

JUJUBE (*ZIZYPHUS JUJUBA*) VARIETAL RESPONSE TO PACKING MATERIALS AND SUBSEQUENT FRUIT PHYSICO-CHEMICAL CHARACTERISTICS

Muhammad Waseem Kalroo¹, Muhammad Siddique Deepar¹, Behari Lal Meghwar¹, Ali Sher Chandio¹, Attaullah Khan Pathan¹, Amir Muhammad Laghari¹, and Hamz Ali Samoon¹

¹Arid Zone Research Institute, (PARC), Umerkot, Pakistan

Corresponding Author: Muhammad Siddique Deepar

Arid Zone Research Institute, (PARC), Umerkot, Pakistan. Cell. No. +92-300-3075841,

e-mail: msdepar@yahoo.com

ABSTRACT: To examine the effect of different packing materials on the physico-chemical properties of jujube varieties, their fruits were obtained and stored at the store house of Arid Zone Research Institute, Umerkot while fruit samples of different stages were analyzed from the laboratory of Institute of Food Sciences and Technology, Sindh Agriculture University Tandojam during the 2013. Results indicated that the moisture of fruits packed in wooden crates was decreased from 83.08 to 79.10 %, pH was increased 5.22 to 5.85; fruit weight 38.65 to 29.66 g, TSS 11.08 to 8.99% and specific gravity decreased from 0.92 to 0.79. The moisture of fruits packed in paper box decreased from 83.26 to 78.11 %, fruit weight 38.16 to 29.79 g, TSS 11.10 to 8.71%, specific gravity 0.92 to 0.80; while pH increased (5.16 to 5.84). Fruit moisture in plastic bags decreased from 83.19 to 81.24 %, fruit weight 38.29 to 31.57 g, TSS 10.85 to 8.07%, specific gravity 0.92 to 0.79 after 6 days storage; pH increased from 5.42 to 5.90. In case of varieties, fruit moisture in Gola Lemai decreased from 84.08 to 80.18%, fruit weight 39.55 to 31.28 g, TSS 11.18 to 8.88%, specific gravity 0.93 to 0.80 and pH increased (5.32 to 5.93). Fruit moisture in Gola White decreased from 82.27 to 78.78 %, fruit weight 37.18 to 29.40 g, TSS 10.84 to 8.30% specific gravity 0.91 to 0.79 but pH increased (5.21 to 5.80), where variety, Gola Lemai proved to be better as compared to Gola White.

Key words: Jujube, *Zizyphus jujube*, packing material, varieties, storage period, physic-chemical characteristics

1. INTRODUCTION

The jujube (*Zizyphus jujuba* Mill.) is originated in China, belongs to the Rhamnaceae family widely cultivated in Pakistan (1). The fruit is a drupe, round to elongate in shape and from cherry to plum in size depending upon cultivar. For two millennia or millenniums Jujube fruits, seeds, leaves, roots etc were utilized as cure of fever (2, 3, 4, 5). The extracted methanol from the fruit protects the liver, suppresses cancer cells from proliferation and creates antioxidant effects (6, 7, 8). A 100 g edible matter of jujube fruit contains 350 calories, protein 7.3 g, fat 1.2 g, fibre 4 g, carbohydrate 84 g, ash 3 g, calcium 130 mg, phosphorus 168mg, iron 3.5mg, sodium 12mg, potassium 1050 mg, vitamins-A 125 mg, thiamine (B₁) 0.1 mg, riboflavin (B₂) 0.18 mg, niacin 2.8 mg and vitamin C 300 mg. Jujube is not only delicious fruit, but also is effective herbal cure. It helps in weight gain, muscular strength and enhances stamina (9). In Pakistan jujube is cultivated in Hyderabad and Khairpur divisions of Sindh province and Multan, Sargodha and Lahore Divisions of Punjab province. Hyderabad is well-known for producing better quality fruit to export. Kheerol, Sanghri, Soofi and White Gola are common varieties, but White Gola is more popular than other varieties (1).

