



## Research Article

### Varietal Impact on Suitability and Acceptability of Mulberry (*Morus alba*) Fruit Drinks: A Comparative Study

Amna Gul<sup>1</sup>, Umar Farooq<sup>1\*</sup>, Afshan Shafi<sup>1</sup>, Khizar Hayat<sup>1</sup>, Mukhtyar Ahmad<sup>1</sup>

<sup>1</sup>Department of Food Science and Technology, MNS-University of Agriculture Multan Pakistan

\*Corresponding author: [umar.farooq@mnsuam.edu.pk](mailto:umar.farooq@mnsuam.edu.pk)

#### Abstract

Mulberry (*Morus alba*) is a deciduous fruit that has therapeutic benefits owing to significant amounts of bioactive compounds like anthocyanins, flavonoids and phenolic compounds. This study was designed to assess the varietal comparison of mulberry drinks. At first, mulberry fruit pulp was prepared and then evaluated for its nutritional composition. The pH was found high ( $6.1 \pm 0.01$ ) in green variety compared to the pH ( $5.1 \pm 0.07$ ) of red variety. Similarly, total soluble solids, crude fat, crude protein and antioxidant activity were found to be higher in the green variety compared to the red variety. The physicochemical results indicated that pH, total soluble solids, crude protein and total phenolic contents were higher in the green variety of mulberry fruit drink than red variety. Mineral analysis also showed that green mulberry drink contained higher mineral contents over the red mulberry drink. The outcome of sensory analysis demonstrated that; although both drinks were acceptable, comparatively green mulberry drink was more accepted by consumers than the red mulberry drink.

**Keywords:** Mulberry fruit; Varietal comparison; Flavonoids; Anthocyanins.

#### Introduction

Mulberry is a fruit categorized under genus "*Morus*" and family "Moraceae" and is generally recognized as deciduous plant. Species of mulberry fruit varies in their physical and chemical compositions due to their differences in variety and likewise soil type variations along with its environmental and climatic conditions. Mulberry fruit also differs in taste when eaten due to its natural difference in varieties as *Morus nigra* known as "black mulberry" are luscious fruits contains an acidic flavor as well as an amazing color and the cultivar *Morus rubra*, commonly recognized as "red mulberry" are sweet in taste and are of low acidic composition and is comprised of an immense quantity of dry matter. *Morus alba* fruits have generally sweet taste and has a potential acidity and because of its perishable nature this fruit (mulberry) is often consumed as a fresh fruit (Özgen *et al.*, 2009; Uzun and Bayir, 2012).

They are succulent, plentiful and gentle berry fruits that are juicy and have low fat compositions, containing abundant quantities of nutrients, hence may help to maintain health due to their richness in minerals, vitamins and polyphenols.

(Received: 31 August 2019, Accepted: 27 October 2019)

Cite as:

Gul.A, Farooq.U, Shafi.,A, Hayat.K and Ahmad.M 2019. Varietal impact on Suitability and Acceptability of Mulberry (*Morus alba*) Fruit Drinks: A Comparative Study. Agric. Sci. J. 1(1): 99-107.

This fruit (mulberry), containing number of health benefits as therapeutic or medicinal and as well as comprising nutritional advantages, there are some products known as functional ice creams and tea made and commercialized as functional foods in Japan and Korea. It also helps to facilitate the health circumstances by lowering the levels of hyper glycemc index and by the help of these medicinal properties. A large number of nutraceuticals are being made. Mulberry fruit helps to put a stop to numerous diseases that may be chronic as this fruit extract has prospective antitumor activity, hypolipidemic effect and antioxidant effect (Zhang *et al.*, 2008) and effective effect in neurons protection (Kang *et al.*, 2006).

This fruit also contains an enormous quantity of biologically active components like the flavonoids, anthocyanins for its color content and other phenolic contents (Huang *et al.*, 2008).

By keeping in view the nutritional as well as therapeutic composition of this minor fruit, the current research has been planned to evaluate its physico-chemical characteristics and preparation of fruit drinks with following objectives:

#### **Objectives**

- Assessment of physico-chemical composition of mulberry fruit
- Preparation of fruit drinks using two different varieties of mulberry

#### **Materials and methods**

##### **Acquirement of material**

Mulberry fruit of two varieties red and white were brought from general market of Multan to the laboratory of Food Science and Technology. Then fruit was cleaned, washed and kept at refrigeration temperature for further work.

