PREPARATION OF HONEY BASED HERBAL BANANA POWDER BY OSMO-AIR DRYING

***[1]CHOLERA, S. P.; [2]MHASKE, A. D.; [2]SEJANI, V. M. AND [2]NALIAPARA, V.A.**

DEPARTMENT OF PROCESSING AND FOOD ENGINEERING
COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
JUNAGADH AGRICULTURAL UNIVERSITY
JUNAGADH – 362 001, GUJARAT, INDIA

EMAIL: spcholera@jau.in

[1]Assistant Professor, Deptt. of Processing & Food Engineering, CAET, JAU, Junagadh
[2]M.Tech. (Agril. Engg.), Processing and Food Engineering Discipline, CAET, JAU, Junagadh

ABSTRACT

India is the largest producer of banana and ranks first in the banana production in the world during 2013-14. The post harvest losses of banana are estimated to be more than 25 % (in terms of rupees ₹ 7,500 crores). A possible alternative solution to this problem is to prepare the best quality banana powder by modern advanced technique of osmo-air drying to get the combined benefits of these two valuable processes. Osmotic dehydration of 5 mm banana slices was carried out at different osmotic variables, viz., process temperature (30^0, 40^0 and 50 ^{0}C) and immersion time (24, 48 and 72 h), whereas concentration of osmotic solution of 60 ^{0}Brix and sample to solution ratio (1:5) were kept constant throughout the experiment. A novel concept of two osmotic agents i.e., 30 % honey and 60 % sucrose in 1:2 proportions with 5 % NaCl supplemented with natural herbs 1 % cardamom, 1 % ginger powder, 1 % Tulsi powder, 1 % cinnamon powder and 1 % clove powder. These osmotically dehydrated banana slices were dried at 55 ^{0}C temperature and 1.25 m/s velocity using laboratory level tray dryer (till 5 to 6 % (wb)). On the basis of highest values of water loss to solid gain ratio (7.01), the treatment with combination of 60 ^{0}Brix osmotic solution concentration, 30^0C process temperature and 72 h immersion time was found to be the best among all the treatments. Lowest drying time of 16 h was required to reduce the moisture content osmotically dehydrated slices of 61.10 % (wb) to 5.81 % (wb). On the basis of overall quality evaluation of osmo-air dried banana powder, highest water solubility index (71.38 %), highest water absorption index (595.04 %), ascorbic acid content (15.00 mg/100 g), titratable acidity (0.88 %), protein content (4.12 %) and crude fibre content (1.85 %) and sensory score (8.74) were obtained in treatment with combination of 60^0C osmotic solution concentration, 30^0C process temperature and 72 h immersion time, among all the treatments.

KEY WORDS: Banana, osmotic dehydration, osmo-air drying, storage, packaging.

INTRODUCTION

Banana is one of the most consumed fruits in tropical and subtropical regions of Southeast Asia, belongs to family *Musaceae* and class *Liliopsida*. Banana is the fourth largest fruit crop of the world. Banana is cultivated in nearly 120 countries in

the world. India is the largest producer of banana and ranks first in the banana production in the world during the 2012-13 (Deshmukh *et al*., 2013). The total world production of banana is 10.53 million tons in the year 2012-13, and having market value equivalent to ₹ 55,000 crores. The 10 major banana producing countries accounted for more than 80 % of total banana production in the year 2012-13.

According to Chadha (2009), at least 35 to 45 % of production of fruits and vegetables in country is lost due to wastage. The post-harvest losses estimated to the tune of ₹ 40,000 crores per annum. This huge wastage of valuable horticultural commodities can be checked successfully, if they are processed into different value added products. Though India is the largest producer of banana, but the processing of banana is less than 2 % and the post harvest losses of banana are estimated to be more than 25 %. As banana is available throughout the year in tropical countries, like India, there is a vast need to utilize for proper processing techniques. It could be processed into different value added products like powder, chips, wine and fig, etc. (Srivastava and Kumar, 2002).

