African Journal of Biotechnology Vol. 11(41), pp. 9825-9828, 22 May, 2012
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB11.3487
ISSN 1684–5315 © 2012 Academic Journals

*Full Length Research Paper*

# Effect of storage on the physicochemical characteristics of the mango (*Mangifera indica* L.) variety, Langra

**Muhammad Shahnawz[1]*, Saghir Ahmed Sheikh[2] and Shahzor Gul Khaskheli[2]**

[1]Department of Food Technology, Karakoram International University, Gilgit, Pakistan.
[2]Institute of Food Sciences and Technology, Sindh Agriculture University, Tandojam, Pakistan.

Accepted 18 January, 2012

**This study was carried out to evaluate "the effect of storage on the physicochemical composition of mango". The experiment involved determination of the physicochemical compositions of moisture, total soluble solid (TSS), acidity, total sugar, reducing sugar, non reducing sugar, crude fat and ash. Washed mangoes were stored either at room temperature (25 ± 4°C) or storage temperature (4 ± 1°C) to determine their storage life. The results were statistically highly significant among all the observations at probability level of (P<0.01). Results indicate that increase in storage time increases the chemical compositions in the stored mangoes, except for acidity and fat that were decreased with the increase of storage time. Besides, refrigerator temperature increases shelf life of the stored mangoes than room temperature.**

**Key words:** Mango, Langra, storage conditions, chemical compositions.

## INTRODUCTION

Mango (*Mangifera indica* L.) is known as king of the fruits due to its excellent flavor, delicious taste and high nutritive values. The mango fruit has great economic importance, especially in the developing countries where annual yield is about 10,000 tones or more (Amin et al., 2008). It was further stated that presently, its economic value has increased due to its importance in the world market. Mangoes have been produced in Pakistan for about two thousand years and the country is now the fifth largest producer (one million tones per annum) in the world, followed by India, China, Mexico and Thailand. Pakistan is also a major exporter of mangoes, with an export of approximately 80,000 tones annually being the third largest exporter in the world. In Pakistan, production is centered in two provinces, the Punjab and the Sindh, producing 67 and 32% of the total production, respectively. All varieties grown in Pakistan are of Indian origin and are characterized by high total soluble solids and aroma. However, mango export witnessed more than 20% decline in 2008 than 2007 as Pakistan received the lowest per kg rate for its mangoes in the international market due to poor quality (Narayana et al., 1996). The decline in export of mangoes can be attributed to lack of proper post-harvest handling, which is yet a significant reason of poor quality of this fruit. Farmers are not able to determine the proper time of fruit maturity (Narayana et al., 1996).

Some of the key components that contribute for the production and acceptance by the consumer are flavor, volatiles texture and chemical constituents. Mango being a climacteric fruit possesses a very short shelf life and reach to respiration peak of ripening process on the 3$^{rd}$ or 4$^{th}$ day after harvesting at ambient temperature (Narayana et al., 1996). Moreover, the shelf life of mango varies among its varieties depending on storage conditions. It ranges from 4 to 8 days at room temperature and 2 to 3 weeks in cold storage at 13°C (Carrillo et al., 2000). Whereas Rodov et al. (1997), Raje et al. (1997) and Srinivasa et al. (2002) reported 8 to 9 days shelf life for Alphanso variety. Usually, after harvest, the mature green mango takes 9 to 12 days to ripen (Herianus et al., 2003), whereas, Manzano et al. (1997) reported 12 to 14

*Corresponding author. E-mail: nawaz_glt@yahoo.com.

days for ripening at ambient temperature 25°C. The ripening process of mango fruit involves a series of metabolic activities that cause chemical changes, increased respiration, change in structural polysaccharides causing softening, degradation of chlorophyll into pigments by carotenoids biosynthesis, carbohydrates or starch into sugars, organic acids, lipids, phenolics and volatile compounds, thus leading to ripening of fruit with softening of texture to acceptable quality (Herianus et al., 2003).