#### **Physical and chemical analysis of mulberry pulp**

The Physical and chemical characterization of mulberry fruit pulp (pH, acidity, total soluble solids, crude fat, protein and ash contents) was evaluated by efficient use of standards (AOAC 2000; AOAC 2006) and chemicals with required equipments.

##### **Antioxidant activity**

The determination of antioxidant activities were assessed by applying the methods of DPPH, 1-diphenyl-2-picrylhydrazyl; ABTS, 2, 20-azino-bis-3-ethylbenzthiazoline-6-sulphonic acid assays to evaluate the free radicals present in this sample given by Mena *et al.* (2011) with some modifications.

##### **Preparation of mulberry fruit drinks**

The preparation of mulberry fruit drinks, different ratios of mulberry fruit pulp and sugar were used according to the treatment plan (Table 1).

##### **Analysis of mulberry fruit drinks**

The prepared mulberry fruit drinks were stored for 60 days and then analyzed by following the parameters after ten days, periodically.

The pH, acidity, total soluble solids, crude protein and crude fat of both samples of mulberry fruit drinks (white and red) were determined by using standard procedures documented by AOAC (2000, 2006).

##### **Mineral profile**

The mineral contents of both white and red mulberry fruit drinks were evaluated by using Atomic Absorption Spectrophotometer and flame photometer following to the standard methods of AOAC (2000); Anon (2003).

##### **Antioxidant activity**

The determination of antioxidant activities were assessed by following the methods of ABTS, 2, 20-azino-bis-3-ethylbenzthiazoline-6-sulphonic acid; DPPH, 1-diphenyl-2-picrylhydrazyl

assays with some modifications to find the free radicals in the sample by following the method given by Mena *et al.* (2011) with some modifications.

#### **Total phenolic contents**

Total phenolic contents (TPC) of mulberry fruit extract were evaluated according to Singleton *et al.* (1999).

#### **Sensory evaluation**

The sensory evaluation of mulberry fruit drinks was performed by following a 9 point hedonic scale following the procedure of Meilgaard *et al.* (2007).

#### **Statistical analysis**

Final data obtained was analyzed statistically by using standards of variance and Duncan's new multiple range test procedures (Montgomery, 2008).

### **Results and Discussions**

#### **Physicochemical analysis of mulberry pulp**

The physicochemical characterization of mulberry fruit pulp was evaluated. The result indicated that the pH of green mulberry pulp was observed  $6.1\pm 0.01$  while the pH value of red mulberry was observed  $5.1\pm 0.7$ . However, the results regarding acidity of green variety of mulberry fruit pulp was found to be  $1.65\pm 0.03$  whereas, the value of acidity in red variety was resulted as  $1.96\pm 0.08$  (Table 2).

The result of total soluble solids of green mulberry pulp was observed  $12.68\pm 0.04$  and result of red variety was  $10.12\pm 0.00$ . However, the values crude protein of green mulberry fruit pulp and red mulberry fruit pulp was observed  $1.21\pm 0.07$  and  $1.18\pm 0.07$ , respectively.

The result related to antioxidant value found in green mulberry fruit pulp was observed  $39.47\pm 0.01$  while the result of red variety was found to be  $37.43\pm 0.02$ , correspondingly (Table 2).

#### **Mulberry fruit drinks**

##### **Selection of recipe**

Different treatments of green and red mulberry fruit drinks were prepared by variation of mulberry pulp and concentration of sugar (Table 1). On the basis of consumer acceptability final recipe of green and red mulberry drinks were selected as T<sub>2</sub> and T<sub>1</sub>, respectively.

##### **Preliminary study**

The preliminary experiments were carried out to choose the final recipe for storage study. In preliminary trials mulberry pulp was found to be the most important factors to obtain highest acceptable scores.

#### **Physicochemical analysis of mulberry drinks**

The result regarding pH of mulberry fruit drinks revealed that there was a significant change in pH of mulberry drinks noticed in both the varieties throughout the duration of storage of 60 days. The  $6.57\pm 0.01$  pH was observed in green mulberry fruit drink whereas in red mulberry fruit drink pH was  $5.67\pm 0.02$ .