Banana fruit is having high initial moisture content of about 72 to 77 % (wb), there are more chances of the fruit getting spoiled or deteriorated. Also, banana is a highly perishable fruit, it has comparative short shelf life and marketing of fresh fruits to different places is very difficult. Therefore, it is necessary to convert it into value added products which retain its colour, flavour and nutrients with longer shelf life. So to increase the shelf life of banana, the fruit is converted into various processed products like powder, dried slices, pulp, juice, RTS, beverages, etc. Banana powder is used in cake, bread, cookies, baby food, ice-cream, flavoured milk, shrikhand, chocolates etc.

A possible alternative solution to this problem is the storage and the transport in powder form. Banana powder by osmo-air drying is a very interesting alternative to recompose the fruit with practically all the properties of the natural product. Preparation of good quality banana powder by using sucrose and honey as an osmotic agents supplemented with the natural herbs cardamom, ginger powder, cinnamon, Tulsi is the novel concept because of the final product will get the nutritional benefits of these osmotic agents and ingredients. Osmotic dehydration prior to hot air drying will retains the colour, flavour, aroma, texture and taste in the final product. Osmotic dehydration prior to hot air drying will also reduce the moisture content, drying time and energy consumption. Subsequent hot air drying will give the dried product of an excellent quality. Osmo-air dried banana powder will maintain nutrients, colour, flavour, and texture often indistinguishable from the original product.

A process for the osmo-air drying of banana fruit was developed. The best operational condition has been identified, so that high performance was achieved both in terms of operation time and quality of the osmo-air dried banana powder. Finally, the osmo-air dried banana powder was packed by vacuum packaging in a different flexible plastic material to extend the shelf life of the products as well as to prevents the deterioration of the product by micro-organism, bacteria, yeast, etc. during the long term storage.

MATERIALS AND METHODS

The fresh banana fruits of *Grand Naine* variety were procured

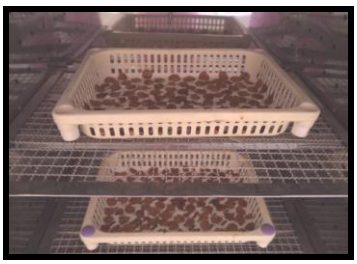
from wholesaler fruits market of Junagadh city for the experimental work. Physical characteristics of fresh banana fruits, *viz*., fruit weight, pulp to peel ratio and fruit hardness (Table 1) were determined. The biochemical characteristics of fresh banana fruits, *viz*., total soluble solids (TSS), ascorbic acid, titratable acidity, protein content, crude fibre content and total sugar (Table 2) were also determined.

Osmotic dehydration of banana slices

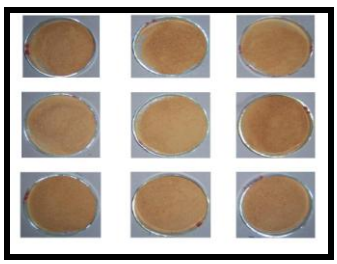
A novel concept of two osmotic agents i.e., 30 % honey and 60 % sucrose in 1:2 proportions with 5 % NaCl supplemented with natural herbs 1 % cardamom, 1 % ginger powder, 1 % Tulsi powder, 1 % cinnamon powder and 1 % clove powder. Diffusion of these natural herbs in banana slice during osmosis improves its taste, quality as well as increases shelf life of the banana powder during storage.

Osmotic dehydration of 5 mm banana slices was carried out at different osmotic variables, *viz*., process temperature (30^0, 40^0 and 50^0C) and immersion time (24, 48 and 72 h), whereas concentration of osmotic solution of 60 ^{0}Brix and sample to solution ratio (1:5) were kept constant throughout the experiment. The observations of different osmotic characteristics, *viz*., solid gain (SG), water loss (WL), water loss to solid gain ratio (WL/SG), weight loss and moisture content of banana slices during osmotic dehydration were recorded. The results of osmotic dehydration of banana slices were statistically analyzed by following Completely Randomized Design (Factorial) with four replications at 0.05 per cent level of significance.

Osmotic dehydration of banana



Osmo-air drying of banana slices



Osmo-air dried of banana powder

Osmo-air drying of banana slices

The samples of osmotically dehydrated banana slices (5mm) obtained by different combinations of osmotic solution concentration (60^0 Brix), process temperature (30^0, 40^0 and 50^0 C), immersion time (24, 48 and 72 h) and sample to solution ratio (1:5) were dried at 55^0C drying air temperature and 1.25 m/s air velocity using laboratory level tray dryer. The moisture content of osmotically dehydrated banana slices during hot air drying was measured by weighing the banana slice samples at the interval of 1 hour. The drying of banana slices was continued till it attains desired moisture contents, i.e., 5 to 6 % (wb).

