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Total phenolics and flavonoids content in ripened and unripened fruits of different mulberry (*Morus alba*) varieties*

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Phytochemicals, phyto-nutrients, bioactive compounds, have become buzzwords in the growing market for natural health-food products and especially in fruit juice drinks. Fruits and vegetables are excellent sources of these compounds, and high consumption of fruits and vegetables have been associated with a lower incidence of diseases such as cancer and cardiovascular disease as well as immune dysfunction (Chun *et al*. 2005). Evidences of the health benefits of wild edible fruits, in addition to established role in nutrition are available. Marinova *et al.* (2005) highlights the preventive role of fruits and vegetables against free radicals effects. *M. esculenta* is an important source of natural antioxidants which can play vital role in reducing the oxidative stress and preventing from certain degenerative diseases (Rawat *et al.* 2011). Phenolic compounds, such as flavonoids, anthocyanins and organic acids, are common in fruits and vegetables, high in antioxidant activity and thought to contribute to the protective effects reported (Chun *et al*. 2005). Phenolic compounds also serve diverse functions such as imparting colour to leaves and fruits, attracting or repelling insects, antimicrobial and antiviral activity, protection from harmful ultraviolet radiation and protection from herbivores (Cushnie and Lamb 2005). Singh *et al*. (2010) observed the compositional differences between the various cultivars of tomato in terms phenols and found that phenolic content was highest in Cherry Red cultivar. Several specific plant phenolic compounds and fruit extracts have been reported to exhibit anti-inflammatory, anti-carcinogenic, vasodilatory and antimicrobial activities. Phenolics and polyphenols are secondary plant metabolites that are ubiquitously present in plants and their products. Many of the phenolics have been shown to contain high levels of antioxidant activities (Razali *et al.* 2008). Mulberry fruits have many bio-active composites such as anthocyanins, coumarins, flavonoids, stilbenes, chalcones flavones, alkaloids. Mulberry fruits rich in flavonoids which have been reported to posses anti-allergic, anti-thrombotic and anti-viral activity (Pawalowska *et al.* 2008). Anthocyanins are major pigments found in mulberry fruits which hold potential use as dietary modulators of mechanisms for various diseases and as natural food colorants. Resveratrol and oxyresveratrol are hydroxystilbenes found in mulberry fruits, in which resveratrol has neuro-protective and cardio-protective effects while oxyresveratrol has an inhibitory effect on tyrosinase to limit melanin biosynthesis and is used as cosmetics materials and medical agents for hyperpigmentation disorders. The production and consumption of mulberry fruits, juices and leaves are increasing rapidly because of their good taste and high nutritional value. Moreover, there are scanty reports regarding phenolic and flavonoids assays in reference to Indian mulberry varieties. Hence, current study was undertaken to determine the total phenolic and total flavonoid content in ripened and un-ripened fruits of different Indian mulberry varieties.

The study was conducted in the experimental mulberry germplasm centre of Babasaheb Bhimrao Ambedkar University, Lucknow in 2010, by using ripened and un-ripened mulberry fruits of different mulberry varieties namely, BR 2, AR 14, S 1, S 13 and K 2. Extraction of phenols and flavonoids was done as per Yunfeng Li *et al*. (2006) with slight modifications. The content of phenolic compounds in the extracts was determined as per Singh and Sakariah (2001). The final results were expressed as tannic acid equivalents. The data were subjected to one-way analysis of variance

*Short note

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Table 1 Total phenolics and flavonoids contents in un-ripened and ripened mulberry fruits

Variety	Total phenolics						Total flavonoids					
	Un-ripened fruits			Ripened fruits			Un-ripened fruits			Ripened fruits		
	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%
AR 14	0.211	0.005	2.140	0.391	0.004	0.922	0.949	0.078	8.221	1.869	0.215	11.483
BR 2	0.198	0.019	9.329	0.316	0.002	0.484	0.600	0.006	1.059	2.000**	0.051	2.561
S 1	0.191	0.004	1.835	0.216	0.002	0.926	0.732	0.006	0.867	0.489	0.014	2.939
S 13	0.146	0.005	3.624	0.296	0.004	1.188	0.642	0.011	1.770	0.539	0.033	6.134
K 2	0.250**	0.024	9.457	0.299	0.013	4.347	1.111	0.070	6.268	1.041	0.089	8.517
F value	21.85	289.91	63.28	133.22								
Inference	HS	HS	HS	HS								
CD @ 5%	0.025	0.012	0.086	0.196								
CD @ 1%	0.036	0.016	0.122	0.278								

HS, Highly significant, **denotes significantly higher value

(ANOVA). Values expressed are means of three replicate determinations.

It was observed that the phenolic content in mulberry fruits varies in accordance to varieties. With regard to un-ripened fruits, maximum phenolic content was recorded in K 2 mulberry variety (0.233 mg/ml), followed by AR 14 (0.210 mg/ml), BR 2 (0.198 mg/ml), S 1 and S 13 respectively (Table 1). The total phenolic content of the ripened fruits in mulberry were found more as compared with unripened fruits in all varieties. In the ripened fruits the total phenolic content was found to be maximum in AR 14 (0.391 mg/ml) mulberry variety followed by BR 2 (0.315 mg/ml), K 2 (0.298 mg/ml), S 13 and S 1 variety respectively. K 2 in respect of unripened and AR 14 in respect of ripened fruits are found to be highly significant among then selected mulberry varieties (Table 1). In un-ripened mulberry fruits, maximum flavonoid content was observed in K 2 (1.111 mg/ml), followed by AR 14 (0.949 mg/ml), S-1 (0.732 mg/ml) and S 13 respectively. In ripe fruits, maximum flavonoid content was observed in BR 2 variety (1.999 mg/ml) followed by AR 14 (1.868 mg/ml), K 2 (1.04 mg/ml), S 13 and S 1 respectively (Table1). According to the study conducted in Korea, the total polyphenol (TP) was found from 2 235 to 2 570 ìg/g gallic acid equivalents, total anthocyanin (TA) content to vary from 1229 to 2057 ìg/g, coloured anthocyanins (CA) from 126 to 190 ìg/g, and total flavanol (TF) from 16.4 to 65.4 ìg/g catechin equivalents except Mocksang (M 5) (Bae 2006). The total flavonoid content was found higher in current study when compared to mulberry fruit cultivars of Korea which was only 0.654 mg/gm (Bae and Suh 2007). Koca, *et al*. (2008) found the maximum total phenolics content in *Morus rubra* (red mulberry fruits). Song *et al.* (2009) found the maximum total flavonoid content in Shanxiguosang cultivar of China while lowest flavonoid content in Sinan 2 hao in cultivar.

SUMMARY

The results of the experiment indicated that K 2 mulberry variety have shown maximum flavonoid and phenolic content in un-ripened fruits, while AR 14 variety have maximum total phenolic content in ripened fruits. The BR 2 mulberry variety has highest total flavonoids content in ripened fruits. The high contents of functional compounds in mulberry juice, fruits, and leaves implied that they might be potential resources for the development of functional drinks and food. Considering the advantages of potential medicinal properties of flavonoids and phenols enriched fruits of mulberry it can be utilized to treat several diseases of animals and human being.

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