Changes in polyphenol content and activity of enzyme polyphenol oxidase during development and maturity in Ber fruit (Ziziphus mauritiana Lamk.) Cvs.

Mehrun-Khedi, Mehrun and MPKV

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Abstract

The changes in polyphenol content of fruit pulp were studied in Ber cultivars Mehrun-Khedi, Mehrun and M.P.K.V. during development and maturity of fruits at regular interval of 20 days from 20 days after fruit-set up to 120 days. The polyphenol content of the Ber fruit pulp showed a sharp decline up to 60 days after fruit-set, but thereafter, it was gradual and steady in all three cultivars up to maturity. At maturity, the polyphenol content was comparatively more in M.P.K.V. than Mehrun-Khedi and Mehrun cultivars. These decreases in polyphenol content of fruit pulp during development and maturity of Ber fruits in all the three cultivars may be attributed to the increased activity of enzyme polyphenol oxidase, associated with reducing astringency of fruit pulp.

Keywords: polyphenol; fruit pulp; enzymes; polyphenol oxidase; maturity

Introduction

Ber (Ziziphus mauritiana), Lamk. is one of the most ancient fruit indigenous to India. It is scattered cultivation all over India is ascribed to it is hardy nature, ability to grow on poor soils and low cost of production. There are about 125 varieties of ber grown in different parts of India. Mehrun-Khedi and Mehrun are the famous varieties of Maharashtra, popularly grown in Jalgaon, Dhule and Nashik districts as these varieties are resistant to rotting by nymphs, better in taste and suitable for processing in to other products. M.P.K.V. is a wild cultivar, locally cultivated in MPAU Rahuri. During development and maturity of ber fruit, it may undergo some characteristics physico-chemical changes. The studies on the changes in polyphenol content during development and maturity in ber fruits have been made by various workers (Kalt et al., 1999; Abbas and Fandi, 2002; Muchuwati, 2005; Li et al., 2007; Lu et al., 2012). The harvesting of fruits at right stage is of paramount importance to receive the higher premium from the produce. From the available literature it has been observed that the work on changes in polyphenol content and the activity of enzyme polyphenol oxidase during development and maturity has not reported in ber Cvs. Mehrun-Khedi, Mehrun and M.P.K.V. Therefore, in the present investigation attempts have been made to study the changes in polyphenol content and the activity of enzyme polyphenol oxidase during development and maturity at different developmental stages right from
fruit setting to maturity in ber cultivar, Mehrun-Khedi, Mehrun and M.P.K.V.

Materials and Methods

The present investigation on Ber (*Ziziphus Mauritiana* Lamk) Var. Mehrun-Khedi, Mehrun and M.P.K.V. was carried out during 2010-2011. Material used and method followed during the investigation are described in the succeeding paragraph. Five year old plants of ber cultivars Mehrun-Khedi, Mehrun and M.P.K.V. growing in the orchards of Mahatma Phule Agricultural University, Rahuri (M.S) were selected for the present investigation. The fruits of these cvs, were collected at an interval of 20 days after fruit-set and the collection continued till the complete ripening stage was reached. The fruit samples were washed with distilled water and adhering impurities were removed before analysis. Total polyphenol content was determined from the fruit pulp of all these three cultivars by using folin Dennis reagent according to the method of Folin and Denis (1915). The polyphenol oxidase activity was measured as per the method of Farkas and Kiraly (1962).

Results and Discussion

The data in respect of polyphenol content and the activity of enzyme polyphenol oxidase from the fruit pulp during development and maturity of fruits in all these three cultivars is depicted in table 1 and figure 1 and 2. The data in respect of polyphenol content of the fruit pulp in all the three cultivars showed a decreasing trend as the fruit advanced to maturity. The polyphenol content of the fruit pulp showed a sharp decline up to 60 days, after fruit set but thereafter, the decrease in it was gradual and steady in all three cultivars till maturity. However, the polyphenol content of this indicate that at maturity the polyphenol content was maximum in Mehrun-khedi followed by Mehrun and M.P.K.V. The green fruits at the time of first sampling (20 days after fruit set) contained 0.365, 0.360 and 0.223 percent total phenolics in Mehrun-khedi, Mehrun and M.P.K.V. respectively. On the last picking date (120 days after fruit set), the total phenolic content in fruits decreased to very low level of 0.098, 0.95 and 0.117 percent in Mehrun-khedi, Mehrun and M.P.K.V. respectively (Table 1, Fig. 1). Bal and Singh (1978c) studied the changes in the total phenolics at different developmental stage from 15 days after fruitset to 190 days and observed a gradual decrease in phenol content of the fruit pulp in Umaran. Bal (1981) also reported a similar trend of decline in the total phenolic content during development and maturity of Ber cultivar Sanuar-2. The pulp of green ber fruit is markedly astringent but this astringency reduced during ripening. This reduced astringency of fruit pulp might be due to their reduced levels of polyphenols of pulp during development and maturity of fruit. The polyphenols were present fairly higher amount in immature ber fruits and were found reduced considerably at maturity indicating their hydrolysis in to components such as sugars, acids and their compounds or owing to their transformation from a soluble into an insoluble form (Singh et al., 1981). These reduced levels of polyphenol of fruit pulp at maturity may be attributed to the increased activity of enzyme polyphenol-oxidase during development and maturity of fruits. Our results (Table 1 and Fig. 1) showed the decrease in polyphenol content of fruit pulp during the development and maturity of fruits in all three cultivars studied are in agreement with those of Kalt et al. (1999), Muchuwati et al. (2005), Adriano and Carlos (2005), Gupta et al. (2011), Mairal et al. (2012), Pareek (2013).
Table 1. Changes in polyphenol content and the activity of enzyme polyphenol-oxidase during development and maturity in ber fruits Cvs. Mehrun-Khedi, Mehrun and M.P.K.V.