The quality evaluation of the osmo-air dried banana powder prepared by 9 different treatments was carried out on the basis of physical, biochemical and sensory characteristics. The physical characteristics of osmo-air dried powder, *viz*., recovery, water solubility index (WSI) and water absorption index (WAI) were determined. The biochemical characteristics of osmo-air dried powder, *viz*., ascorbic acid, titratable acidity, protein content, crude fibre content and total sugar were also

determined.. Also, sensory characteristic of osmo-air dried powder in terms of colour, flavour, taste, odour and overall acceptability were determined.

Finally, the high value osmo-air dried powder prepared by different treatments was light dark creamy colour, excellent in fragrance, and highly hygroscopic in nature. The excellent sensory and nutritive characteristics of prepared osmo-air dried powder was due to diffusion of herbs, *viz*., honey, cardamom powder, ginger powder, Tulsi powder, cinnamon powder, and clove powder.

The best quality banana powder was evaluated by analyzing all the physical, bio-chemical and organoleptic quality parameters. The treatment producing best quality powder among all the 9 treatments was selected for packaging and storage studies. Osmo-air drying of banana slices was carried out considering Completely Randomized Design (Factorial) with four replications at 0.05 per cent level of significance. Finally, the best quality powder due to its excellent physical, biochemical and sensory characteristics, it could be used as a better alternative to baby food powder.

RESULTS AND DISCUSSIONS

The physical properties of fresh banana fruits like fruit weight, maximum and minimum diameter of whole fruit, pulp to peel ratio and hardness of fresh banana fruits are reported in Table 1. Also, the biochemical parameters of fresh banana fruits like total soluble solids (TSS), total sugar, ascorbic acid, titratable acidity, crude fibre content and protein content were determined as reported in Table 2.

Osmotic dehydration of banana slices

The observations of different osmotic characteristics *viz*., solid gain (SG), water loss (WL), water loss to solid gain ratio (WL/SG), weight loss and moisture content of banana slices during osmotic dehydration were recorded. Treatment wise analyzed data are given in Table 3. The mean values of different osmotic characteristics are reported in Table 4.

The highest values of solid gain (7.53 %), water loss (38.97 %) and weight loss (31.44 %) of banana slices were obtained in treatment with combination of 60^0Brix osmotic solution concentration, 50 ^{0}C process temperature and 72 h immersion time during osmotic dehydration, whereas the lowest values of solid gain (4.45 %), water loss (26.47 %) and weight loss (22.02 %) were obtained in banana slices in treatment with combination of 60^0Brix osmotic solution concentration, 30^0C process temperature and 24 h immersion time during osmotic dehydration This indicated that the solid gain, water loss and weight loss of banana slices was increased with the increase in process temperature and immersion time during its osmotic dehydration. The increase of solid gain, water loss and weight loss in the banana slices with increase in process temperature (T) and immersion time (I) during osmosis may be due to the increase in pressure gradient of osmotic solution which may accelerate the mass transfer process of water and solid diffusion (Table 3). The influence of process temperature may be attributed to decrease in the external resistance to mass transport from the surface of banana slices and also decreased in viscosity of osmotic medium and facilitating the outflow of water through cellular membranes structure of banana slices favoured when slice-solution contact time was extended.

It was observed that (Table 3, Table 4) the highest values of water

loss to solid gain was 7.01 % obtained in treatment O_3 (30^0C process temperature + 72 h immersion time), whereas lowest of 5.16 % in treatment O_6 (40 ^{0}C process temperature + 72 h immersion time). The ratio of water loss to solid gain is the indication of an efficient process, as process of osmotic dehydration always aims to minimum uptake of solid (sugar) with maximum release of water. So, high value of water loss to solid gain indicated that there was intensive water removal from the banana slices accompanied with minimal solid gain.

