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Effects of combined osmotic drying methods on quality characteristics of orange slice

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ABSTRACT

Orange is a food with high content of healthy nutrients and it has great tradition and economic importance in Valencia. The development of new orange products would be a good way to promote the consumption of this fruit, improving the nutritional health of society. In this way, the osmotic dehydration (OD) has been widely used for conservation and design of new products from fruits. Orange slices have been osmotically dehydrated using as osmotic agents healthy sweeteners sucrose. Tray drying of orange slices was conducted in two stages. In the first stage, osmosis was carried out using three different concentrations of sugar solution (40%,50%,60%) with 1.5% potassium metabisulphite (KMS) at 60^0 c temperature were maintain for 16 hours. The combination of different samples was slightly increased with different storage period. The combined effect of solution temperature, sugar concentration and time of moisture loss was investigated by developing treatment combinations. It was found that relationship exists between moisture loss and solution temperature, sugar concentration and time. The final conditions of osmotic dehydration were determined on the basis of permissible moisture loss in orange slices and were found as 60% sugar solution concentration, 60^0c solution temperature and 16 hour time. The best process temperature was selected on the basis of statistical analysis of quality parameters, namely, rehydration ratio, dehydration ratio, sugar content, carbohydrate content, protein content fat content, ash content vitamin C content acid and sensory quality parameters(color ,texture taste, appearance, overall acceptability) and it was 60^0 C tray drying temperature requiring 16 hour drying time.

Keywords— Orange, osmotic dehydration, tray drying, vacuum drying, drying characteristics, sulphur compounds.

1. INTRODUCTION

The orange (sweet orange) is the fruit of citrus species Citrus sinensis in the family Rutaceae. The fruit of the Citrus sinensis is considered a sweet orange, whereas the fruit of the Citrus aurantium is considered a bitter orange. The orange is a hybrid between pomelo (Citrusmaxima) and mandarin (Citrus reticulata). The sub-genus Citrus (Swingle), family Rutaceae and subfamily Aurantioideae is of three types: Citrus, Fortunella (Kumquat) and PoncirusTrifoliata. There are three genera and eighteen defined species, but other natural mutations exist resulting to numerous hybrids which are widely spread throughout the world (Guo and Deng, 2001) During the osmotic dehydration the water and little amounts of natural solutes (vitamin C) are transferred from fruit to the solution and the solute is transferred from the osmotic solution to the fruit in a countercurrent manner Park et al. (2002). Orange was first cultivated in southern china and northern India (Parle milind and Appian F(2010). The fruit of the orange tree can be eaten fresh or processed for its juice or fragrant peel. As of 2012, sweet oranges accounted for approximately 70% of citrus production. Citrus is widely grown in Nigeria and many other tropical and subtropical regions (Kareem et al, 2008) Orange has a long, convoluted history, in part because it is not wild fruit. There are a very few studies on osmotic dehydration of oranges. Osmotic dehydration is the phenomenon of removal of water from lower concentration of solute to higher concentration through semi permeable membrane results in the equilibrium condition in both sides of membrane Osmotic dehydration (OD) is one of most important complementary treatment and food preservation technique in the processing of dehydrated foods, since it presents some benefits such as reducing the damage of heat to the flavor, color, inhibiting the browning of enzymes and decrease the energy costs (Alakali et al, 2006., Torres et al, 2012., Khan, 2012). Osmotic dehydration found wide application in the preservation of food-materials since it lowers the water activity of fruits and vegetables. Osmotic dehydration is preferred over other methods due to their color, aroma, nutritional constituents and flavor compound retention value. In osmotic dehydration, the solutes used are generally sugar syrup with fruit slices or cubes and salt (sodium chloride) or brine with vegetables. This is a multicomponent diffusion process. In this process water flow from fruits or vegetables to the solution and along with water some components of fruits and vegetables such as minerals, vitamins, fruit acids etc. also move

towards a solution. During extended osmotic treatment, the increase of solute concentrations results in the increase in water loss and solid gain rates (AOAC 2012).

