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Studies on drying characteristics of onion (variety-*Arka kalyan*) slices using different drying methods

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Abstract

Fresh *Arka kalyan* onion (*Allium cepa* L.) were treated with 10% NaCl for 1 h, 0.2% KMS for 15 min and 10% NaCl+0.2% KMS for 15 min and dried in solar tunnel dryer (STD) and open yard sun drying (OYSD). A comparative study was conducted to evaluate two drying methods with respect to temperature and time combinations. The sample of *Arka kalyan* onion required 17 to 21 h to dry under open yard sun drying and 15 to 17 h in solar tunnel drier to bring down initial moisture content ranging from 545.16-992.90% (d.b.) to final moisture content of 4.95-5.21% (d.b.).

Keywords: *Arka kalyan*, STD and OYSD, *pre-treatment*, *drying*

1. Introduction

Onion is one of major bulb crop grown in India which presently attracting attention of all persons due to rise in prices. Both immature and mature bulbs are used as vegetable and condiment. The onion is the world's leading news publication, offering highly acclaimed, universally revered coverage of breaking national, international and local news events. Onions not only provide flavour, they also provide important nutrients and health-promoting phytochemicals. It contains vitamin B and a trace of vitamin C and also traces of iron and calcium. As a culinary ingredient it adds to the taste and flavour in a wide range of food preparations and it is also used as a salad. Thus there is a steady increase in the demand for onion across the world (Mitra *et al.*, 2012) [5]. The outstanding characteristic of onion is its pungency, which is due to a volatile oil known as allyl-propyl disulphide. Eating raw onions helps to reduce cholesterol levels because they increase levels of high density lipoproteins. Onions help in controlling coronary heart disease, thrombosis and blood pressure (Nuutila *et al.*, 2003) [6].

Onion is one of the important vegetable crops grown in India. The production as well as market value of this potential vegetable is increasing day by day. India produces all three varieties of onion *viz.* red, yellow and white. Globally, the country occupies the second position after China in onion production with a share of around 14% (www.agriexchange.apeda.gov.in). In India, during the year 2009-10, the total area under onion cultivation was around 755 thousand hectares with a production of 12166 thousand tonnes. However, the productivity of onion is highest in Ireland (58 tonnes.ha⁻¹), followed by Korea Republic (57 tonnes.ha⁻¹), USA (55.88 tonnes.ha⁻¹), Spain (52 tonnes.ha⁻¹), Chile (48.50 tonnes.ha⁻¹), Australia (49 tonnes.ha⁻¹) while India has a productivity of 13.20 tonnes.ha⁻¹ (www.nhb.gov.in). Although onion is cultivated almost all over the country, the major onion growing states are Andhra Pradesh, Bihar, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu and Uttar Pradesh. These nine states together account for over 90 per cent of both the area and production of onion in the country. Karnataka is one of the leading states in the cultivation of onion next to Maharashtra occupying 20 per cent of area and 18 per cent of the total output of onion in the country.

The onions are perishable commodity and cannot be stored for a long time after harvest in an ordinary condition. Dehydration is simply, effective and economical for preserving the onions during seasons of abundance and using them during off seasons. Dehydrated Onions have been produced in small quantities since the nineteenth century. Dehydrated onions are a great food storage item. They are cheap to pack compared with canned goods. They do not require refrigerated storage as do frozen onions. Dehydrated onions will make your meals easy and delicious. Dried onions can be used just like fresh onions. Easily reconstituted either by adding them to dishes with lots of cooking liquid like soup, stew, chili, etc.

Drying of onion into flakes has scope in Karnataka as it reduces the storage losses and helps in stabilizing the prices. The market potential for dehydrated onion is reasonably high, as the onion products are exported to UK, Canada, Germany, Poland, Finland, Denmark, Australia, etc. Export of dehydrated onion during the year 2008-09 was 16.71 million tonnes worth of Rs. 1816.14 crores (www.msamb.com). Total export of onion from India to the other countries of the world is about 13.7 lakh MT (2006-07). Hence, dehydration technology might fetch good profit for onion growers of Karnataka. This might improve their socio-economic status of the farmers by generating additional employment opportunity in the production catchments.