Due to mishandling, inadequate storage or lack of harvest technical knowledge, producers and traders have to face about 20 to 30% losses (Tahir et al., 2002). Spoilage of mango due to end rot and anthracnose limit its storage potential and the shelf life is decided on the bases of spoilage (10%) during storage. The loss of water from fruit is due to skin evaporation (transpiration) and to some extent respiration. When the fruit looses weight, shriveling will occur and the appearances will deteriorate thus reducing its market value (Narayana et al., 1996). The competitiveness for its sale is also primarily based on these factors in the international markets. Keeping in view the above scenario the present study was conducted.

## MATERIALS AND METHODS

Unripe good quality mango of same size were purchased from the local farm near Tandojam and were brought to the laboratory of the Institute of Food Sciences and Technology, Faculty of Crop Production, Sindh Agriculture University, Tandojam. The mangoes were washed and dried with muslin cloth. Analyses were carried out at initial stages. The mangoes were either stored at room temperature 25 ± 4°C and storage temperature at 4 ± 1°C to determine their shelf life under different temperature regimes. At the end of the experiment (19 days), their physicochemical properties were determined.

### Determination of sugars

Sugars (total sugar, reducing sugar and non-reducing sugar) were carried out through Lane and Eynon method as described by James (1995). Five grams of sample was taken into a beaker and 100 ml of warm water was added. The solution was stirred until all the soluble matter was dissolved and filtered through Whatman filter paper into a 250 volumetric flask. Next, 100 ml of the solution prepared was pipetted into a conical flask, added with 10 ml diluted hydrogen chloride (HCl) and boiled for 5 min. On cooling, the solution was neutralized to phenolphthalein with 10% NaOH and made up to volume in a 250 ml volumetric flask. This solution was used for titration against Fehling's solution and readings were calculated by the follow formulas.

$$\text{Total sugar (\%)} = \frac{\text{Factor (4.95)} \times \text{dilution (250)} \times 2.5}{\text{Titre} \times \text{weight of sample} \times 10}$$

$$\text{Reducing sugar (\%)} = \frac{\text{Factor (4.95)} \times \text{dilution (250)}}{\text{Titre} \times \text{weight of sample} \times 10}$$

Non-reducing sugar was estimated as the difference between the total sugar content and reducing sugar content on subtraction (total sugar - reducing sugar).

### Determination of moisture content

The moisture content was determined according to AOAC (2000). The sample materials were taken in a flat-bottom dish (pre-weighed), kept overnight in an oven at 100 to 110°C and weighed. The loss in weight was regarded as a measure of moisture content, and was calculated by the following formula:

$$\text{Moisture (\%)} = \frac{\text{Weight of fresh sample} - \text{Weight of dry sample}}{\text{Weight of fresh sample}} \times 100$$

### Determination of ash content

For the determination of ash content, method of AOAC (2000) was followed. According to the method, 10 g of each sample was weighed in a silica crucible. The crucible was heated in a muffle furnace for about 4 to 5 h at 525°C. It was cooled in desiccators and weighed. To ensure completion of ashing, it was reheated again in the furnace for half an hour more, cooled and weighed. This was repeated consequently till the weight became constant (ash became white or grayish white). Weight of ash gave the ash content and was calculated by the following formula.

$$\text{Ash (\%)} = \frac{\text{Weight of sample after ashing}}{\text{Weight of fresh sample taken}} \times 100$$

