Physiochemical and Bioactive Characteristics of Osmo-Air Dried Mulberry Fruit

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Abstract

The research was aimed at studying the effect of Osmo-air drying on physiochemical quality and bioactive properties of black mulberry fruit. Mulberry was steeped in the 55˚Bx sugar solution for 5 hours at temperature 40˚C and then dried at 60˚C for 8 hours in cabinet drier. Acidity (% citric acid) decreased from 1.03±0.01 to 0.92± 0.01% along with increase of pH from 3.87±0.01 to 3.9±0.02. Ash content (% db.) reduced to 0.73±0.02 from 5.02±0.26, calcium (mg/100g) and iron (mg/100g) reduced from 272.16 ±8.00 and 48.78 ±3.94 to 155.07±4.53 and 29.66±3.51, respectively. Total soluble solid increased to 29.33±0.57% from 12.00 ±0.3%. Vitamin C, total phenol, anthocyanin and antioxidant activity of fresh fruit were found to be 15.38 ±1.24mg%, 5080.67 ±7.05mg/100g, 1293± 4.06 mg/100g and 91.90±1.04 %, respectively, while significant reduction in vitamin C (9.6±0.26 mg %), total phenol (722.33±3.33mg/100g db), anthocyanin (154.86±3.32mg/100g db) and antioxidant activity (74.33± 1.53%) were observed in Osmo-air dried fruits. Osmo-air drying process not only preserves seasonal fruit but also produce dried fruit that may have potential to use in various food products for value addition and product diversification.

Keywords: *Anthocyanin, Antioxidant Activity, Osmo-air drying, Total Phenol*

Introduction

Mulberry is a fast growing deciduous fruit tree that belongs to the genus *Morus* of the family Moraceae (Kako, 2012). Mulberries are well known among berries and their popularity and acceptability among consumer are not only due to nutritive value but also due to known health promoting properties (medicinal value). High concentrations of bioactive compounds such as phenolics, flavonoids, anthocyanins, Vitamin C and Vitamin E contribute substantially to the antioxidative capacity of mulberry fruit (Kao, 2006). In Nepal, mulberry plants can be commercially be cultivated at height of 500-2000 meters from tropical to sub-tropical climates. *Morus nigra*, *Morus rubra* and *Morus alba* are some available species with some local varieties in Nepal. Though plants are not new to Nepalese geography, fruits are not utilized efficiently (Shrestha, 2006). The plant bears edible fruit and is extremely perishable with very short shelf-life as it is the seasonal bearer and has very limited market demand, when production is high and this leads to post-harvest losses (Doymaz, 2004). Mulberry is traditionally used as a feed for ruminants to increase milk production and also has been used in sericulture but not used for food production (Shrestha, 2006; Uprety *et al.*, 2012). Osmotic dehydration (OD) is one of the most important complementary treatment and food preservation technique in the processing of dehydrated foods. Osmotic treatment followed by conventional air-drying (50-60˚C) further reduces moisture content and process is called Osmo-air drying. Osmotic treatment is a procedure that involves immersing of solid food in hypertonic aqueous solution and improves sensory properties without affecting bioactive component and its texture (Tortoe 2010; Giovanelli *et al.* 2012; Djendoubi *et al.* 2013).Many researchers has found that the Osmo-air drying reduce the bioactive components lesser compared to conventional air drying for a same moisture of dried fruit (Riva *et al*., 2005; Sanjinez-Argandona *et al.*, 2005).

The main aim of this research was to produce dried form of fruits using Osmo-air drying technique to overcome postharvest losses of mulberry fruit of Nepal and furthermore dried fruit produced with this technique could be used in food industries as such dried fruits and be added to various products like yoghurt, cakes, cookies, bread, and many

more products as they serve excellent nutrient and functional property. Therefore, it is necessary to strengthen the research into the mulberry fruit utilization and to promote the industrialization of mulberry fruit produces.

Material and Methods

Materials

Fresh mulberry fruit grown in the field of *Damauli*, Nepal were harvestedand then refrigerated. Crystallized sugar was brought from local market.2,2-diphenyl-1-picrylhydrazyl (DPPH)made by Sigma-Aldrich company, Germany was used to access antioxidant activity. Phenol reagent (Finar limited, India), Gallic acid (LOBA Chemie, India) and Methanol (Fisher Scientific, India) were used to determine the total phenol content and anthocyanin. All chemicals used were of analytical grade. The spectrophotometer used was of model GENESYS^{TM} 10S Vis Spectrophotometer (Thermo Scientific^{TM}, Germany).