2. Methodology

The present study on drying of *Arka kalyan* onion was carried out in the solar tunnel dryer of one tonne capacity installed at the Department of Processing and Food Engineering, Raichur. The dryer has tunnel shape made of semi cylindrical metallic (galvanized pipe) structure covered with UV-stabilized transparent thermic polyethylene sheet of 200 micron. Fresh onion (*Allium cepa L.*) of *Arka kalyan* onion was purchased from the local market of Bijapur district of Karnataka. The onions were washed in tap water to remove the soil and dirt adhered to the onion. The onions were pre-treated in selected preservatives and dried in STD and under OYSD. The treatment combinations were laid out in two factorial completely randomized block design with three replications. The details of pre-treatments selected for the investigation are as given below.

P₁ = Untreated

P₂ = 10% NaCl for 1 h

P₃ = 0.2% KMS for 15 min

P₄ = 10% NaCl+0.2% KMS for 15 min

2.1 Drying kinetics of selected onion varieties

In open yard sun drying (OYSD) and in solar tunnel dryer (STD), the ambient temperature was recorded during the drying period. In dehumidified air dryer, 50±1 °C and 15±1% RH, were maintained during the drying period. The weight of dried sample was taken at an interval of 1 h. Reductions in moisture content v/s drying time, drying rate v/s drying time and moisture ratio v/s drying time curves were plotted.

2.1.1 Moisture content

The reduction in moisture content of onion slices was recorded at an interval of one hour during drying process. The moisture content was calculated by using the following equation

$$\text{Moisture content (\%)} = \frac{W_1 - W_2}{W_1} \times 100 \quad \dots (2.1)$$

Where,

W₁ = Initial weight of the sample, g

W₂ = Final weight of the sample, g

2.1.2 Drying rate

The physiological loss in weight of onion was recorded at an interval of one hour during drying process (Saravacos and Charm., 1962)^[13]; (Derya and Mehmet, 2010)^[12]. The drying rate was calculated by using the following equation

$$\text{Drying rate (\% d.b. h}^{-1}\text{)} = \frac{dM}{dt} \quad \dots (2.2)$$

Where,

dM = Difference in moisture content (% d.b.)

dt = Difference in drying time (h)

2.1.3 Moisture ratio

The moisture ratio was calculated by using the following equation

$$\text{Moisture ratio (\% d.b. h}^{-1}\text{)} = \frac{M - M_e}{M_0 - M_e} \quad \dots (2.3)$$

Where,

M = Moisture content at any specified time t (% d.b.)

M_e = Equilibrium moisture content (% d.b.)

M₀ = Initial moisture content (% d.b.)

2.2 Statistical analysis

All the experiments in the study were conducted in triplicate and mean values reported. Factorial completely randomised design (FCRD) was used to analyse the data. After proper analysis, data were accommodated in the tables as per the needs of objectives for interpretation of results. The Microsoft Excel was used for analysis and interpretation. The statistical procedures for agricultural research given by Gomez and Gomez (1984)^[9] were referred. Analyses of variance (ANOVA) were conducted to determine whether significant effect exists on type of drying methods, onion varieties and pre-treatments on the quality of dehydrated onion slices.

