<td>58^de</td>
<td>54^de</td>
<td>53^de</td>
</tr>
<tr>
<td>12°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>69^ab</td>
<td>70^b</td>
<td>70^b</td>
</tr>
<tr>
<td>B</td>
<td>60^de</td>
<td>61^cd</td>
<td>53^i</td>
</tr>
<tr>
<td>M</td>
<td>55^de</td>
<td>55^de</td>
<td>51^c</td>
</tr>
<tr>
<td>P</td>
<td>53^de</td>
<td>50^de</td>
<td>58^cde</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resistant starch content (mg/100/mg dry weight)</th>
<th>Kufri Bahar</th>
<th>Kufri Jyoti</th>
<th>Kufri Sindhuri</th>
</tr>
</thead>
<tbody>
<tr>
<td>4°C</td>
<td>C 12h 48h</td>
<td>C 12h 48h</td>
<td>C 12h 48h</td>
</tr>
<tr>
<td>R</td>
<td>1.32^ef</td>
<td>1.18^b</td>
<td>1.60^bc</td>
</tr>
<tr>
<td>B</td>
<td>1.04^f</td>
<td>1.29^efg</td>
<td>1.69^ab</td>
</tr>
<tr>
<td>M</td>
<td>1.28^gh</td>
<td>1.22^gh</td>
<td>1.46^c</td>
</tr>
<tr>
<td>P</td>
<td>1.33^e</td>
<td>1.35^e</td>
<td>1.52^d</td>
</tr>
<tr>
<td>12°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>1.19^a</td>
<td>1.59^bc</td>
<td>1.43^cd</td>
</tr>
<tr>
<td>B</td>
<td>1.28^gh</td>
<td>1.71^f</td>
<td>1.39^gh</td>
</tr>
<tr>
<td>M</td>
<td>1.34^e</td>
<td>1.51^ed</td>
<td>1.37^def</td>
</tr>
<tr>
<td>P</td>
<td>1.32^e</td>
<td>1.54^de</td>
<td>1.28%^</td>
</tr>
</tbody>
</table>

Different letters indicate significant statistical differences.

of decrease varied with the cooking method and cultivar. The decrease in starch content was invariably accompanied by an increase in reducing sugars and sucrose content. Alpha amylase with an optimum activity at 70-75°C is reported to cause the hydrolysis of starch to sugars in cooked sweet potatoes (Walter et al., 1975). Hydrolysis of starch to sugars during microwave cooking (Lewthwaite et al., 1997) and steam heating (Takahata et al., 1992) have also been reported in sweet potatoes. During microwave cooking, the immediate rise in temperature inside the tubers might have also resulted in thermo-chemical cleavage of starch. The substantially lower levels of starch coupled with higher levels of reducing sugars and sucrose in Kufri Jyoti and Kufri Bahar compared to marginal decreases in Kufri Sindhuri indicate higher rate of hydrolysis of starch in Kufri Jyoti and Kufri Bahar.

Effect of cooking on starch fractions

The RS content of cultivars in raw tubers varied with Kufri Sindhuri (1.35%) showing higher RS content followed by Kufri Bahar (1.32%) and Kufri Jyoti (1.27%) (Table 2). Cultivar differences in RS content of potatoes have been reported (Mulinacci et al., 2008). The RS content was affected by the method...
of cooking. There was a decrease in the RS content in boiled and microwave cooked tubers and a non-significant increase in pressure cooked tubers in all the three cultivars. The extent of decrease was greater in boiled tubers. RS content in foods mainly depends on the method of cooking. It also depends on the degree of gelatinization and retrogradation during cooling of the cooked foods (Garcia-Alonso and Goni, 2000). Factors such as amylose content, amylose chain length, amylose: amylopectin ratio, temperature during cooking and storage can affect the content of RS (Ozturk et al., 2009).

RDS contents were determined in cooked tubers of cv Kufri Bahar only (Table 3). RDS content was higher in boiled tubers (57.95%), followed by pressure cooked (53.76%) and microwave cooked tubers (51.36%). Starch digestibility is improved after processing and it is affected by the cooking methods with boiled potatoes showing the highest rate of digestion (Garcia-Alonso and Goni, 2000).