The results of similar pattern for different osmotic characteristics were reported by Kumar and Sagar (2009) for mango slices, Kumar and Devi (2011) for pineapple slices and Jadav (2012) for gooseberry segments. The results were also in accordance with that reported by Azoubel and Murr (2003) for osmotic dehydration of cashew apple using sucrose and corn syrup as an osmotic agent. The results were also in close agreement with Kshirsagar (2006) for osmotic dehydration of sapota slices under different osmotic variables for 5 mm thick sapota slices.

Osmo-air drying of banana slices

The initial values of moisture contents after osmotic dehydration of banana slices before loading into the cabinet dryer are graphically represented in Figure 1. Also, the osmo-air drying time and values of drying constant obtained to reduce the initial moisture contents to 5 to 6 % (wb) for different treatments are also graphically represented in Figure 2 and Figure 3.

The moisture content and drying rate of osmotically dehydrated banana slices decreased with increase in drying time for all the treatments. The rate of moisture removal was decreased with increase in drying time for all the treatments. It was also observed that drying of osmosed banana slices for all the treatments was done in falling rate period. It became constant at the later stage of drying of banana slices (i.e., constant rate period).

It can be clearly seen from Figure 1 and 2 that the higher drying time was required for banana slices having higher moisture content after osmotic dehydration. Highest drying time of 24 h required to reduce the moisture content of 61.10 % (wb) to 5.63 % (wb) for treatment O_1 (30^0C process temperature + 24 h immersion time), whereas lowest drying time of 16 h required to reduce the moisture content of 51.10 % (wb) to 5.09 % (wb) for treatment O_9 (50 ^{0}C process temperature + 72 h immersion time).

The highest value of drying constant (k) of 0.35 h^{-1} was obtained in treatment with combination of 60^0Brix osmotic solution concentration, 50^0C process temperature and 72 h immersion time, whereas lowest value of drying constant (k) of 0.21 h^{-1} was obtained in treatment with combination of 60 ^{0}Brix osmotic solution concentration, 30 ^{0}C process temperature and 24 h immersion time (Fig. 3).

Quality evaluation of osmo-air dried banana powder of different treatments

The high value osmo-air dried powder prepared by different treatments was light dark creamy colour, excellent in fragrance and highly hygroscopic in nature. The quality evaluation of osmo-air dried banana powder was carried out on the basis of physical, biochemical and organoleptic parameters as described hereunder in following sub sections. It was observed (Table 5) that the physical parameters of osmo-air dried banana powder, highest water

solubility index (71.38 %), highest water absorption index (595.04 %) as well as reasonable recovery of powder (27.85 %) were obtained in treatment with combination of 60^0C osmotic solution concentration, 30^0C process temperature and 72 h immersion time, among all the treatments.

It was also noticed (Table 5) that highest retention of ascorbic acid content (15.00 mg/100 g), titratable acidity (0.88 %), protein content (4.12 %) and crude fibre content (1.85 %) were obtained in treatment with combination of 60 ^{0}C osmotic solution concentration, 30^0C process temperature and 72 h immersion time, among all the treatments.

The sensory characteristics of the osmo-air dried banana powder were evaluated in terms of colour, flavour, taste, odour and overall acceptability as per the 9 point hedonic taste. On the basis of highest sensory score of 8.74 in terms of colour, flavour, taste, odour, and overall acceptability of osmo-air dried banana powder was obtained in treatment with combination of 60^0C osmotic solution concentration, 30 ^{0}C process temperature and 72 h immersion time, among all the treatments, it might be attributed to highest retention of physical, biochemical parameters as well as highest value of water loss to solid gain during the osmotic process.

CONCLUSION

From the above results and discussion, it can be concluded that on the basis of highest values of water loss to solid gain ratio (7.01), the treatment with combination of 60^0Brix osmotic solution concentration, 30^0C process temperature and 72 h immersion time was found to be the best among all the treatments. The highest drying time of 24 h was required to reduce the moisture content of 51.10 % (wb) to 5.09 % (wb), whereas lowest drying time of 16 h was required to reduce the moisture content of 61.10 % (wb) to 5.81 % (wb). This might be attributed to higher the moisture content of banana slices resulted into the higher drying time and vice versa. Finally, considering the osmo-air drying study, it could be concluded that treatment with combination of 60^0C osmotic solution concentration, 30^0C process temperature and 72 h immersion time was found to be the best among all the treatments on the basis of physical, biochemical and sensory characteristics of osmo-air dried banana powder.