3. Results and Discussion

3.1 Effect of pre-treatments on moisture content of *Arka kalyan* onion with different drying methods

The effects of different pre-treatments on moisture content of *Arka kalyan* onion under open yard sun drying method are shown in Fig. 1. Drying required 17-21 h of drying in open yard sun drying to dry the different pre-treated onion samples from moisture content of 545.16-992.90% (d.b.) to a safe storage moisture content of 4.97-5.16% (d.b.). This variation might be due to less ambient air temperature and more relative humidity fluctuations in the atmosphere. Open yard sun drying is widely practiced in tropical countries, but the method is extremely time-consuming, weather dependent and has the problem of contamination, infestation and microbial attack (Ratti and Mujumdar, 1997)^[14]. The present results are in good agreement with Kadam *et al.* (2008)^[3] who reported that the pre-treated onion slices required 19 sunshine hours in green house/solar dryer.

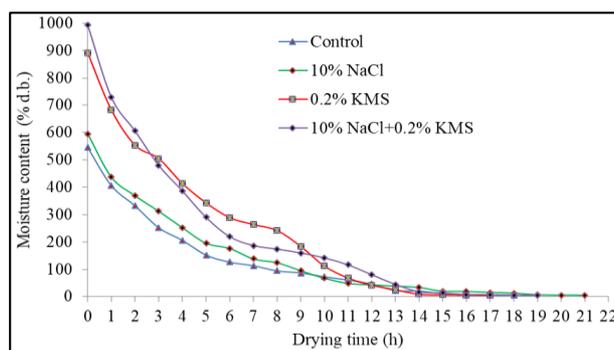


Fig 1: Effect of different pre-treatments on moisture content of *Arka kalyan* (Red) onion dried under open yard sun drying

In case of solar tunnel dryer, the drying required 15-17 h of drying time for various pre-treated onion samples from moisture content of 545.16-774.13% (d.b.) to attain a safe moisture content of 4.95-5.21% (d.b.) as depicted in Fig. 2. This might be due to partial control of temperature and relative humidity in the solar tunnel dryer so that the drying required 15-17 h as compare to open yard sun drying. The present results are in good agreement with Edukondalu and Samuel (2009) [4] who reported that the onion slices required 15 sunshine hours in solar dehydration unit. This difference probably might be due to the different cell arrangements and water activity in the food materials.

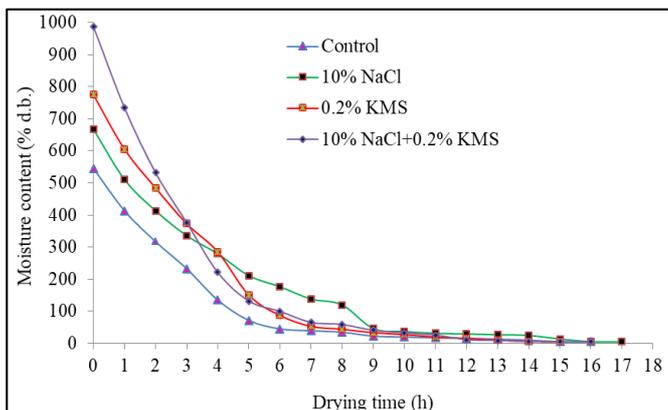


Fig 2: Effect of different pre-treatments on moisture content of *Arka kalyan* (Red) onion dried under solar tunnel dryer

3.2 Effect of pre-treatments on drying rate of *Arka kalyan* onion with different drying methods

The drying rate was calculated as quantity of moisture removed per unit time per unit dry matter. It can be seen that drying process mainly consisted of three drying periods i.e., heating up, constant rate and falling rate period. The per cent moisture loss and drying rate with drying time of *Arka kalyan* onion dried under OYSD and STD with different pre-treatments are presented in Fig. 3 and 4. The drying rate of *Arka kalyan* onion dried under OYSD with pre-treatments 10% NaCl, 0.2% KMS, 10% NaCl+0.2% KMS and untreated (control) was varied from 158.25, 208.00, 263.83 and 139.13% m.c. (d.b.). h^{-1} in the first hour to 0.56, 0.60, 0.60 and 0.26% m.c. (d.b.). h^{-1} , respectively. In OYSD, the drying rate is mainly depends on varying drying temperature and relative humidity. The drying temperature and relative humidity varies with climatic condition. Whereas in STD, the drying rate was varied from 156.13, 169.25, 253.08 and 131.93% m.c. (d.b.). h^{-1} in the first hour to 0.31, 1.23, 0.41 and 0.58% m.c. (d.b.). h^{-1} during the final stage of drying. This variation might be due to more moisture content was lost in less time and the free moisture available in onion was less at later stages as compared to OYSD. Edukondalu and Samuel (2009) [4] who reported that the initial drying rate for the chemically treated samples was fast, there was no significant difference in the drying time. All the samples treated and