### Effect of cooking on amylose content

Changes in amylose content are shown in Table 3. The amylose content was 29, 25 and 26% in Kufri Bahar, Kufri Jyoti and Kufri Sindhuri, respectively. Kufri Bahar is reported to have higher amylose content than Kufri Jyoti (Ezekiel and Rani, 2007). There was no significant effect of cooking methods on the amylose content of starch in Kufri Bahar and Kufri Jyoti. Microwave cooking increased the amylose content non-significantly in Kufri Jyoti and Kufri Sindhuri. Pressure cooking decreased the amylose content non-significantly in Kufri Bahar and Kufri Jyoti. Amylose chain alignment that leads to retrogradation occurs in the disorganized amilopectin of gelatinized potato starch, and this is sufficient to impede but not prevent digestion (Fredriksson et al., 2000).

### Effect of cooking method and storage conditions on sugars and starch content

In raw tubers, the reducing sugars content increased when stored at 4°C and the increase was considerable even after 12 hour of storage (Table 1). However, the extent of increase in reducing sugars was higher in Kufri Bahar and Kufri Jyoti and lower in Kufri Sindhuri. In Kufri Bahar, storage at 4°C increased the sucrose content after 12 and 48 hour. At 12°C, the increase in sucrose content was minimal. The starch content showed a decrease 12 hour after storage in all the three cultivars and the decrease was 1-3% at 4°C and 1-2% at 12°C (Table 2). It decreased further with increase in storage duration to 48 hour. In boiled, microwave cooked and pressure cooked tubers, there was an increase in reducing sugars and a decrease in starch content after storage at different temperatures for different durations (Tables 1 and 2). The extent of increase or decrease varied with the cultivar. The sucrose content generally increased with storage (Table 1) but showed a decrease in some cases.

A comparison among different cooking methods showed that storage of boiled tubers (cv. Kufri Bahar) at 4°C for 12 hour can result in 7% reduction in starch content but 10% increase in reducing sugars and 5% increase in sucrose content. Whereas, storage for 48 hour can result in 7% reduction in starch content but 35% increase in reducing sugars content and 40% increase in sucrose content. Storage of microwave cooked tubers at 4°C for 12 hour can result in 2% reduction in starch content but 8% increase in reducing sugars and 15% increase in sucrose contents. Storage for 48 hour can result in 9% reduction in starch content but 43% increase in reducing sugars content and 25% increase in sucrose content. Storage of pressure cooked tubers at 4°C for 12 hour can result in 7% reduction in starch
content but 13% increase in reducing sugars content. Storage for 48 hour can result in 9% reduction in starch content but 24% increase in reducing sugars content and 42% reduction in sucrose content.

Storage of boiled tubers of cv. Kufri Bahar at 12°C for 48 hour resulted in 11% increase in reducing sugars, 5% decrease in sucrose content and 1% increase in starch content. Whereas increase in reducing sugars under the same conditions was 9-19% in microwave and pressure cooked tubers. In microwave cooked tubers 1% reduction in starch content was accompanied by 47% increase in sucrose content. In pressure cooked tubers 1% increase in starch content was accompanied by 29% decrease in sucrose content. Increase in reducing sugars has been observed in potatoes after storage at different temperatures (Richardson et al., 1990; Es van and Hartmans, 1987). Cooking methods such as roasting and frying have also been reported to increase reducing sugars and sucrose contents in potatoes (Murniece et al., 2011).