2. MATERIAL AND METHOD

The experimental studies were carried out in the Dept. of Food Process Engineering Vaugh School of Agriculture, Technology and Sciences, Allahabad. The methodology adopted has been described under the following heading. Experiment were conduct in two stages to optimize pre-treatment with KMS compounds and preservatives and energy in osmotic dehydration of orange slices by tray drying and vacuum drying process in the first stage osmosis was carried out using three concentration of sugar solution (40% 50% 60%) with 1.5% potassium meta bisulphate (KMS) in osmotic solution at constant temperature 60C°.

In the second stage, slices were exposed for osmosis up to the mentioned time established in the first stage and were then dried to a tray dryer and vacuum dryer at constant temp 60C°.

Osmotic dehydration

Commercial grade sucrose were used as the active osmotic agent. Fifty slices were immersed in 600ml of 40% 50% and 60% sucrose solution placed in a beaker the osmotic treatment took place over a period of 16 h at 22-degree centigrade under constant agitation. Average values from three osmotic treatments were calculated. The water content was determined by drying in a 60C° oven at 100mm Hg until a constant weight was reached (AOAC, 1995).

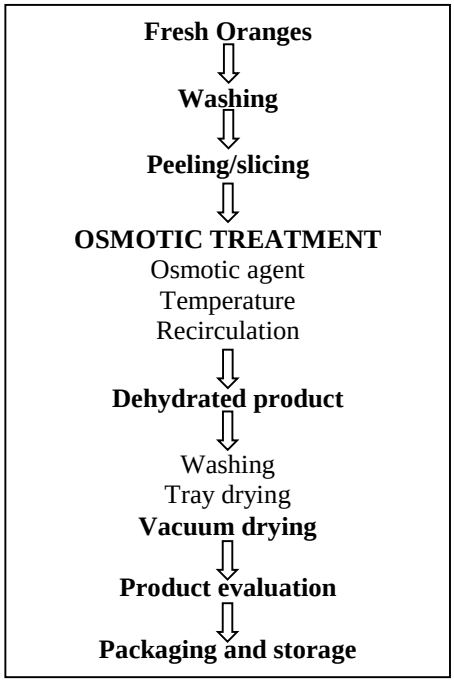

Fig. 1: Osmotic Dehydration

2.1 Rehydration ratio

The sample was cooked in a beaker one part of dehydrated vegetable in 10 parts water for 20 minutes and then allowed it to cool at room temperature. The time taken for cooking was counted from boiling. Then beaker was filtered with No. 4 What man paper with care and inverting the container for 5 minutes. Cooled material was weighed.

Calculation:

$$Rehydration\ ratioo = \frac{\text{Weight of reconstituted sample}}{\text{Weight of dehydrated sample}}$$

Source: Handbook of Analysis and Quality control for Fruit and Vegetable Products S. Ranganna, 1986 Page 978)

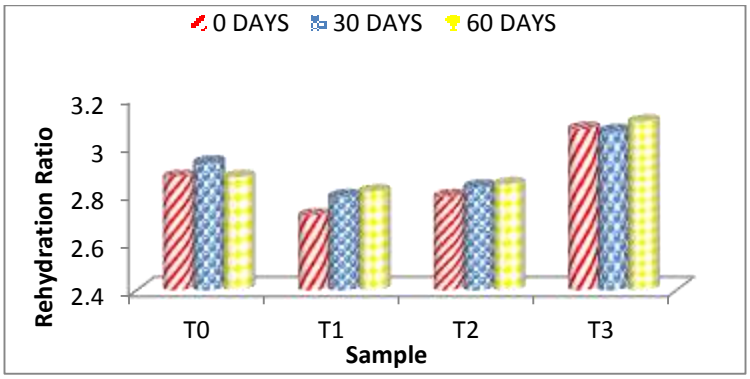

Fig. 1: Rehydration ratio

2.2 Dehydration Ratio

Dehydration ratio was calculated by taking the weights of the sample before drying and the weight of the sample after drying. Higher dehydration displayed at a higher temperature on tray drying& vacuum drying which might be due to the faster drying process that caused less cellular and structural changes in the final product while dehydration was poor in lower temperature. In increased storage condition that was found that dehydration ratio of orange powder was increased as shown in **(table 4.11)** Thus may be due to a long time for drying poor texture of the product& fluctuation in air flow **(Khedkar and Roy 1988)**