After harvesting of fruits, packaging is a very challenging and important step to reach fresh produce to consumer from grower through long and complicated journey. There are several types of packing materials, such as: Wooden, paper or plastic bags, crates, baskets, cartons, cardboard boxes, baskets, plastic netting and pallets are suitable for managing, transporting, and marketing of fresh produce. A properly designed container protects and identifies the produce also satisfy everyone from grower to consumer (10). Modifications in pectins, organic acids, carbohydrates, proteins, amino acids, and lipids results in softening of fruits and also influence the flavor quality of fruits. Loss in vitamin-C is disadvantage to nutritional quality.

The proper storage is crucial for lengthening the utilization period of fruits, regulating their supply to the market and also

for transportation. The best qualities were observed up to 8 days in mature yellow fruits stored at room temperature in perforated polyethylene bags. Hence, packing materials have significant effect on the post harvest quality and marketing of jujube. Locally, the packaging is prepared from wood, paper, plastic, etc. and the fruits respond to the packaging from these materials differentially (11, 12). Keeping in view the importance of jujube fruits and the trend of consumption in Pakistan, the present research was carried out to determine the effect of packing materials on the fruit physico-chemical characteristics of jujube varieties Gola Lemiae and Gola White at different storage periods.

2. MATERIAL AND METHODS

The fruits were obtained and stored at the store house of Arid Zone Research Institute, Umerkot while fruit samples of different stages were analyzed from the laboratory of Institute of Food Sciences and Technology, Sindh Agriculture University Tandojam. After arrival of fruits, the fruits were cleaned for packing. The yellow coloured fruits of both the jujube varieties were separated and packed in different packing materials.

The samples of jujube fruits were initially washed with distilled water and dried with muslin cloth. The fruits of both the qualities were weighed and each quality was divided into three groups i.e. A, B and C. Fruits in group 'A' were packed in wooden boxes, while the fruits in group 'B' were packed in paper made boxes. Similarly, the fruits of group 'C' were packed in plastic bags. The jujube fruits were examined for their weight at day 1 (fresh) and day 6 after storage. Jujube fruits packed in packaging prepared from different packing materials were stored for storage.

2.1. Methods for quality determinations

2.1.1. Moisture Content: An empty flat-bottomed dish was weighed and the sample was placed in the weighed dish, again the dish was weighed with the sample and then placed in an oven at 70 °C. The dish was removed from oven after 3 hours and weighed after cooled in desiccator for one hour.

The moisture content was computed as per the following formula Talukdar *et. al.* (13):

$$\text{Moisture (\%)} = \frac{\text{Wt. of dish \& sample} - \text{Wt. of dish \& dried sample}}{\text{Wt. of dish \& sample} - \text{Wt. of the empty dish}} \times 100$$

2.1.2. Fruit pH: The pH values were determined by using with pH meter. Pericarp tissue or pulp of fruit was grounded in juicer machine diluted with distilled water and pH was determined.

2.1.3. Fruit Weight: The fruit weight was examined by the means of electronic balance and the reading so obtained in grams for each fruit.

2.1.4. Total Soluble Solids: The total soluble solids (T.S.S) were concluded by the method using hand Refractometer. After cleaning, the equipment was adjusted to zero using distilled water. Then a certain quantity of prepared solution of jujube pulp was dropped on the Prism-plate of the Refractometer and lid was placed over to cover it. The reading for total soluble solids was recorded in brix.

2.1.5. Specific Gravity: Specific gravity of fruit was determined by water displacement method Miano *et. al.* (14). Sample fruit fingers/slices of jujube were washed with distilled water dried and weighed one by one. A cylinder measuring 1000 ml was taken and filled with 500 ml of distilled water, sample jujube fingers/slices were dipped in measuring cylinder. The volume of water was noted and increased up to required quantity. The specific gravity (SG) was calculated by the following formula Tutorvista.com (15):

$$\text{SG} = \frac{\text{Wt. of the substance}}{\text{Wt. of the equal amount of water}}$$

Or

$$\text{SG of jujube} = \frac{\text{Weight of jujube fruit fingers/slices}}{\text{Increased volume of water}}$$

2.2 Statistical analysis:

All proposed parameter were subjected to statistical analysis using analysis of variance to ascertain the significance level of the differences due to treatments, while the LSD test was employed to compare the mean values for each treatment group, following the statistical methods suggested by Gomez and Gomez (16).

