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Influence of Ambient Environmental Conditions on Physical Properties of Stored Kinnow Fruit

Vijay K. Singh, Yadvika, Rajender Kumar, Y. K. Yadav, Sunil Kumar, Nitin Kumar, Arun K. Attkan, Raveena Kargwal, Sushant Bhardwaj, Sachin, Ravi Kumar

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ABSTRACT

The Kinnow fruits were stored at ambient condition for the period of 21 days. The average temperature and relative humidity were 15.8˚C and 75.46 % respectively during storage period in the month of January and Initial moisture content of the Kinnow fruits was 78.52% on wet basis. This study covers, the variation in physical properties of Kinnow i.e. weight loss, bulk density, true density, porosity and spherisity were studied during storage. Weight loss of Kinnow was increased from 8.93% to 33.64%. The bulk density and true density were increased from 583.40 kg/m^3 to 520.10 kg/m^3 and 881.20 kg/m^3 to 862.50 kg/m^3 while the sphericity and porosity were decreased from 0.96 to 0.93 and 33.76% to 39.69% respectively. Weight loss of Kinnow was more influenced as compared to other physical properties over a storage period of time.

Keywords: Relative humidity, Weight loss, Bulk density, Porosity, True density.

INTRODUCTION

Fresh fruits and vegetables form an important and essential component of human diet and are good source of vitamins. Most fruits are consumed raw and most of the vegetables are consumed at the unripe stage with the exception of tomato. Thus quality of fruits and vegetables is of most importance. Kinnow is a variety of citrus fruit cultivated extensively in India. No major differences in the total antioxidant capacity were observed during this period, indicating that storage does not have any deleterious effect on the antioxidant properties of the investigated fruits extract (Hosu *et al.* 2016). The present findings indicate that mandarin can be stored up to four weeks when treated with wax as well as wax with bavistin in the condition with 14˚C - 18˚C temperature and 45% - 73% relative humidity (Rokaya *et al.* 2016). Total aerobic psychrotrophic bacteria and yeast and molds were noticed in all treatments during storage but the growth was not significant in coated fruits at 4˚C. Kinnow fruit can be kept in good quality after coating for four months at 4 ˚C and for 2 months at

Vijay K. Singh* Sunil Kumar, Nitin Kumar, Arun K. Attkan,
Dept. of Processing and Food Engineering

Yadvika, Y. K. Yadav
Dept. of Renewable and Bio-energy Engineering

Raveena Kargwal, Sushant Bhardwaj, Sachin Ravi Kumar
Research Scholar,

Rajender Kumar
Dept. of Basic Engineering, COAE & T, CCSHAU,
Hisar 125004, Haryana, India
Email: vijurss@gmail.com
*Corresponding author

10˚C (Shah *et al.* 2015). The Kinnow fruit is large with 12 to 25 seeds and a globular shape. It matures in January or February. This "easy peel" citrus has assumed special economic importance and export demand due to its high juice content, special flavor and as a rich source of vitamin C. Kinnow has highest content of limonene, a compound which has anti-cancer properties and it also has cholesterol lowering properties. The typical pectin content in kinnow mandarin juice is 0.97% when extracted with a screw type juice extractor (Lotha and Khurdiya 1994). Citrus fruit juice has higher molecular weight compound, 'pectin' which has in the range 100–200 kDa and consist of 150–1500 galacturonic acid units (Bennett 1987). The factors which have contributed to the success of this fruit are its beautiful golden-orange color (a major asset from a marketing viewpoint), abundant juice, excellent aroma and taste. Its trees are highly productive. Returns are much higher than those obtained from most of other fruit crops. Kinnow harvesting starts when the fruits external color becomes orange, from December to February. The best harvesting time is mid-January to mid-February. India ranks second in fruits and vegetables production in world. In India total area under fruit cultivation was 6.3 million hectare and production was 71.51 million tonne. Citrus fruits were grown on 0.9 million hectare with production of 9.6 million tonne. In Haryana fruits were grown on 0.041 million hectare and the production was 0.303 million tonne (Indian Horticulture Database 2010). In India Kinnow is mainly produced in North-West states with highest production in Punjab. In Haryana it is mainly grown in Sirsa, Fatehabad and Hisar districts. Due to lack of proper processing facilities post-harvest losses in Kinnow are 23-30% (Gangwar *et al.* 2007). Kinnow quality starts deteriorating right after harvest if not properly managed. Losses results from insufficient packing house, limited cold chain facilities and slow marketing system. Storage study of Kinnow at ambient temperature will reveal changes in its color, weight, volume during storage. These physical parameters can be used to establish criteria for its use for various processes. Therefore the study was taken to evaluate primary processing plant's performance and storage of Kinnow at ambient temperature. Allowing lower physiological weight loss, reducing decay incidence and maintaining retention of color and texture of fruits during extended shelf life (Sharma *et al*. 2010). In particular, Kinnow peels have a comparatively higher concentration of phenolic compounds and thus have more antioxidant potential than fruit pulps (Deng *et al.* 2012, Goulas and Manganaris 2012, Jabbar 2015). Coating with WPI provided the best protection on ascorbic acid. According to obtained results in the study, coating with SA (sodium alginate) or WPI (whey protein isolate) can be suggested for coating fruit bars (Eyiz *et al.* 2020). The quadratic model based on geometric mean diameter ($R^2 = 0.956$) and ellipsoid volume ($R^2 = 0.955$) are recommended for predicting the mass of ungraded fruits with maximal accuracy (Mahawar *et al.* 2020). The kinnow fruit is grown commercially for fresh consumption and since the processing techniques are less prominent, a plentiful amount of harvested fruit goes for waxing and grading operations. To reduce the post-harvest losses, appropriate processing techniques need to be followed as considerable fruit waste is generated while processing (Mahawar *et al*. 2019).