Calculation:

$$Rehydration\ ratioo = \frac{\text{Weight of sample before drying}}{\text{Weight of sample after drying}}$$

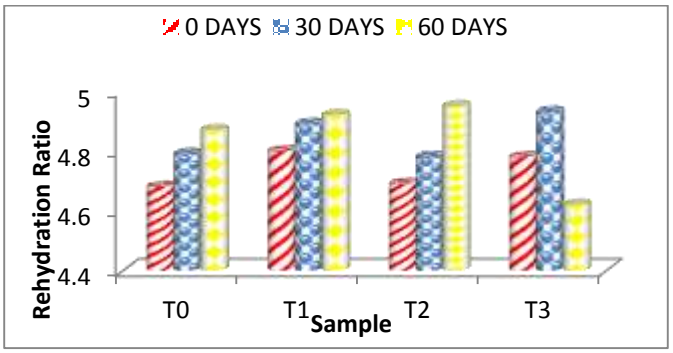

Fig. 2: Dehydration ratio

2.3 Effect of pre-treatment, packaging material, and storage period (LDPE) on the moisture content of dehydrated orange slices

At 60°C air temperature, the initial moisture content of with KMS slices at 0 days moisture content was (T0, T1, T2, T3) 7.29%, 8.20%, 7.19%, 6.90%respectively. orange slices were increased the moisture content after 60days T0,T1,T2,T3 7.59%, 8.35%, 7.42%, 7.07% drying respectively. The moisture content of orange slices was found to increase rapidly during the initial to storage condition. Thus the result was obtained as significant in similar values obtained by Mudgal and Pande (2008).

The lowest moisture content was found for sample T3 (60% osmotic solution). the reason for highest moisture loss can be attributed to using high process temperature level. These findings are in accordance with the finding of (Lazarides et al. 1997 and Ramaswamy 2006)

Analysis of the results showed that an increase in osmotic solution concentration was increased the moisture loss (Lazarides et al. 1995 Khin et al. 2007)

2.4 Effect of Pre-treatment and storage period on the moisture content of orange slices

Effect of Pre-treatment, packaging material, and storage period (LDPE) on ash content of dehydrated orange slices: The ash content (%) of orange increased slightly during the fermentation process as it could be due to the breakdown of complex substances into smaller molecules that is why some minerals became free during that process. But after drying it remained almost constant and its content reduces negligibly as the storage period increases.

On the critical evaluation of the result, it was found that the ash content varied very little during the storage period because the ash content only gives an idea about non-volatile material present in food and undergoes very minimum change and disintegrate during the storage period. The percent score of ash content minimum was found in T1 0days that is 0.23 and maximum ash content was found in T3 in 60 days that is 0.22.

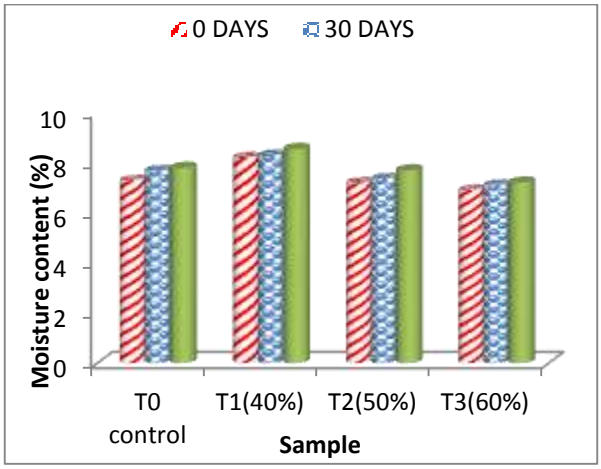

Fig. 3: Moisture content

The main reason for the increase of ash content at higher temperature was due to the loss of moisture content rapidly at higher temperature due to the loss of moisture at higher concentration and hydrolysis of sugar at higher temperature increases the ash content in dehydrated orange slices (Priyanka et al.2003)