3. RESULTS AND DISCUSSION

The climatic conditions of Sindh province are most favourable for jujube production and several varieties are cultivated for production of quality jujube fruits. At farmer level, the quality parameters are well considered and this fruit keeps export potential to earn foreign exchange. Apart from the production quality, the storage facilities are lacking and a major part of this fruit is either locally consumed or wasted in the orchards. The need is to train farmers for proper harvesting time and about the physiological maturity stage. Moreover, post harvest losses need to be diminished using scientific methods to improve the shelf life of the fruit. Mengjun and Liu (17) stated high coefficient of variation for packaging and packing materials, which showed a linear effect on the fruits due to different packing materials, while the physico chemical properties were changed when different packing materials were used for packaging fruits. Hiwale and Raturi (18) also mentioned that the fruits packing response was also varied with different materials such as wooden box and plastic packaging. Singh *et. al.* (19) stated that physico-chemical characters were better in ber fruit when packed in wooden boxes, followed by plastic bags. Feeling the gravity of

the situation, the present study was carried out to examine the effect of different packing materials on the physico-chemical properties of jujube.

3.1. Moisture content (%): The moisture loss decreases the visual quality and contributes to the loss of turgor pressure and subsequent softening Chien *et. al.* (20). A significant effect ($P < 0.05$) of packing materials, varieties as well as storage period on the moisture content of jujube were analyzed. The moisture content in jujube fruits before packing in wooden crates on average was 83.08 percent; while the moisture content in fruits before packing in paper box and plastic bag was 83.26 and 85.19 percent, respectively. However, the differences in moisture content in jujube fruits before packing were statistically non-significant ($P > 0.05$); but significant ($P < 0.05$) between varieties (Table-1).

Regardless the packing material, the moisture content in jujube fruits was significantly reduced after six days of storage under room temperature. The moisture content in fruits packed in wooden crates reduced from 83.08 to 79.10 percent; in fruits packed in paper box reduced from 83.26 to 78.11 percent; while in fruits packed in plastic bag, the moisture content reduced from 85.19 to 81.24 percent after six days of storage under room temperature. Apparently the moisture content was maximally reduced after six days of storage in jujube fruits packed in paper box, while the reduction in moisture content was minimal in fruits packed in plastic bag. Similarly Gupta (21) reported that the moisture of fruits packed in plastic bags was higher than those packed in wooden crate and paper box. Whereas Saini *et. al.* (22) indicated that the use of plastic materials for packing produced better results in relation to physical and chemical properties of the ber fruits.

The moisture content in fruits of variety Gola Lemai reduced from 84.75 percent to 80.51 percent after six days of storage under room temperature; while in Gola white, the moisture content was reduced from 82.93 percent to 79.11 percent. The overall results for storage period indicated that the moisture content on average before packing the jujube fruits was 83.84 percent, which reduced to 79.81 percent after six days of storage under room temperature.

3.2. Fruit pH: The results showed that on average the pH value of jujube fruits before packing in wooden crates was 5.22; while the pH value of fruits before packing in paper box and plastic bag was 5.16 and 5.42, respectively; and the differences in pH value of jujube fruits before packing were statistically significant ($P < 0.05$). This indicates that naturally the jujube fruits may vary significantly for pH, probably due to the variation in maturity status of individual fruits (Table-2).

Irrespective of packing materials, the pH value of jujube fruits was significantly increased after six days of storage under room temperature. The pH value in fruits packed in wooden crates increased from 5.22 to 5.85; pH value of fruits packed in paper box increased from 5.16 to 5.84; while pH value of fruits packed in plastic bag increased from 5.42 to 5.90 after six days of storage under room temperature. The pH value was maximally increased after six days of storage for jujube fruits packed in plastic bag, while the increase in pH value was minimal for fruits packed in wooden crate and paper box. Similarly Gupta (21) found relatively higher pH value when fruits were packed in plastic bags than those packed in wooden crate and paper box.