Preparation of Osmo-air dried mulberry

Fruits were primarily selected for uniform size and maturity based on their physical appearance e.g. external color (black colored; ripen fruits). 2000 g fresh fruit were dipped in 0.1% potassium metabisulfite solution for 10 minutes then drained well followed by the quick rinse. Fruit was then treated with $Ca(OH)_2$ at the rate of 2% for texture reinforcement purpose for 10 minutes. Pre-treated fruits were immersed in the osmotic solution of commercial sucrose at a concentration of 55˚Bx for 5 hours to achieve the desired 30˚Bx. Osmosis was carried out at 40˚C to avoid fruit disintegration and cooking. The fruit pieces were drained and then were spread in a monolayer on stainless steel sieve and dried in the cabinet drier at 60˚C for 8 hours (Klewicki *et al.*, 2009; Chavan, 2012). On Osmo-air dehydration 725 g dried mulberries were obtained as moisture was loss due to osmotic dehydration and conventional drying.

Analysis of fresh and dried mulberry fruits

Analysis of physiochemical properties

Fresh mulberries and Osmo-air dried mulberries were analyzed for various parameters. Moisture content, acidity (% citric acid), dry matter, total soluble solid (TSS), pH, ash, minerals (calcium and iron), Vitamin C were analyzed as per Association of Official Analytical Chemists (AOAC), 2005.

Extract preparation

The extract of fresh fruit and osmo-air dried fruits were prepared according to the method described by Kostic *et al.*, 2013 with some modification. 20 g of each sample were ground with 80% methanol (30ml) and this was kept under continuous shaking for 20 minutes and then was filtered through Whatman no. 1 filter paper. The residue was again submitted to two more extraction cycle for 20 minutes each totalizing 60 minutes of extraction time. The filtrate was combined in the volumetric flask, and the volume was made up to 100ml. The extracts were stored in the refrigerator until analysis.

Total phenol content

The total phenol content of sample extract was measured by using Folin-Ciocalteumethod as described by Mahdavi *et al.*, 2010. The absorbance was measured using a UV-VIS spectrophotometer at 750 nm. The result was expressed as mg of gallic acid equivalents (GAE) per 100g of sample.

Total anthocyanin content

Total anthocyanin content of the extracts was determined using pH differential method (Guisti *et al.*, 2003) using a UV-VIS spectrophotometer. Absorbance was measured at520 nm and 700 nm, using two buffer solutions, namely potassium chloride buffer for pH 1.0 and sodium acetate buffer for pH 4.5. Results were expressed as mg of cyanidin-3-O-glucoside equivalents (CGE) per 100g. Absorbance was calculated using following equation

$$A = (A520 - A700)\ pH1.0 – (A520 – A700)\ pH4.5 \quad \ldots\ldots\ (1)$$

$$TAC = (A * MW * DF * 100)/MA \quad \ldots\ldots\ldots\ (2)$$

Where, A is the absorbance in nm, MW is the molecular weight of cyanidin-3-Oglucoside (449.2), DF is the dilution factor (DF =final volume/initial volume), MA is the molar absorptivity cyanidin-3-O-glucoside (26,900).

Antioxidant activity by DPPH Assay

The antioxidant activity (% scavenging activity) of the extract was determined by the free radical scavenging activity using DPPHassay (Stajcic *et al.*, 2012). The capability to scavenge the DPPH radicals (DPPH radical scavenging activity) was calculated using equation,

$$\% \text{ DPPH radical scavenging activity} = [(Ao - A_1 / Ao) \times 100]$$

Where, Ao is the absorbance of the control (DPPH); A_1 is the absorbance of sample extract.

Statistical Analysis

All determination was done in triplicate and all were averaged. The experimental results were expressed as a mean ± standard error of mean (SEM) of three determinations. Significant differences among mean values, where applicable, were determined by t-test method.

Results and Discussion

Physiochemical properties of mulberry fruit

Osmo-air drying result in significant change in moisture content (%),total dry weight (%), acidity (% citric acid), pH, TSS (%), Ash (% db), Calcium(mg/100gm) and Iron (mg/100g) of fresh fruit, which is shown in table 1.

Table 1. Physiochemical characteristics of Mulberry Fruit (Fresh and Osmo-air dried)

Analysis parameter	Fresh fruit	Osmo-air dried fruit
Moisture Content (%)	85.67 ±0.60^a	9.59 ±0.40^b
Total dry weight (%)	14.25 ±0.56^a	90.40 ±0.04^b
TSS (%)	12.00±0.3^a	29.33 ±0.57^b
Acidity (% citric acid)	1.03 ±0.01^a	0.92 ±0.01^b
pH	3.87±0.01^a	3.93±0.02^b
Ash (% db.)	5.02 ±0.26^a	0.73 ±0.02^b
Calcium(mg/100gm)	272.16 ±8.00 ^{a}	155.07 ±4.53^b
Iron (mg/100g)	48.78 ±3.94^a	29.66±3.51^b

*The values in the table are the mean of triplicates with standard error of mean (±).