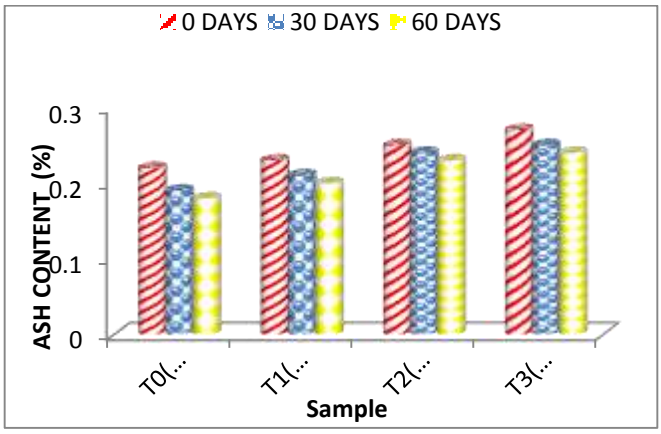

Fig. 4: Effect of Pre-treatment and storage period on ash content of the orange slice

2.5 Effect of Pre-treatment packaging material and storage period on Fat content of orange slices

In this table we can see the fat content experimental sample (T0, T1, T2, T3) at 60 days interval during storage the fat content of experiments (T1 and T3) was found lower than control and T2 found higher than control.

After comparing the value of fat content in all samples after 0 to 60 days it was found the T1 was the best as it contains the maximum amount of fat content.

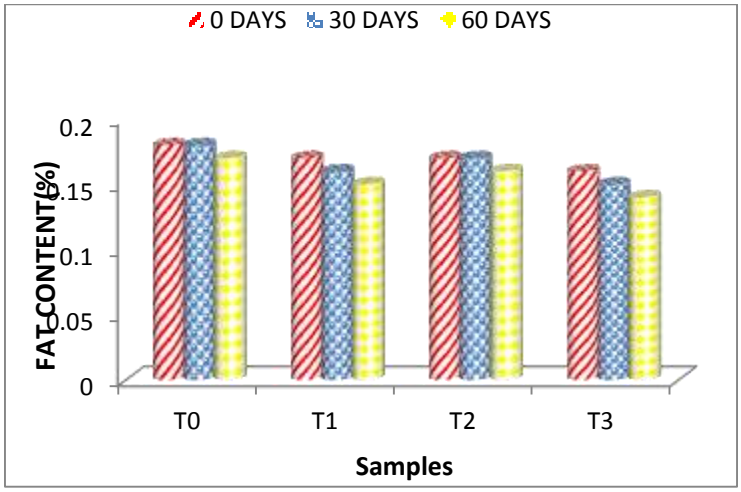

Fig. 5: Effect of Pre-treatment and storage period on Fat content of orange slices

2.6 Effect of pre-treatment and storage period on the protein content of orange slices

Below this table, we can see the protein content experimental sample (T0, T1, T2, T3) at 60 days interval during storage the protein content of experiments (T3, and T2) whereas T0 control sample was found maximum deterioration.

The percent score of the protein content of content of the experimental sample (T0, T1, T2, and T4) after 60 days was found .that was observed there was not found significant variations in 0days (T0, T1, T2, T3) form the storage period of 60 days. In 60 days storage period it was found that T3 was the best as it contains the maximum amount of protein content (Taiwo and Adeyem 2009)

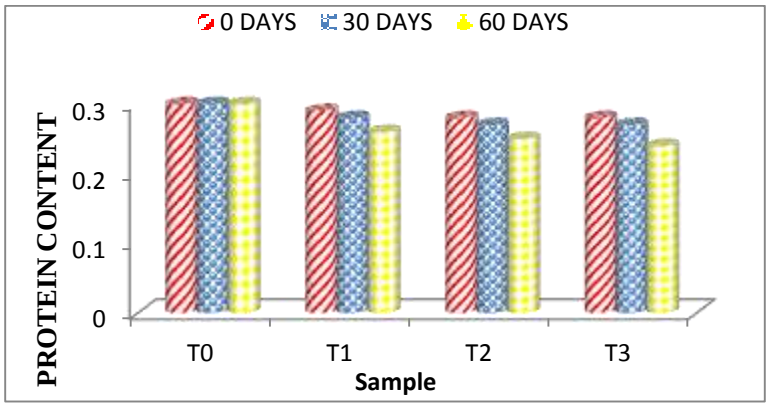

Fig. 6: Effect of Pre-treatment and storage period on the protein content of orange slices