**Table 1: Treatment plan for the selection of final recipe of mulberry (green and red) drinks**

Varieties	Treatments	Mulberry pulp (%)	Sucrose (%)
Green	T1	8	10
	<b>T2</b>	<b>10</b>	<b>8</b>
	T3	12	6
Red	<b>T1</b>	<b>8</b>	<b>10</b>
	T2	10	8
	T3	12	6

**Table 2: Physicochemical parameters of green and red mulberry pulp**

Parameters	Green	Red
<b>pH</b>	6.1±0.01	5.1±0.7
<b>Acidity</b>	1.65±0.03	1.96±0.08
<b>TSS</b>	12.68±0.04	10.12±0.00
<b>Crude protein</b>	1.21±0.07	1.18±0.07
<b>Crude fat</b>	0.82±0.03	0.78±0.05
<b>Antioxidant activity</b>	39.47±0.01	37.43±0.02

The acidity of both types of mulberry fruit drinks revealed a highly significant change in acidity throughout the storage duration of 60 days. The acidity was seemed to be lower 1.45±0.02 in green variety while the red variety indicated higher acidity (1.94±0.01). The red mulberry fruit juice was seemed to be more acidic than green according to the results. While the result of total soluble solids showed higher contents in green mulberry drink (14.68±0.01) as compared

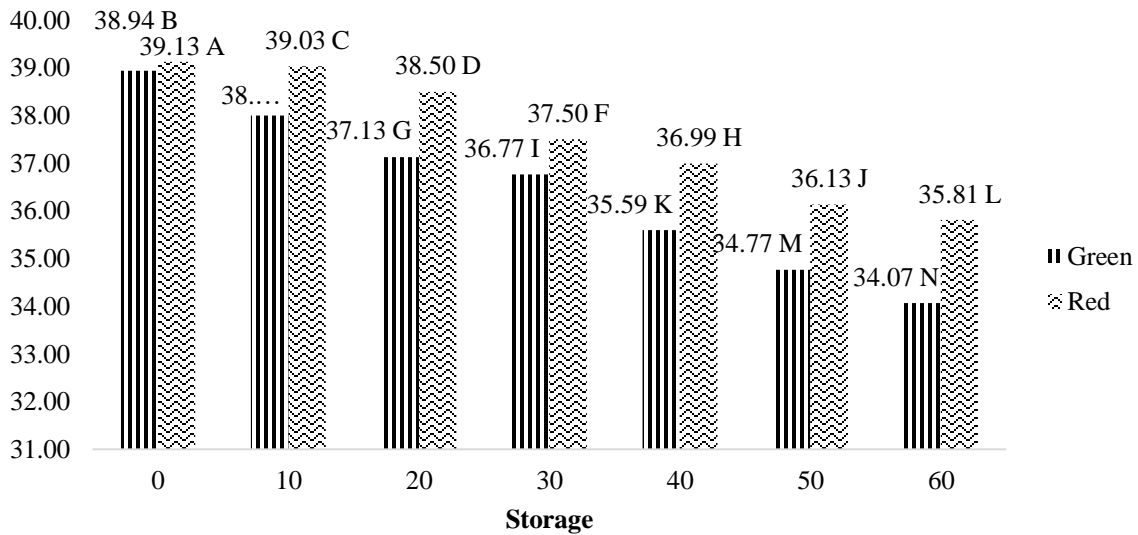
to red mulberry drink (12.12±0.01) (Table 3). The crude protein was found to be as 1.32±0.00 in green mulberry drink against protein content in red mulberry fruit drink as seemed to be 1.31±0.00. The crude fat was observed as 0.92±0.00 in green mulberry fruit drink and 0.93±0.00 in red mulberry fruit drink. The value of total phenolics was found to be as 17.45±0.02. Similarly, the total phenolic content in red mulberry fruit drink was found to be 15.47±0.01 (Table 3).

### Antioxidant activity

The impact of antioxidant activity of mulberry fruit drinks revealed a highly significant change in antioxidant was noticed in varieties throughout the storage

duration of 60 days (Table 3). The antioxidant value was seemed to be as  $38.94 \pm 0.04$  in green mulberry. Similarly, the antioxidant in red mulberry fruit drink was found to be  $39.13 \pm 0.02$ , respectively (Fig. 1).

### Figure Legends



**Fig 1: Impact of storage and variety on antioxidants of mulberry drinks**

### Mineral analysis

#### Sodium

Sodium analysis in mulberry fruit drinks revealed a highly significant change in sodium present in mulberry drinks was noticed in varieties throughout the storage duration of 60 days. The sodium was seemed to be  $1.50 \pm 0.00$  in green mulberry. Similarly, the sodium present in red mulberry fruit drink was found to be  $0.21 \pm 0.05$  (Table 4).