REFERENCES

Azoubel, P. M. and Murr, F. E. X. (2003). Optimisation of osmotic dehydration of cashew apple (*Anacardium occidentale L.*) in sugar solutions. *Food Sci. Tech. Int.*, **9**(6): 427-433.

Chadha, K. L. (2009). Handbook of Horti. IARI Publications, New Delhi.

Deshmukh, D. S.; Bornare, P. P. and Anawade, P. (2013). Constraints in banana marketing and scope of improvement: a case study for Jalgaon region. *Pratibha: Int. J. Sci. Spirituality, Business, Technol.*, 2(1):74-78.

Jadav, S. D. (2012). Preparation of honey based herbal candy from Indian gooseberry. M. Tech. thesis (Unpublished) submitted to Junagadh Agricultural University, Junagadh

Kshirsagar, V. A. 2006. Studies on osmotic air drying characteristics of sapota slices. M. Tech. thesis (Unpublished) submitted to

Junagadh Agricultural University, Junagadh

Kumar, P. and Devi, P. (2011). Optimization of some process variables in mass transfer kinetics of osmotic dehydration of pineapple slices. *Int. Food Res. J.*, **18**: 221-238.

Kumar, P. S. and Sagar, V. R. (2009). Influence of packaging materials and storage temperature on quality of osmo-vac dehydrated aonla segments. *J. Food Sci. Tech*., **46**(3): 259-262.

Srivastava, R. P. and Kumar, S. (2002). Fruit and Vegetable Preservation: Principles and Practices. 3rd Edn., Army Printing Press, Lucknow, India, pp: 11–20.

Table 1: Physical properties of fresh banana fruits

Sample Numbers	Fruit Weight (g)	Pulp to Peel Ratio	Hardness (N/mm^2)
1	125.38	2.21	3.82
2	126.12	2.29	4.11
3	126.32	2.24	3.90
4	125.94	2.27	3.87
5	123.88	2.18	3.92
Mean	125.52	2.24	3.90
SD	0.88	0.04	0.09

Table 2: Biochemical parameters of fresh banana fruits

Sample Numbers	Total Soluble Solids (^0B)	Titratable Acidity (%)	Ascorbic Acid (mg/100 g)	Crude Fiber Content (%)	Protein Content (%)	Total Sugar (%)
1	20.08	0.56	11.25	1.77	1.89	18.93
2	19.74	0.48	11.15	1.89	2.07	20.04
3	20.60	0.38	11.38	1.91	1.93	17.88
4	20.25	0.55	11.57	1.84	2.00	19.12
5	19.88	0.51	11.53	1.87	2.09	20.23
Mean	20.11	0.50	11.37	1.85	1.99	19.24
SD	0.34	0.06	0.18	0.04	0.09	0.84

Table 3:Statistically analyzed data on effect of osmosis on osmotic characteristics of banana slices

Treatments	Solid Gain (%)	Water Loss (%)	WL/SG Ratio	Water Loss (%)	Moisture Content (%) (wb)
Process temperature (T)					
T_1 (30 ^{0}C)	4.81	29.83	6.19	25.02	58.60
T_2 (40 ^{0}C)	5.09	32.68	6.44	27.60	56.80
T_3 (50 ^{0}C)	6.37	35.81	5.78	29.45	53.90
S.Em.±	0.350	0.346	0.063	0.201	0.003
C.D. at 5%	1.016	1.004	0.182	0.582	0.008
Immersion time (I)					
I_1 (24 h)	4.59	29.83	6.48	25.240	59.20
I_2 (48 h)	5.46	32.36	6.03	26.898	56.20
I_3 (72 h)	6.21	36.13	5.89	29.928	54.00
S.Em.±	0.350	0.346	0.063	0.201	0.003
C.D. at 5%	1.016	1.004	0.182	0.582	0.008
T X I					
S.Em.±	0.023	0.599	0.109	0.347	0.005
C.D. at 5%	0.067	NS	0.315	1.008	NS
C.V.%	0.86	3.66	3.54	2.54	1.62