The results further showed that the pH value of fruits of variety Gola Lemai increased from 5.32 to 5.93 after six days of

storage under room temperature; while in case of jujube variety Gola white, the pH value was increased from 5.21 to 5.80. The results for storage period showed that the pH value on average before packing the jujube fruits was 5.26 which increased to 5.86 after six days of storage under room temperature. Also Ezhilarasi and Tamilmani (23) found that pH slowly rose in peel and pulp of the jujube fruit. This indicates that with development of storage period under room temperature, the pH value of jujube fruits was increased.

3.3. Fruit weight (g): The weight of jujube fruits on average before packing in wooden crates was 38.65 g; while the fruit weight before packing in paper box and plastic bag was 38.16 g and 38.29 g, respectively (Table-3); but the differences in fruit weight of jujube fruits before packing were statistically non-significant ($P>0.05$).

In spite of packing materials, the fruit weight of jujube was significantly decreased after six days of storage under room temperature. The fruit weight packed in **wooden crates decreased from 38.65 g to 29.66 g; weight** of fruits packed in paper box decreased from 38.16 g to 29.79 g; while weight of fruits packed in plastic bag decreased from 38.29 g to 31.57 g after six days of storage under room temperature. The maximum decrease in fruit weight after six days of storage was noted when packed in wooden crate and paper box, while the minimum decrease in fruit weight was observed when packed in plastic bag. Similarly Gupta (21) stated that weight of fruits packed in plastic bags was higher (less reduction in fruit weight) than those packed in wooden crate and paper box. Also Bandyopadhyay and Sen (24) observed that the packaging and packing materials, the fruits stored at room temperature in plastic bags maintained quality optimally almost upto 13 days as compared to other packaging materials. Similarly Zhang and Zhang (25) also mentioned that jujube is responsive to packing materials and fruits packed in plastic bags remained well edible upto 14 days.

In case of varieties, the fruit weight of Gola Lemai was naturally higher than the Gola White and there was a simultaneous decrease in fruit weight after six days of storage. The fruit weight of variety Gola Lemai decreased from 39.55 g to 31.28 g; while in case of variety Gola white, the fruit weight was decreased from 37.18 g to 29.40 g. According to reports of Tembo *et. al.* (26) jujube fruits at intermediate and ambient temperatures production of ethylene and respiration increases and fruit weight decreases.

It was further noted that the fruit weight on average before packing the jujube fruits was 38.37 g which was significantly decreased to 30.34 g after six days of storage under room temperature. This showed that with progression of storage period under room temperature, the fruit weight of jujube was adversely affected.

3.4. Total soluble solids (TSS %): The Total soluble solid is an important quality parameter Kamiloglu (27). The results proved that on average the T.S.S. in jujube fruits before packing in wooden crates was 11.08 percent; while the T.S.S. Content in jujube fruits before packing in paper box and plastic bag was 11.10 and 10.85 percent, respectively; and the differences in T.S.S. content of jujube fruits before packing varied significantly ($P<0.05$).

The T.S.S. in jujube fruits was significantly decreased after six days of storage under room temperature. The T.S.S. in fruits packed in wooden crates decreased from 11.08 to 8.99 percent; fruits packed in paper box deteriorated T.S.S. content from 11.10 g to 8.71 percent; while T.S.S. content in fruits packed in plastic bag decreased from 10.85 to 8.07 percent after six days of storage under room temperature. The maximum decrease in T.S.S. after six days of storage was noted when packed in plastic bag, while minimum decrease in T.S.S. Was noted when packed in a wooden crate and paper box (Table-4). Similarly Gupta (21) showed that fruits stored in wooden crates and paper boxes were decreased less after six days of storage and had higher TSS values than those packed in plastic bags.