### Determination of crude fat

Crude fat was determined by Mojonnier tube method (James, 1995). The fat content was determined gravimetrically after extraction with diethyl ether ($C_4H_{10}O$) (ethoxyethane) and petroleum ether ($C_6H_{14}$) from an ammonia alcoholic solution of the sample. About 10 g of sample was taken into a Mojonnier tube, and then 1 ml of 0.880 ammonia with 10 ml ethanol ($C_2H_5OH$) was added, mixed well and cooled. Next, 25 ml diethyl ether was added, then the tube was then stoppered and shaken vigorously, after which 25 ml petroleum ether was added and the tube was left to be stand for 1 h. The extraction was repeated three times using a mixture of 5 ml ethanol, 25 ml diethyl ether and 25 ml petroleum ether and also added the extraction to the distillation flask. Distilled off the solvents, dried the flask for 1 h at 100°C and reweighed. The percentage fat content of the sample was calculated by the following formula which gave the difference in the weight of the original flask and the flask plus extracted fat represent the weight of fat present in the original sample.

$$\text{Fat content (\%)} = \frac{W_2 - W_1}{W_3} \times 100$$

Where, $W_1$ is the weight of empty flask (g); $W_2$ represent the weight of flask + fat (g) and $W_3$ is the weight of sample taken (g).

### Determination of titratable acidity

Titratable acidity as malic acid was determined according to the

**Table 1.** Effect of storage period on the physicochemical characteristics of mango at room and refrigerator temperature.

| Treatment | Moisture | Total soluble solid | Acidity | Non-reducing sugar | Reducing sugar | Total sugar | Fat | Ash |
|---|---|---|---|---|---|---|---|---|
| Initial (control) | 77.99$^{d}$ | 7.66$^{c}$ | 0.31$^{a}$ | 3.37$^{b}$ | 2.51$^{a}$ | 5.89$^{a}$ | 0.83$^{a}$ | 0.16$^{ab}$ |
| Room temperature (25 ± 4°C) | 83.33$^{ab}$ | 19.37$^{ab}$ | 0.02$^{d}$ | 8.33$^{a}$ | 1.23$^{b}$ | 9.57$^{d}$ | 0.45$^{c}$ | 0.13$^{b}$ |
| Refrigerator (4 ± 1°C) after 7 days | 80.21$^{c}$ | 10.21$^{c}$ | 0.23$^{b}$ | 4.45$^{b}$ | 2.18$^{a}$ | 6.64$^{b}$ | 0.63$^{ab}$ | 0.26$^{a}$ |
| Refrigerator (4 ± 1°C) after 14 days | 82.44$^{b}$ | 15.86$^{b}$ | 0.14$^{c}$ | 7.77$^{a}$ | 1.41$^{b}$ | 9.18$^{c}$ | 0.63$^{ab}$ | 0.18$^{ab}$ |
| Refrigerator (4 ± 1°C) after 19 days | 84.44$^{a}$ | 20.23$^{a}$ | 0.04$^{d}$ | 9.36**a** | 0.94$^{b}$ | 10.31$^{d}$ | 0.43$^{b}$ | 0.16$^{ab}$ |
| SE | 0.465$^{6}$ | 1.2752 | 0.0161 | 0.5372 | 0.2262 | 0.1879 | 0.0691 | 0.0511 |
| LSD at 1% | 1.5623 | 4.2789 | 0.0509 | 1.8027 | 0.7589 | 0.6305 | 0.2191 | |
| LSD at 5% | 1.0737 | 2.9407 | 0.0358 | 1.2389 | 0.5215 | 0.4333 | 0.1540 | 0.1139 |

method of AOAC (2000). Each sample of the products was treated with 0.1 N NaOH solution using titration kit, along with 3 to 5 drops of phenolphthalein indicator. The volume of alkali used was noted and calculated by using the following formula:

$$\text{Titratable acidity (\%)} = \frac{1 \times \text{Eq. weight of acid} \times \text{Normality of NaOH} \times \text{titer}}{10 \times \text{Weight of sample (g)}} \times 100$$

**Determination of total soluble solids**

The total soluble solids (TSS) were determined as per method described by Mazumdar and Majumder (2003) using Digital-Bench-Refractometer. An appropriate quantity of sample of each product was placed on the prism-plate of the refractometer and the reading appearing on the screen was directly recorded as total soluble solids (brix).