Table 4: Mean values of osmotic characteristics of banana slices during osmotic dehydration

Treatments	Solid Gain (%)	Water Loss (%)	WL/SG Ratio	Water Loss (%)	Moisture Content (%) (wb)
O_1 (T_1I_1)	4.45	26.47	5.944	21.53	61.10
O_2 (T_1I_2)	4.61	30.00	6.510	24.03	59.13
O_3 (T_1I_3)	4.71	33.01	7.006	26.21	57.33
O_4 (T_2I_1)	4.67	29.32	6.279	25.70	58.63
O_5 (T_2I_2)	4.84	32.29	6.666	24.95	56.80
O_6 (T_2I_3)	6.87	35.47	5.164	27.60	53.27
O_7 (T_3I_1)	5.29	33.69	6.366	24.17	56.30
O_8 (T_3I_2)	5.80	35.75	6.159	26.31	54.60
O_9 (T_3I_3)	7.53	38.97	5.177	27.32	51.10

Process temperature T_1 = 30 ^{0}C, T_2 = 40 ^{0}C, T_3 = 50 ^{0}C and Immersion time I_1 = 24 h, I_2 = 48 h, I_3 = 72 h,

Table 5: Mean values of physico-chemical parameters of osmo-air dried banana powder prepared by different osmo-air drying treatments.

Sr. No.	Treatments	Recovery (%)	WAI (%)	WSI (%)	Ascorbic Acid (mg/100g)	Titratable Acidity (%)	Crude Fibre (%)	Total Sugar (%)	Protein Content (%)
1	O_1(T_1I_1)	24.35	545.84	68.23	13.00	0.83	1.74	28.84	3.75
2	O_2(T_1I_2)	26.11	573.04	71.63	14.34	0.85	1.79	35.41	3.84
3	O_3(T_1I_3)	27.85	595.04	74.38	15.00	0.88	1.85	40.69	4.12
4	O_4(T_2I_1)	24.47	530.80	66.35	12.39	0.82	1.72	30.71	3.70
5	O_5(T_2I_2)	26.55	568.88	71.11	13.69	0.84	1.76	37.67	3.79
6	O_6(T_2I_3)	27.92	576.40	72.05	14.34	0.86	1.81	43.61	3.88
7	O_7(T_3I_1)	24.51	528.00	66.00	12.22	0.79	1.66	33.25	3.57
8	O_8(T_3I_2)	26.70	566.80	70.85	13.56	0.81	1.70	39.84	3.66
9	O_9(T_3I_3)	28.25	570.00	71.25	14.28	0.82	1.72	46.43	3.70

Process temperature T_1 = 30 ^{0}C, T_2 = 40 ^{0}C, T_3 = 50 ^{0}C and Immersion time I_1 = 24 h, I_2 = 48 h, I_3 = 72 h,

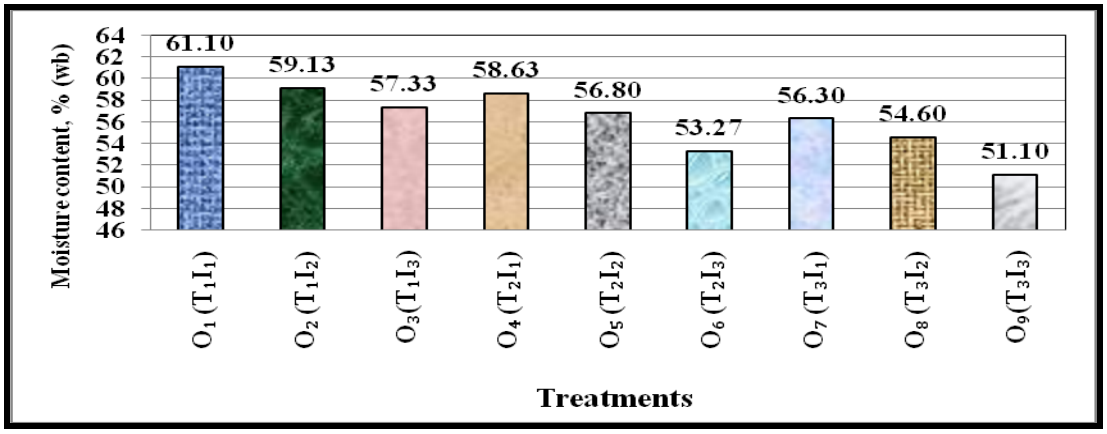


Figure 1: Moisture contents of banana slices after osmotic dehydration for different Treatments