In case of varieties, the T.S.S. of Gola Lemai was naturally higher than the Gola White and there was a concurrent decrease in T.S.S. after six days of storage. The T.S.S. of variety Gola Lemai decreased from 11.18 to 8.88 percent; while in case of variety Gola white, the T.S.S. was decreased from 10.84 to 8.30 percent. Whereas Lal and Fageria (28) reported that TSS increases during transportation and up to 3 days of storage and then dwindles on later days of storage.

The average results on the effect of storage period on T.S.S. content in jujube fruits indicated that before packing the T.S.S. content in jujube fruit was 11.01 percent which was markedly decreased to 8.59 percent after six days of storage under room temperature. This showed that with increasing storage of jujube fruits under room temperature, their T.S.S. content is negatively influenced.

3.5. Specific gravity: The specific gravity of jujube fruit before packing in wooden crate, paper box and plastic bag was equally 0.92. Similarly Kishan *et. al.* (12) stated that specific gravity was not significantly affected by treatments. The specific gravity of jujube fruit was markedly reduced after six days of storage under room temperature. The specific gravity of fruit packed in wooden crate decreased from 0.92 to 0.79; specific gravity of fruit packed in paper box decreased from 0.92 to 0.80; while the specific gravity of fruit packed in plastic bag decreased from 0.92 to 0.79 after six days of storage under room temperature. The maximum decrease in specific gravity after six days of storage was noted when packed in wooden crate and plastic bag (Table-5). Gupta (21) also stated same results that fruits packed in wooden crate and plastic box after six days of storage had higher specific gravity than those packed in plastic bags.

In varieties, the specific gravity of Gola Lemai fruit was naturally higher than the Gola White and there was a simultaneous decline in specific gravity with development of storage period. The specific gravity of variety Gola Lemai decreased from 0.93 to 0.80; while in case of variety Gola white, the specific gravity was decreased from 0.91 to 0.79. Specifically for storage period on average, the specific gravity of fruit before packing was 0.92 which was markedly decreased to 0.80 after six days of storage under room temperature.

Table-1, Moisture content (%) of fruits in two jujube varieties as affected by different packing materials

| Packing materials | Before storage | | | After 6 days of storage | | |
|-------------------|-------------------|------------|-----------|-------------------------|------------|---------|
| | Gola Lemai | Gola White | Mean | Gola Lemai | Gola White | Mean |
| Wooden crate | 84.10 | 82.06 | 83.08 b | 79.90 | 78.30 | 79.10 c |
| Paper made box | 84.10 | 82.42 | 83.26 b | 78.90 | 77.32 | 78.11 b |
| Plastic bag | 86.05 | 84.33 | 85.19 a | 81.78 | 80.73 | 81.24 a |
| Mean | 84.75 (a) | 82.93 (b) | 83.84 A | 80.51 (a) | 79.11 (b) | 79.81 B |
| | Packing materials | | Varieties | Storage periods | | |
| S.E.± | 0.3612 | | 0.4424 | 0.3614 | | |
| LSD 0.05 | 0.7491 | | 0.9175 | 0.7493 | | |
| LSD 0.01 | 1.0182 | | 1.2470 | 1.0184 | | |

Table-2, pH value of fruits in two jujube varieties as affected by different packing materials

| Packing materials | Before storage | | | After 6 days of storage | | |
|-------------------|-------------------|------------|-----------|-------------------------|------------|--------|
| | Gola Lemai | Gola White | Mean | Gola Lemai | Gola White | Mean |
| Wooden crate | 5.27 | 5.16 | 5.22 b | 5.91 | 5.80 | 5.85 b |
| Paper made box | 5.21 | 5.11 | 5.16 c | 5.91 | 5.77 | 5.84 b |
| Plastic bag | 5.48 | 5.37 | 5.42 a | 5.96 | 5.84 | 5.90 a |
| Mean | 5.32 (a) | 5.21 (b) | 5.26 B | 5.93 (a) | 5.80 (b) | 5.86 A |
| | Packing materials | | Varieties | Storage periods | | |
| S.E.± | 0.0166 | | 0.0203 | 0.0167 | | |
| LSD 0.05 | 0.0343 | | 0.0421 | 0.0344 | | |
| LSD 0.01 | 0.0647 | | 0.0572 | 0.0469 | | |