**Effect of cooking method and storage conditions on starch fractions**

In raw tubers of Kufri Bahar, there was 21% increase in RS content after 48 hour of storage (Table 2). Maximum increase in RS content after storage was observed in boiled tubers. The RS content in boiled tubers was 1.04 mg/100 mg dry weight. The increase was 63 and 64% at 4 and 12°C, respectively, after 48 hour of storage. RS increases on cooling due to starch retrogradation. When boiled potatoes were cooled for 20 hour in a refrigerator, the RS content was reported to have increased from 1.18 to 4.63% (Garcia-Alonso and Goni, 2000). Elmstahl (2002) reported a RS content of 2% in boiled potatoes and 5.9% in boiled and cooled potatoes. Mulinacci et al. (2008) reported a RS value ranging from 1.76 to 4.18% in boiled potatoes. The increase in RS content after cooling observed by us was lower than that observed by other researchers. In microwave cooked tubers, the RS content increased only after 48 hour of storage at 4°C. Mulinacci et al. (2008) reported a RS value ranging from 2.85% to 6.31% in microwave cooked potatoes. In pressure cooked tubers, the RS content increased from 12 hour to 48 hour at 4°C. In Kufri Jyoti, the RS content increased in raw, boiled, microwave cooked and pressure cooked tubers stored at both the temperatures. Maximum increase (35 to 37%) was observed in boiled tubers and minimum increase (8 to 10%) was observed in microwave cooked tubers. In Kufri Sindhuri, increase in RS content was observed after 48 hour at 4°C and 12°C in microwave cooked tubers. Maximum values were observed in boiled tubers after 48 hour of storage at 4 and 12°C. An increase (23.5%) in RS content after 24 hour of storage at 4°C of pressure cooked potato tubers has been reported (Yadav, 2011). Storage temperature, processing technique and duration of storage affects the gelatinization and retrogradation processes and hence the formation of RS (Chou et al., 2010). The reduction in digestibility of cooked potatoes after cool storage has been attributed to partial starch retrogradation (Karlsson et al., 2007).

In Kufri Bahar, in boiled tubers the RDS content decreased after 12 and 48 hour of storage (Table 3). The decrease was 7% after 48 hour of storage at 4 and 12°C (Table 3). The decrease was 7% after 48 hour of storage at 4 and 12°C. In microwave cooked tubers maximum decrease (8%) was observed at 4°C after 48 hour. In pressure cooked tubers, maximum decrease of 10% in RDS was observed at 4°C after 48 hour. In microwave cooked tubers stored at 12°C. Monro et al. (2009) reported an increase in RS and SDS and decrease in RDS after 44 hour of storage of cooked potatoes of nine cultivars at 4°C. In cooked and cooled
Table 3. Changes in amylose and rapidly digestible starch content in potato tubers cooked by different methods and stored at different temperatures.

<table>
<thead>
<tr>
<th>Temperature °C</th>
<th>Amylose content (mg/100mg dry weight)</th>
<th>Kufri Bahar</th>
<th>Kufri Jyoti</th>
<th>Kufri Sindhuri</th>
</tr>
</thead>
<tbody>
<tr>
<td>4°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>12h</td>
<td>48h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>29&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>27&lt;sup&gt;de&lt;/sup&gt;</td>
<td>23&lt;sup&gt;i&lt;/sup&gt;</td>
<td>25&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>B</td>
<td>28&lt;sup&gt;ad&lt;/sup&gt;</td>
<td>26&lt;sup&gt;e&lt;/sup&gt;</td>
<td>30&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>26&lt;sup&gt;v&lt;/sup&gt;</td>
</tr>
<tr>
<td>M</td>
<td>29&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>31&lt;sup&gt;a&lt;/sup&gt;</td>
<td>30&lt;sup&gt;de&lt;/sup&gt;</td>
<td>26&lt;sup&gt;v&lt;/sup&gt;</td>
</tr>
<tr>
<td>P</td>
<td>28&lt;sup&gt;ad&lt;/sup&gt;</td>
<td>31&lt;sup&gt;a&lt;/sup&gt;</td>
<td>29&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>24&lt;sup&gt;de&lt;/sup&gt;</td>
</tr>
<tr>
<td>12°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>26&lt;sup&gt;e&lt;/sup&gt;</td>
<td>23&lt;sup&gt;i&lt;/sup&gt;</td>
<td>21&lt;sup&gt;s&lt;/sup&gt;</td>
<td>22&lt;sup&gt;de&lt;/sup&gt;</td>
</tr>
<tr>
<td>B</td>
<td>27&lt;sup&gt;de&lt;/sup&gt;</td>
<td>27&lt;sup&gt;de&lt;/sup&gt;</td>
<td>24&lt;sup&gt;de&lt;/sup&gt;</td>
<td>24&lt;sup&gt;de&lt;/sup&gt;</td>
</tr>
<tr>
<td>M</td>
<td>29&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>31&lt;sup&gt;a&lt;/sup&gt;</td>
<td>26&lt;sup&gt;de&lt;/sup&gt;</td>
<td>26&lt;sup&gt;de&lt;/sup&gt;</td>
</tr>
<tr>
<td>P</td>
<td>29&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>31&lt;sup&gt;a&lt;/sup&gt;</td>
<td>23&lt;sup&gt;s&lt;/sup&gt;</td>
<td>24&lt;sup&gt;de&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rapidly digestible starch content (g/100g dry weight)</th>
<th>Kufri Bahar</th>
</tr>
</thead>
<tbody>
<tr>
<td>4°C</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>12h</td>
</tr>
<tr>
<td>B</td>
<td>57.95&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>M</td>
<td>51.36&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>P</td>
<td>53.76&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>12°C</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>57.79&lt;sup&gt;s&lt;/sup&gt;</td>
</tr>
<tr>
<td>M</td>
<td>50.94&lt;sup&gt;s&lt;/sup&gt;</td>
</tr>
<tr>
<td>P</td>
<td>53.20&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Different letters indicate significant statistical differences.