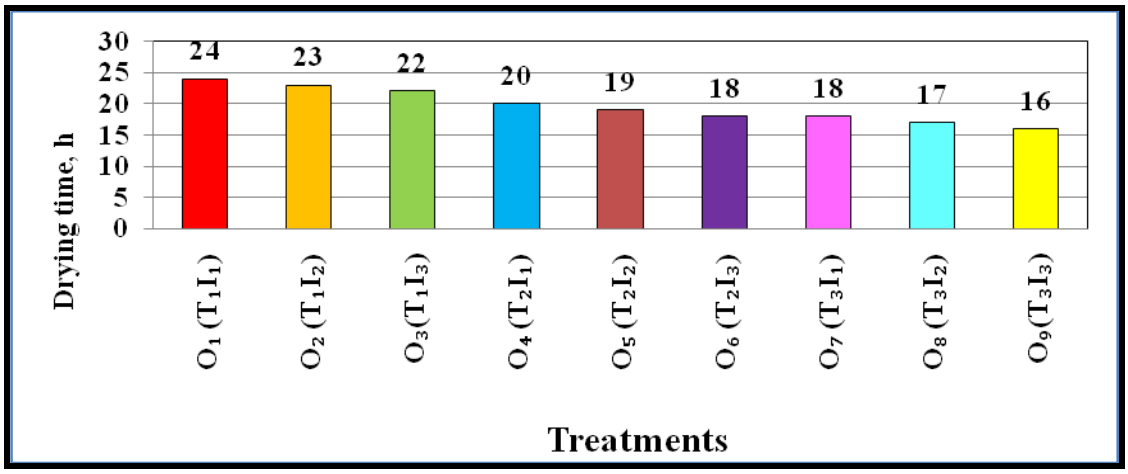


Figure 2: Drying time required for air drying of osmosed banana slices for different treatments

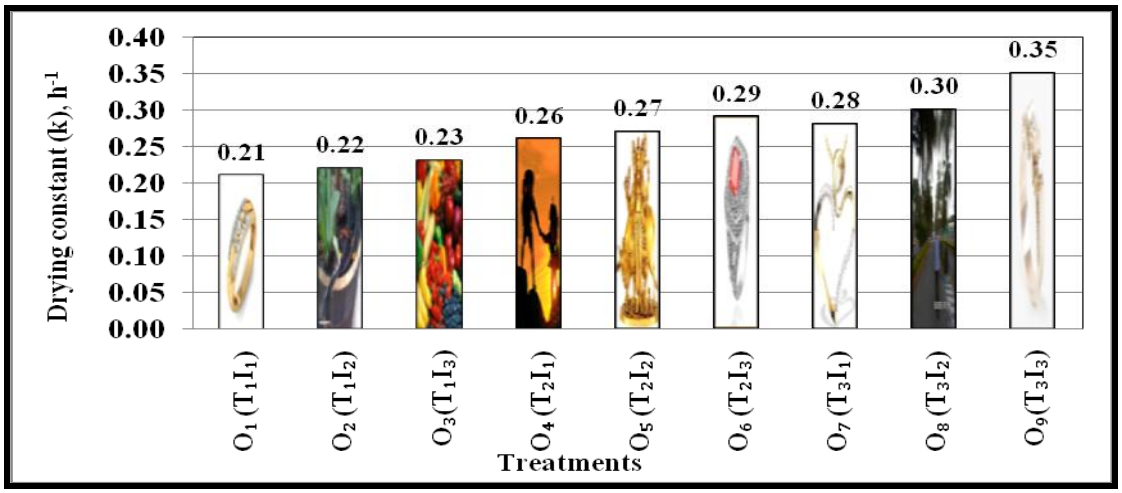


Figure 3: Drying constants of banana slices for different treatments

[MS received: August 22, 2016] *[MS accepted: September 16, 2016]*