#### Potassium

Potassium analysis in mulberry fruit drinks revealed a highly significant change in potassium present in was

seemed in varieties throughout the storage duration of 60 days. The value of potassium was indicated as  $47.27 \pm 0.00$  in green mulberry. Similarly, the potassium present in red mulberry fruit drink was found to be  $24.99 \pm 0.05$  (Table 4).

#### Calcium

Calcium analysis in mulberry fruit drinks revealed that there was highly significant change in calcium present in was seemed in varieties throughout the storage duration of 60 days. The calcium was noticed as  $7.12 \pm 0.01$  in green mulberry. Similarly, the calcium present in red mulberry fruit drink was found to be  $0.96 \pm 0.01$  (Table 4).

**Zinc**

Zinc analysis in mulberry fruit drinks revealed a highly significant change in zinc present in was observed in varieties throughout the storage duration of 60 days. The zinc was seemed to be  $2.66\pm 0.05$  in green mulberry. Similarly, the zinc present in red mulberry fruit drink was found to be  $3.25\pm 0.00$  (Table 4).

**Fe (iron)**

Fe analysis showed that there was highly significant change in Fe was noticed in varieties throughout the storage duration of 60 days. The Fe was noticed as  $3.29\pm 0.00$  in green mulberry. Similarly, the Fe in red mulberry fruit drink was found to be  $3.29\pm 0.00$  (Table 4).

**Sensory Analysis**

Observed in

The outcome of color of mulberry fruit drinks revealed a highly significant change in color was observed in varieties during the storage duration of 60 days. The color was seemed to be as  $8.56\pm 0.01$  in green mulberry. Similarly, the color of red mulberry fruit drink was found to be  $8.72\pm 0.01$ . The impact of flavor of mulberry fruit drinks revealed a highly significant change in flavor observed in varieties throughout the storage duration of 60 days. The flavor was seemed to be  $8.52\pm 0.01$  in green mulberry. Similarly, the flavor in red mulberry fruit drink was found to be  $8.34\pm 0.01$ . The effect of aroma of mulberry fruit drinks revealed a highly significant change in aroma

**Table 3: Physicochemical attributes of mulberry fruit drinks**

Varieties	Physicochemical Attributes						
	pH	Acidity	TSS	Crude fat	Crude protein	Antioxidant activity	Total phenolics
Green	$6.57\pm 0.01$	$1.45\pm 0.02$	$14.68\pm 0.01$	$0.92\pm 0.00$	$1.32\pm 0.00$	$38.94\pm 0.04$	$17.45\pm 0.02$
Red	$5.67\pm 0.02$	$1.94\pm 0.01$	$12.12\pm 0.01$	$0.93\pm 0.00$	$1.31\pm 0.00$	$39.13\pm 0.02$	$15.47\pm 0.01$

**Table 4: Mineral profile of mulberry fruit drinks**

Varieties	Mineral Profile				
	Sodium	potassium	calcium	Zinc	Fe
Green	$1.50\pm 0.00$	$47.27\pm 0.00$	$7.12\pm 0.01$	$2.66\pm 0.05$	$3.29\pm 0.00$
Red	$0.21\pm 0.05$	$24.99\pm 0.05$	$0.96\pm 0.01$	$3.25\pm 0.00$	$3.27\pm 0.00$

**Table 5: Sensorial acceptability of Mulberry fruit drinks**

Varieties	Sensory Attributes					
	Color	Aroma	Flavor	Consistency	Mouth feel	Overall acceptability
Green	8.56±0.01	8.55±0.01	8.52±0.01	8.17±0.01	8.52±0.01	8.57±0.01
Red	8.72±0.01	8.55±0.01	8.34±0.01	8.17±0.01	8.34±0.01	8.67±0.01

Varieties during the storage duration of 60 days. The aroma was observed as 8.55±0.01 in green mulberry. Similarly, the aroma in red mulberry fruit drink was found to be 8.55±0.01 (Table 5). The impact of consistency of mulberry fruit drinks showed that there was highly significant change in consistency noticed in varieties throughout the storage duration of 60 days. The consistency was observed as 8.17±0.01 in green mulberry. Similarly, the consistency in red mulberry fruit drink was found to be 8.17±0.01. The outcome of mouth feel of mulberry fruit drinks showed that there was highly significant change in mouth feel was revealed in varieties throughout the storage duration of 60 days. The mouth feel was noticed as 8.52±0.01 in green mulberry fruit drink. Similarly, the mouth feel in red mulberry fruit drink was found to be 8.34±0.01. The effect of overall acceptability of mulberry fruit drinks revealed a highly significant change in overall acceptability was noticed in varieties throughout the storage duration of 60 days. The overall acceptability was 8.57±0.01 in green mulberry. Similarly, the overall acceptability in red mulberry fruit drink was found to be 8.67±0.01 (Table 5).