potatoes a decrease in RDS, and an increase in SDS and RS has been reported (Mishra et al., 2008). These changes in starch fractions on cooling can be interpreted as improving the nutritional quality of potato.

**Effect of storage temperature and duration on amylose content**

Storage of boiled tubers at 4°C first decreased the amylose content up to 12 hour and then non-significantly increased it at 48 hour storage in Kufri Bahar (Table 3). Low temperature storage of microwave cooked tubers non-significantly increased the amylose content in Kufri Bahar, with little effect in Kufri Jyoti and Kufri Sindhuri. Storage of pressure cooked tubers at 4°C for 48 hour increased the amylose content non-significantly in Kufri Bahar and a decrease was observed in Kufri Jyoti. At 12°C, amylose content decreased non-significantly in Kufri Bahar and significantly in Kufri Jyoti after 12 and 48 hour storage of boiled tubers. In microwave cooked tubers, amylose content did not change after 12 hour storage in Kufri Bahar and Kufri Jyoti. Increase in amylose content was reported at 12°C after 48 hour in Kufri Bahar and Kufri Sindhuri.

**CONCLUSIONS**

Extent of resistant starch formation on cooking and cool storing the potatoes is cultivar dependent. Digestibility of potato starch is influenced by the domestic way of processing and storage. Formation of
resistant starch was reported at both the storage temperatures viz. 4 and 12°C in all the cultivars. Out of the three cultivars studied, the extent of RS formation was high in boiled and cooled tubers of Kufri Bahar compared to Kuri Jyoti and Kufri Sindhuri. Cooling of cooked tubers at 4°C for 48 hour resulted in 7% reduction in starch content and 7% reduction in rapidly digestible starch content with 63% increase in resistant starch content. An interesting observation was the concomitant increase in reducing sugars and sucrose content. The beneficial effect of cooling on increase in resistant starch content of cooked potatoes is diminished by the undesirable increase in sugars content.

LITERATURE CITED


Ezekiel R, Mehta A, Singh B, Kumar D, Kumar NR, Paul V, and Das M (2005) CIPC (Isopropyl N-(3-chlorophenyl) carbamate) for sprout suppression on potatoes during storage. CPRI, Shimla: 50p


Ozturk S, Koksel H and Ng PKW (2009) Characterization of resistant starch samples prepared from two high-amylose maize starches through debranching and heat treatments. Cereal Chem 86: 503-10


MS received: 13 November 2013; Accepted: 12 May 2014