MATERIALS AND METHODS

Experiments were conducted for storage study of Kinnow at ambient temperature in terms of engineering properties i.e. sphericity, true density (kg/m^3), bulk density (kg/m^3), porosity (%), weight loss (%).

Sphericity

The shape of a food material is usually expressed in terms of its sphericity. It is an important property used in fluid flow and heat and mass transfer calculations. Sphericity was determined using the measured geometric dimensions in the formula (Mohsenin 1970):

$$\text{Sphericity} = \frac{(l \times b \times t)^3}{l}$$

Where, l, b, t are the major, intermediate and minor diameter of fruit.

True density

This is the ratio of mass of sample to its pure volume.

For Kinnow fruit, true density was determined by the water displacement method (Heidarbeigi *et al.* 2008, Abdullah *et al.* 2011). The true density was then calculated as:

$$\rho_T = \frac{M_\alpha}{M_w} \times \rho_w$$

Where, P_T and P_w are fruit and water densities (kg/m^3), M_a is mass of fruit in air, kg and M_w is mass of displaced water, kg.

Bulk density

Bulk density was measured as per the method described by ASAE Standerds 2001. The container was filled full with fruits and the mass of fruits was taken and bulk density was calculated by using the formula:

$$\textit{Bulk density} = \frac{\textit{Mass of fruits (kg)}}{\textit{Volume of container } (m^3)}$$

Porosity

Porosity is a vital physical property that characterizes the amount of air spaces in a bulk. It is needed in modeling and design of various heat and mass transfer processes. It is defined as the volume fraction of air in the bulk sample and is calculated.

$$\textit{Porosity (\%)} = \frac{\textit{True density–Bulk density}}{\textit{True density}} \times 100$$

Weight loss

The weight loss (%) was determined as per following method

$$\textit{Weight loss (\%)} = \frac{\text{Initial weight–Final weight}}{\textit{Initial weight}} \times 100$$

RESULTS AND DISCUSSION

Storage study of Kinnow fruits at ambient temperature was carried out at the Laboratory of fruits and vegetables processing, Department of Processing and Food Engineering, CCSHAU, Hisar. Initial moisture content of the Kinnow fruits was 78.52% on wet basis and it was stored at 15.8˚C temperature and 75.46 % relative humidity. A summary of the determined physical properties i.e. sphericity, true density, bulk density, porosity and weight loss of Kinnow fruits are presented in Table 1.

Effect on sphericity and wet loss of stored Kinnow fruits

It can be seen from Table 1, the sphericity of varied from 0.955 to 0.935 during the storage period. Reduction in sphericity of Kinnow fruits may be loss of weight day to change the spheroid properties of stored Kinnow however the wet loss of Kinnow increase from 8.93 % to 33.64%, it was due to reduction of water from Kinnow fruits during storage period of time over 21 days.

Effect on true and bulk density and porosity of stored Kinnow fruits

Table 1 reveals that the true density of Kinnow fruits were decreased from 881.20 kg/m^3 to 862.20 kg/m^3, it may be because of reduction of water tend to deflection of shape was in Kinnow fruits as compared to weight reduction, similarly the same effects were found in case of bulk density and it was varied from 583.40 kg/m^3 to 520.10 kg/m^3. It can be seen from following summarized table, the porosity of Kinnow fruits increased from 33.79 (%) to 39.68 (%), it was due to change in shape as irregular during the storage period

Table 1. Changes in physical properties of Kinnow fruits at ambient temperature. Storage conditions: Temperature = 15.8˚C, RH= 75.46 %.

Days	Sphericity	Weight loss (%)	True density (kg/m^3)	Bulk density (kg/m^3)	Porosity Porosity
1st	0.955	0.0	881.20	583.40	33.79
5th	0.946	8.93	877.18	568.50	35.19
9th	0.945	17.09	873.10	554.18	36.52
13th	0.940	23.78	869.30	540.71	37.79
17th	0.937	29.93	865.77	529.31	38.86
21st	0.934	33.64	862.20	520.10	39.68

The maximum weight losses of Kinnows 33.64 % at 21st day storage period of time and mass of all fruits decreased during the storage in near about same shape of Kinnow fruits. True density and bulk density decreased during the storage period of time. Porosity increased and higher weight loss was observed during the storage. After complete analysis of all recorded parameters during the 21 days storage period of time, it was found that these changes at ambient storage conditions were mainly due to uncontrolled metabolic and enzymatic activities in fruits. Hence appropriate storage conditions are to be developed to prevent the post-harvest losses.

CONCLUSION

In this study, some physical properties desirable to the design and development of handling and processing equipment of Kinnow fruit was evaluated. The storage study of Kinnow fruits were stored at ambient condition. The average temperature and relative humidity were 15.8˚C and 75.46 % respectively during storage period. The variation in physical properties of Kinnow i.e. moisture content, bulk density, true density, porosity and spherisity were studied during storage. Weight loss of Kinnow was increased from 8.93% to 33.64%. The bulk density and true density were increased from 583.40 kg/m^3 to 520.10 kg/m^3 and 881.20 kg/m^3 to 862.50 kg/m^3 while the sphericity and porosity were decreased from 0.96 to 0.93 and 33.76% to 39.69% respectively.

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