### Discussion

Fruit juices are becoming the leading drinks of current era because of the health consciousness as well as nutritional point of

view (Iqbal *et al.*, 2010). In the current study mulberry fruit drink was conducted using two different varieties (red and green) of mulberry fruit and then these drinks were evaluated for their acceptability. The results of current study are in good agreement with Iqbal *et al.* (2010) who has also explored that averaged pH ranges for mulberry fruit drinks or fresh juices were ranged from 3.8 to 4.1. The result of total acidity found in fresh or prepared juices of mulberry fruit was observed to be 1.60% reported by Ercisli *et al.* (2007). Similar amount of total soluble solids in mulberry drinks was documented by Koyuncu *et al.*, (2004). These results were also supported by the study of Lee *et al.* (2004). Likewise, the results of study conducted by Kim *et al.* (2003) was in favor with the outcomes of current study regarding protein analysis.

Proximate analysis of crude fat resulted in 1 to 1.5% fat in mulberry fruit juice according to Kim *et al.* (2003). The antioxidant activity of mulberry fruit drinks was observed to be 20µmol/g and its average range varies in between 19-21 µmol/g TE in a DPPH assay according to Özgen *et al.* (2009). The results of total phenolic contents (TP) present in mulberry fruit drinks was assessed as 1500 to 2570 µg/g present in mulberry drinks (Bae and Suh, 2007; Lin & Tang, 2007). The total amount of sodium found in

mulberry drink indicated was similar with the results of mineral analysis exploration conducted by Imran *et al.* (2010). There seemed to be an immense amount of sodium to be (272 mg/100 g) in mulberry fruit varieties (*M. nigra*, *M. alba*, *M. rubra*) that were grown in Turkey (Imran *et al.*, 2010). The amount of potassium present in some varieties of mulberry fruit (*M. rubra*, *M. alba* and *M. nigra*) was seemed to be as 834–1668 mg/100 g given by Orhan and Ercisli (2007) as well as its amount was also seemed to be higher in mulberry fruit extracts as 1300 mg/100 g reported by Imran *et al.* (2010).

The amount of anthocyanin contents found in black, red and purple mulberry fruits and prepared drinks was observed to be in range between 99 and 571 µg/g Cy 3-glu equivalent (Özgen *et al.*, 2009b) and some of its varieties grown in China revealed a range from 22 to 3300 mg/l Cy-3-glu equivalent resulted to be 16 mg per 100 ml according to Hojjatpanah *et al.* (2011). The products prepared with mulberry fruit along with its extracts revealed favorable results according to Kim *et al.* (2003). In the sensory attributes Kim *et al.* (2003) documented the vital results of just using 2 to 3% of extracts of mulberry fruit in mulberry sherbet, ice-cream and it had best aroma, texture and flavor. In the sensory analysis of consistency of mulberry fruit juices revealed that the result of consistency of mulberry drinks was found to be 3% more favorable than others according to Kim *et al.* (2003). The results of the sensory analysis of mouth feel of mulberry fruit drinks found to be in favor with the results of Kim *et al.* (2003).

#### **Conclusion:**

It is conclusive that mulberry fruits are rich in essential nutrients (protein, fat and total minerals). Mulberry fruit possessed a strong mineral profile containing Na, K, Ca, Fe and Zn. Along with this nutritional profile, it contains considerable quantity

of total phenolic contents and that may result in a strong antioxidant activity.

Therefore, mulberry fruit might be helpful in promoting human health. This berry fruit could be used to minimize the risk of hyperglycemia and as well as facilitates good metabolism to control obesity, high blood pressure, diabetes and cardiovascular diseases, respectively. Furthermore, there is a need of more pre-clinical and clinical research to explore its potential therapeutic attributes.

#### **Conflict of Interest:**

There is no conflict of interest in my research.