<table>
<thead>
<tr>
<th>Days after fruit-set</th>
<th>Mehrun-Khedi</th>
<th>Mehrun</th>
<th>M.P.K.V.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Polyphenol (%)</td>
<td>Polyphenol oxidase*</td>
<td>Polyphenol (%)</td>
</tr>
<tr>
<td>20</td>
<td>0.365</td>
<td>0.20</td>
<td>0.360</td>
</tr>
<tr>
<td>40</td>
<td>0.275</td>
<td>0.30</td>
<td>0.270</td>
</tr>
<tr>
<td>60</td>
<td>0.180</td>
<td>0.38</td>
<td>0.165</td>
</tr>
<tr>
<td>80</td>
<td>0.163</td>
<td>0.38</td>
<td>0.160</td>
</tr>
<tr>
<td>100</td>
<td>0.135</td>
<td>0.41</td>
<td>0.132</td>
</tr>
<tr>
<td>120</td>
<td>0.098</td>
<td>0.48</td>
<td>0.095</td>
</tr>
</tbody>
</table>

*O.D. min\(^{-1}\)g\(^{-1}\) fresh wt.

Fig. 1. Changes in polyphenol content during development and maturity of Ber fruits

Fig. 2. Changes in activity of polyphenol oxidase during development and maturity of Ber Fruits

The polyphenol oxidase is a copper containing enzyme which can undergo reversible oxidation and reduction in the process of hydroxylation and oxidation (Mayer and Harel, 1979). In hydroxylation Cu\(^+\) is oxidized to Cu\(^{2+}\) and in oxidation (Mayer, 1987) Cu\(^{2+}\) is reduced to Cu\(^+\). This enzyme catalyses two reactions, the hydroxylation of monophenols to the corresponding ortho di-hydroxy compounds called cresolase activity and the oxidation of orthodi-hydroxy phenols to orthoquinones called catecholase activity (Macheix et al., 1990). The activity of enzyme polyphenol-oxidase showed an increasing trend from fruit-set to maturity in all three cultivars (Table 1, Fig. 2). The activity increased gradually from 20 days to 60 days after fruit set in Mehrun-Khedi, Mehrun and thereafter, it was remained more or less similar up to maturity stage (120 days).

However, in M.P.K.V, the activity of enzyme polyphenol oxidase was increased slowly throughout the fruit growth. At maturity, the polyphenol-oxidase activity was found to be higher in Mehrun followed by Mehrun-khedi and M.P.K.V. This increased polyphenol activity may be correlated with the reduced level of polyphenol during development and maturity of ber fruits in all three cultivars of present investigation. It also appears that increase in polyphenol oxidase possibly increases the free amino acids due to hydrolysis of polyphenols. Adrino and Carlos (2005) and Ferrer et al. (2011) studied polyphenol oxidase activity browning potential and phenolic content of Peaches during post harvest ripening.
and during controlled atmosphere storage and reported that the amount of total phenolics and chlorogenic acid in the fruit of Peaches decreased during storage and activity of polyphenol-oxidase increased up to ripening stage. Othman (2012) studied polyphenol oxidase and peroxidase activity during open air ripening storage of Pineapple Mango and Papayya fruits and founds that polyphenol-oxidase activity increased at maturity but it was decreases during the ripening. A similar trend of increase in polyphenol-oxidase activity in fruit pulp during development and maturity was reported by Wissmann and Lee (1980) in grape berries, Lilly and Norman (1981) in fruits and vegetables. Kadam et al. (1993) in ber. Ada et al. (1999), Satjawatcharphong et al. (2006) and Susana et al. (2011), in apple fruits and Mairal et al. (2012) in Peaches.

**Conclusion**

Polyphenol-oxidase is characteristically copper containing proteins (Kertesz, 1957). In general polyphenol-oxidase plays a vital role in biochemical processes leading to fruit development and senescence. The polyphenols were present fairly higher amount in immature ber fruits and were found reduced considerably at maturity indicating their hydrolysis in to components such as sugars, acids and their compounds. These reduced levels of polyphenol of fruit pulp at maturity may be attributed to the increased activity of enzyme polyphenol- oxidase during development and maturity of fruits.

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