2.7 Effect of pre-treatment, packaging material, and storage period (LDPE) on vitamin C of orange slices

The effect of the storage period, different sucrose strength and different time & temp on vitamin C content of Osmo-dried orange slices packed in LDPE presented in table 4.6. The result showed that the maximum vitamin C content was found in T1. The storage period considerably less vitamin C content was found in T0 sample. Thus the storage period considerably reduced the vitamin C content of orange slices probably due to increase in moisture content with increase in storage period.

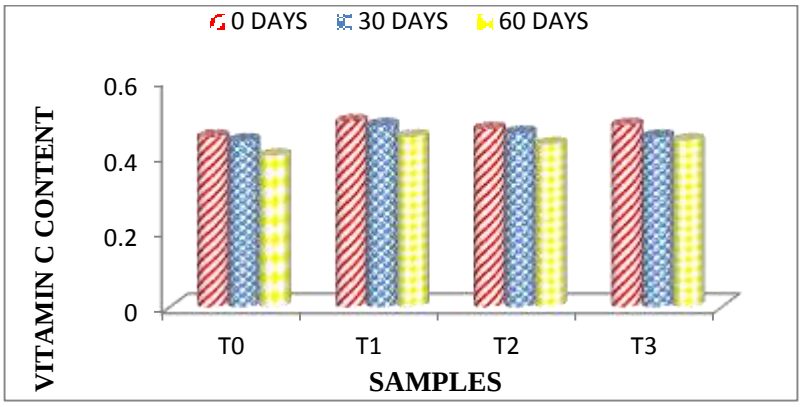

Fig. 7: Effect of pre-treatment, packaging material and storage period on vitamin C of orange slices

2.8 Effect of pre-treatment and storage period on the sugar content of orange slices

The mean score of the sugar varied from 9.42% to 8.78% (Table 4.8). the maximum value of control sample during 60 days was found 9.13%. thus decreased in sugar content might be due to the non-specific hydrolysis of macromolecules, interconversion of sugar and aggregation of monomers at a higher temperature. Reported by Sanjuan et. al (2003)

The reduction of sugar level may be due to the catabolic activities of acid and alkaline invertase enzyme and sucrose (Lavelli et al. 2006 Wyse and Dexter1971) the enzyme can reduce the sucrose content of orange slices by their ability to degraded the sucrose and indirectly by producing invert sugars(Joshi et al.2001). Another reason may be due to microbiological activity levans formation sucrose into invert sugar raffinose and another organic compound may also account for the reduction in sugar level during storage (Wyse and Dexter 1971)

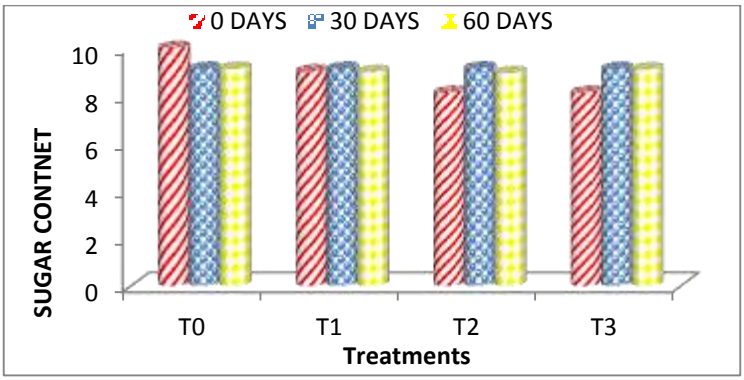

Fig. 8: Effect of Pre-treatment, packaging material, and storage period (LDPE) on the sugar content of orange slices

2.9 Effect of Pre-treatment, packaging material, and storage period (LDPE) on carbohydrate content dehydrated of orange slices

It has been observed that during the storage period from 0 days to 60 days there was very less deterioration in the carbohydrate in control as well as the other treatments (T0, T_1, T_2, and T_3). In 0 day the carbohydrate content of T_0 sample was 90.86% and after 60 days it was decreased to 90.46%. It has been observed that the initial value of all the samples are 90.86%, 89.91%, 90.76% and 90.07% (T0, T_1, T_2, and T_3) and after the storage period of 60 days the carbohydrate content observed was 90.46%, 89.30%, 90.27%, 90.01% (T_0, T_1, T_2, T_3). The results of the ANOVA table for the analysis of carbohydrate content was carried out the level of significance for 60 days of storage period.