#### **References**

- Anonymous. 2003. In: Official Methods of Analysis of Association of Official Analytical Chemists International. (Ed.): W. Horwitz, W. 17th ed. AOAC Press, Arlington, VA, USA.
- AOAC. 2010. Official Methods of Analysis of Association of Official Analytical Chemists. 18th Edition, Washington, DC.
- AOAC. 2000. Official Methods of Analysis. The Asso. of Analy. Chemists. 17th Ed. Arlington, USA.
- AOAC. 2006. Official Methods of Analysis of Association of Official Analytical Chemists International. In: Horwitz, W. (Ed.), 18th ed. AOAC Press, Arlington, VA, USA.
- Bae, S. H., and Suh, H. J. 2007. Antioxidant activities of five different mulberry cultivars in Korea. *LWT - Food Science and Technology*, 40, 955-962.
- Ercisli, S., and E. Orhan. 2007. Chemical composition of white (*Morus alba*), red (*Morus rubra*) and black (*Morus nigra*) mulberry fruits. *Food Chemistry*, 103(4): 1380-1384.
- Harrigan, W.F. (1998). *Laboratory methods in food microbiology*. 3rd



- Ed. Academic Press Limited, London.
- Hojjatpanah, G., M. Fazaeli, Z.E. Djomeh. 2011. Effects of heating method and conditions on the quality attributes of black mulberry (*Morus nigra*) juice concentrate. *International Journal of Food Science & Technology* 46(5):956 - 962
- Huang, H.P., Y.W. Shih, Y.C. Chang, C.N. Hung and C.J. Wang. 2008. Chemoinhibitory effect of mulberry anthocyanins on melanoma metastasis involved in the Ras/PI3K pathway. *J. Agric. Food Chem.* 56:9286–9293.
- Imran M, Khan H, Shah M, Khan R, Khan F. 2010. Chemical composition and antioxidant activity of certain *Morus* species. *J Zhejiang Univ Sci B.* Dec;11(12):973-80.
- Iqbal, M., K. Mir Khan, M. S. Jilani, and M. M. Khan. 2010. Physico-chemical characteristics of different mulberry cultivars grown under agro-climatic conditions of Miran shah, north Waziristan (Khyber Pakhtunkhwa
- Kang, T.H., J.Y. Hur, H.B. Kim, J.H. Ryu and S.Y. Kim. 2006. Neuroprotective effects of the cyanidin-3-O-beta-D-glucopyranoside isolated from mulberry fruit against cerebral ischemia. *Neurosci. Lett.* 391:122–126.
- Kim SB, Chang BY, Jo YH, Lee SH, Han SB, Hwang BY, Kim SY, Lee MK. Macrophage activating activity of pyrrole alkaloids from *Morus alba* fruits. *J Ethnopharmacol.* 2013 Jan 9;145(1):393-6. Epub 2012 Nov 16.
- Koyuncu, F., M.A. Koyuncu, F. Yıldırım, E. Vural.2004. Evaluation of Black Mulberry (*Morus nigra* L.) Genotypes from Lakes Region, Turkey. *Eur. J. Hort. Sci.* 69(3):25-131
- Lee, K.S., You, K.H., Choo, J.K., Han, Y.M., Yu, K. (2004). *Drosophila* short neuropeptide F regulates food intake and body size. *J. Biol. Chem.* 279(49): 50781--50789.
- Lin, J. and Tang, C. (2007) Determination of Total Phenolic and Flavonoid Contents in Selected Fruits and Vegetables, as Well as Their Stimulatory Effects on Mouse Splenocyte Proliferation. *Food Chemistry*, 101, 140-147. foodchem.2006.01.014
- Meilgaard, M.C., G.V. Civille & B.T. Carr. 2007. Sensory evaluation techniques, 4th ed. C.R.C. Press L.L.C., New York.
- Mena, P., García-Viguera, C., Navarro-Rico, J., Moreno, D. A., Bartual, J., Saura, D., & Martí, N. 2011. Phytochemical characterization for industrial use of pomegranate (*Punica granatum* L.) cultivars grown in Spain. *J. of the Sci. of Food and Agri.* 91(10) : 1893–1906.
- Montgomery, D. 2008. Introduction to factorial design.in,Design and analysis of experiments, Jhon Willey and Sons, inc, USA.
- Singleton, V.L., R. Orthofer and R.M. Lamuela-Raventos. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu
- Uzun, H.I. and A. Bayir. 2012. Biochemical contents of mulberry (*Morus* spp.) fruits. *Planta Medica.* 78(11):1064-1064.
- Zhang W, F. Han, J. He, C. Duan. 2008. HPLC-DAD-ESI-MS/MS analysis and antioxidant activities of nonanthocyanin phenolics in mulberry (*Morus alba* L.). *J. Food Sci.* 73:C512–C518.