## RESULTS AND DISCUSSION

The data determined on physicochemical characteristics of mango included total sugars, reducing sugar, non-reducing sugar, ash, total soluble solids, moisture, fat and total acidity. The statistically interpreted results of all the parameters are given in the Table 1.

The results indicate that the highest moisture content of 84.44% was recorded in mango fruit stored in refrigerator for 19 days followed by mango fruit of 82.44% stored in refrigerator for 14 days, whereas pretreatment samples under room temperature showed low moisture content 77.99% during storage. The moisture content variations in stored mangoes may be due to storage conditions. This hypothesis was verified by Manzano et al. (1997) that storage temperature affects the moisture content of fruits during storage. Likewise, the highest total soluble solids (20.23%) were determined in mangoes stored at refrigerator temperature for 19 days, followed by mangoes (19.37%) stored at room temperature. These results reveal that time and temperature both are equally responsible for physicochemical changes of fruits and the major changes occur when fruits are stored for long time at high temperature. For instance, Doreyappa et al. (2001) reported that seven hybrid varieties of green mature mangoes underwent a series of physicochemical changes and major changes were observed in TSS (19.0%) when stored at 18 to 34°C.

The results of this study further indicate that increasing time and temperature decrease the acidity in stored mangoes. The initial acidity of storing mangoes was recorded as 0.31% which was decreased down to 0.02% at ambient temperature. Whereas refrigerator temperature did not allow decreasing acidity much more except slight decrease and this may be due to storage conditions. These suggestions are also supported by Srinivasa et al. (2002), who reported that acidity values of Alphonso mango either packed in carton or control sample also showed a decreasing trend from 2.17 to 0.08% on the 12$^{th}$ day when stored at ambient temperature 27 ± 1°C with 65% RH. Similar changes were also reported by Kudachikar et al. (2001) in Neelum mango where pH and acidity decreased from 4.2 to 3.0 and 1.9 to 0.05%, respectively during storage.

The highest total sugar (10.31%) was determined in mango fruit stored at refrigerator temperature for 19 days followed by 14 and 7 days in decreasing order. Results indicate that sugars in stored fruits could be increased during storage; however, increase of sugars may be rapid at high temperature than low temperature. Besides, non-reducing sugar was more increased than reducing sugars. Similar trend of increase in total sugar content during storage at ambient temperature and slight decrease during low temperature was observed by Baldwin et al. (1991). They reported that total sugar content of tomatoes was higher in tomatoes stored in evaporative (at room) storage. This could be associated with the

higher rates of hydrolysis of higher molecule sugar under ambient temperature which is in agreement with the results of Koksal (1989). This indicates that lowering the storage temperature reduces respiration, while high storage temperature hastens the senescence of fruit. Wang (1989) suggested that low temperature storage is the most effective method for preserving the chemical composition of most perishable horticultural commodities because it retards respiration and delays ripening, besides imposing other undesirable metabolic changes

Finally, the initial value of fat content in mangoes sample was determined as 0.83%. However, during storage, fat contents were decreased gradually and more decrease was observed in mangoes stored at ambient temperature. Furthermore, with the increase of storage time, more decrease in fat content was observed. This observation was supported by Rattanaporn et al. (2005) who reported slight changes in proximate chemical composition such as protein and crude fats during 5 months storage. Moreover, regarding ash content, there was no significant decrease or increase during storage of mangoes except a slight increase. For instance, in the initial stage, the ash content in mango sample was observed to be 0.16% and this remained the same even after 19 days storage at refrigerator temperature. Hence, it is stated that there was not a considerable increase or decrease in ash content. Ash is the inorganic residue remaining after the water and organic matter and could not be decreased during storage (Jain et al., 1992; Nielsen, 1998). The data indicates that the results are statistically highly significant at 1% level of significance ($P<0.01$).

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