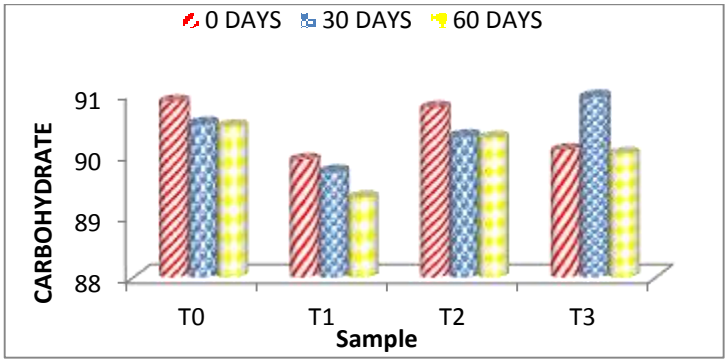

Fig. 9: Effect of Pre-treatment, packaging material and storage period on the carbohydrate content of the orange slice

2.10 Effect of Pre-treatment and storage period on the total energy content of orange slices

Form the below table4.10 It shows the energy value in samples (T0, T_1, T_2, T_3,) samples was observed (377.28 kcal, 375.91 kcal, 377.40 kcal, 379.77 kcal) respectively. Thus the sample T3 having excellent result 379.77 kcal in the storage period of 60 days.

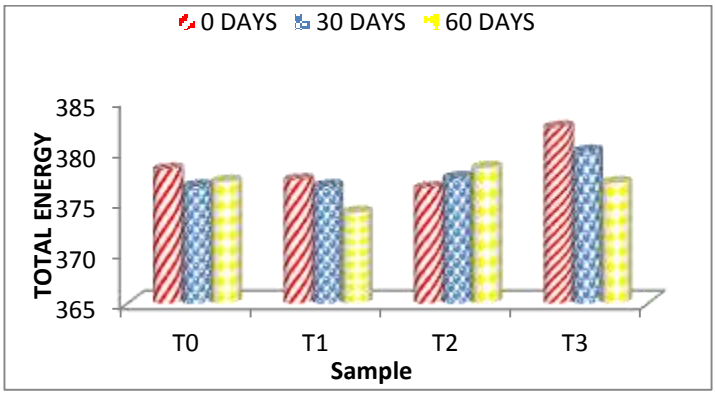

Fig. 10: Effect of Pre-treatment and storage period on the total energy content of orange slices

3. CONCLUSION

The osmosis process can be used for removing almost 46 % of initial moisture at 60ºC temperature using 60% sugar solution and for 16 hours without deteriorating the quality of orange slices. Both the moisture loss and increased non-linearly with duration of osmosis at a given sugar concentration and given solution temperature.

The combined effect of concentration, temperature and time can be described the moisture loss pattern by tray drying for osmotically dehydrated orange slices samples closely at all tray drying temperatures (60ºC).

Osmo-tray drying of orange slices with sulphur compounds treatment is a potential alternate method of dehydration capable of yielding a good quality finished product within 16 hours. The sugar analysis of orange powder using Sulphur compound was found to be maximum as it contains its original form.

The ascorbic acid content of orange powder using sulphur compound was found Ato as it content in its differential varieties proportions and formulations. The ash content of orange slices in this work was found to be in the range of 0.29% and 0.34%. The Optimized result for the best-suited sample of osmotically dehydrated orange slices at 60ºC and at 60% sugar solution for 16 hours is a well dried orange slice under tray drying temperatures.

4. ACKNOWLEDGMENT

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