Table-3, Fruit weight (g) of two jujube varieties as affected by different packing materials

| Packing materials | Before storage | | | After 6 days of storage | | |
|-------------------|-------------------|------------|-----------|-------------------------|------------|---------|
| | Gola Lemai | Gola White | Mean | Gola Lemai | Gola White | Mean |
| Wooden crate | 39.84 | 37.45 | 38.65 | 30.28 | 28.74 | 29.66 |
| Paper made box | 39.34 | 36.98 | 38.16 | 30.71 | 28.86 | 29.79 |
| Plastic bag | 39.48 | 37.11 | 38.29 | 32.55 | 30.60 | 31.57 |
| Mean | 39.55 (a) | 37.18 (b) | 38.37 A | 31.28 (a) | 29.40 (b) | 30.34 B |
| | Packing materials | | Varieties | Storage periods | | |
| S.E.± | 0.3872 | | 0.4742 | 0.3873 | | |
| LSD 0.05 | 0.8030 | | - | 0.8031 | | |
| LSD 0.01 | 0.0914 | | - | 1.0916 | | |

Table-4, TSS (%) of two jujube varieties as affected by different packing materials

| Packing materials | Before storage | | | After 6 days of storage | | |
|-------------------|-------------------|------------|-----------|-------------------------|------------|--------|
| | Gola Lemai | Gola White | Mean | Gola Lemai | Gola White | Mean |
| Wooden crate | 11.25 | 10.91 | 11.08 a | 9.13 | 8.85 | 8.99 a |
| Paper made box | 11.27 | 10.93 | 11.10 a | 9.34 | 8.09 | 8.71 b |
| Plastic bag | 11.02 | 10.69 | 10.85 b | 8.19 | 7.94 | 8.07 c |
| Mean | 11.18 (a) | 10.84 (b) | 11.01 A | 8.88 (a) | 8.30 (b) | 8.59 B |
| | Packing materials | | Varieties | Storage periods | | |
| S.E.± | 0.0592 | | 0.0725 | 0.0594 | | |
| LSD 0.05 | 0.1228 | | 0.1503 | 0.1229 | | |
| LSD 0.01 | 0.1669 | | 0.2043 | 0.1660 | | |

Table-5, Specific gravity of two jujube varieties as affected by different packing materials

| Packing materials | Before storage | | | After 6 days of storage | | |
|-------------------|-------------------|------------|-----------|-------------------------|------------|--------|
| | Gola Lemai | Gola White | Mean | Gola Lemai | Gola White | Mean |
| Wooden crate | 0.93 | 0.91 | 0.92 a | 0.80 | 0.78 | 0.79 a |
| Paper made box | 0.93 | 0.91 | 0.92 a | 0.81 | 0.80 | 0.80 a |
| Plastic bag | 0.93 | 0.91 | 0.92 a | 0.80 | 0.78 | 0.79 a |
| Mean | 0.93 (a) | 0.91 (b) | 0.92 A | 0.80 (a) | 0.79 (b) | 0.80 B |
| | Packing materials | | Varieties | Storage periods | | |
| S.E.± | 0.0055 | | 0.0068 | 0.0055 | | |
| LSD 0.05 | 0.0115 | | - | 0.0115 | | |
| LSD 0.01 | 0.0156 | | - | 0.0156 | | |

4. CONCLUSIONS

On the basis of results achieved from the present research it was concluded that the moisture, pH and weight of fruits packed in plastic bags was higher than those packed in wooden crate and paper box, but total soluble solids (TSS) and specific gravity was lowest; while on the other hand in wooden crate and plastic box, the fruits after six days of storage had higher TSS and specific gravity than those packed in plastic bags. Among varieties, Gola Lemai proved to be better in all the physico-chemical properties investigated as compared to Gola White.

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