**Values in the row bearing different superscript are significantly different.

Moisture and total dry weight content of fresh mulberry fruit was change and found to be 9.59% and 90.4% respectively for the Osmo-air dried mulberry fruit. Ercisli and Orhan (2007) reported moisture 72.6% and total dry weight 27.4% of *Morus nigra*. The osmotic pressure gradient cause moisture loss during osmosis and further decrease were accelerated by hot air drying by supplying thermal energy for vaporization (Ratii, 2001). TSS content of black mulberry was reported 8.88% by Iqbal *et al.*, (2010), whereas Koyumau *et al.*, (2004) reported 13.11 to 16.23%.The increased total soluble solid content of dried fruit was due to solute gain action during osmosis process and air drying (Giraldo *et al.*, 2003).

Gundogdua *et al.* (2011) reported acidity in the range of 0.76-1.08%, which was similar to the above findings. However, Imran *et al.*, (2010) reported acidity for black mulberry 1.5% -2.07%. Elmaci and Altug (2002) reported pH values of mulberry fruit in the range of 3.60-3.80, whereas Ercisli and Orhan, (2007) reported pH in the range of 3.52-5.60. The reduction in acidity of blood orange was reported by Sebastiano (2001), due to elution of low molecular weight substances along with water during osmosis and drying.

Imran *et al.*, 2010 reported ash content of *Morus* species to be 5.3% which was slightly higher than above findings. Calcium contain of 150-470mg/100g while iron of 40-63mg/100g on dry basis were reported by Imran *et al.*, 2010. The significant decrease in the ash content and minerals could be due high sugar concentration of solution and temperature of 40°C of solution and also due to leaching of some minerals during osmotic step (Agoreyo, 2011).

Bioactive component of Mulberry fruit

Bioactive component of mulberry fruit and osmo-air dried mulberry fruit is shown in table 2.

Table 2. Bioactive componentof mulberry fruit

Parameters	Fresh fruit	Osmo-air dried fruit
Vitamin C (mg%)	15.38± 1.24[a]	9.6 ±0.26[b]
Total phenols (mg GAE/100gdb)	5080.67±7.05[a]	722.33±3.33[b]
Total anthocyanin (mg/100gdb)	1293± 4.06[a]	154.86±3.32[b]
Antioxidant activity (% scavenging activity)	81.90±1.04[a]	74.33±1.53[b]

*The values in the table are the mean of triplicates with standard deviation (±).

**Values in the row bearing different superscript are significantly different.

Imran *et al* (2010) reported ascorbic acid was in the range of 15-17 mg%, while Iqbal *et al* (2010) reported ascorbic acid 32.25 mg%. A similar reduction in ascorbic acid of jackfruit fruit was found on osmo-air dehydration (Prasannath and Mahendran, 2010).Total phenol content in mulberry fruits were reported to be 1223 to 1551mg GAE (Khalid *et al.*, 2011) and 1000to 2141mg GAE per 100g on dry basis (Bae and Suh, 2007). Stojanovic and Silva(2007) reported more than one half of total phenols present in fruits were lost on dry basis (68.8%) while Chottamann *et al.*, (2012) reported more reduction in phenolic content for mulberry treated with sucrose solution as it induced the phenolic degradation. This decline in vitamin C content and polyphenols can mainly attribute to leaching of water soluble vitamin and total phenolics (hydrophilic smallest phenolic compounds) through the skin of berries with water into osmotic solution and even during drying process where losses by volatilization or thermal decomposition of chemical compounds might occur (Mahmood, 2011).

Anthocyanin was found to be lower than that of black mulberry (4800 mg CGE/100) from Turkey (Ercisli *et al.*, 2010). Stojanovic and Silva, 2007 reported half to two third loss of anthocyanins (dry basis) in Osmo-treated blueberries and cherries.

Stojanovic and Silva (2007) reported a similar reduction in antioxidant activity of Osmo-dried mulberries. Liang *et al.*, 2012 reported antioxidant activity of mulberry in the range of 50-96%.Variation in values with that of reported values might be linked to several factors such as varied genetic makeup and fruit maturity, species and cultivars, cultivation site and extraction method and even can attributed to environmental factors which influence bioactive compounds formation (e.g. Light, temperature, agronomics practices, various stresses)(Lee and Kader, 2000).The decrease in antioxidant activity of dried fruit could be due to loss of vitamin C, total phenolics and anthocyanin during a treatment, which are the potent source of antioxidant activity in fruits.

Conclusion

Osmo-air drying results in significant change in physio-chemical composition and bio-active component of mulberry fruit. Thus, Osmo-air drying process not only preserves seasonal fruit but also produce dried fruit that could be eaten as such and can be further added to various food products like breakfast cereals, biscuits, yoghurt, cake, etc. for value addition and product diversification. Hence, Mulberry can be a better alternative and potential crop with high market value for farmers in Nepal.

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