control took about 15 h to reach to a final moisture content of $7.0 \pm 0.5\%$ d.b.

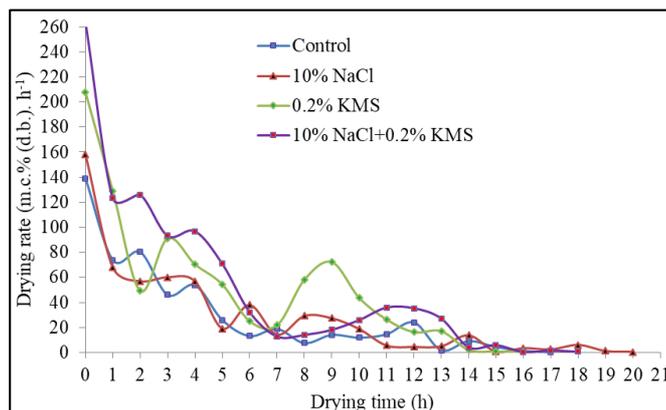


Fig 3: Effect of different pre-treatments on drying rate of *Arka kalyan* (Red) onion dried under open yard sun drying

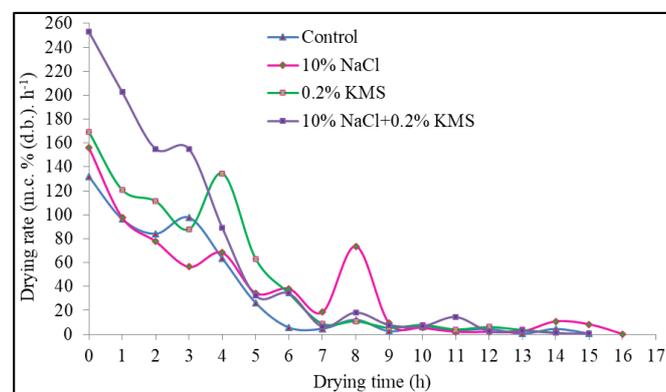


Fig 4: Effect of different pre-treatments on drying rate of *Arka kalyan* (Red) onion dried in solar tunnel dryer

3.3 Effect of pre-treatments on moisture ratio of *Arka kalyan* onion with different drying methods

The initial moisture content was not same for all the drying experiments because of various pre-treatments. Hence, the drying curves were normalized by converting the moisture content to moisture ratio (MR). The change in moisture profile with respect to time for different drying methods for both treated and untreated *Arka kalyan* onion slices is presented in terms of moisture ratio (M/M_i) versus time graphs shown in Fig. 5 and 6. The moisture ratio for different pre-treatments was varied from 1.0 to 0.0086, 0.0056, 0.0050 and 0.0095 in 17-21 h of open yard sun drying in samples pre-treated with 10% NaCl, 0.2% KMS, 10% NaCl+0.2% KMS and untreated (control), respectively. Whereas in solar tunnel dryer, the moisture ratio was varied from 1.0 to 0.0078, 0.0064 and 0.0050 and 0.0092 for samples treated with 10% NaCl, 0.2% KMS and 10% NaCl+0.2% KMS and untreated (Control), respectively for 15-17 h. The variation might be due to different drying methods, varieties and pre-treatments. These results were in good agreement with earlier researchers Kumar *et al.*, (2006) [12] and Jain and Pathare (2004) [10].

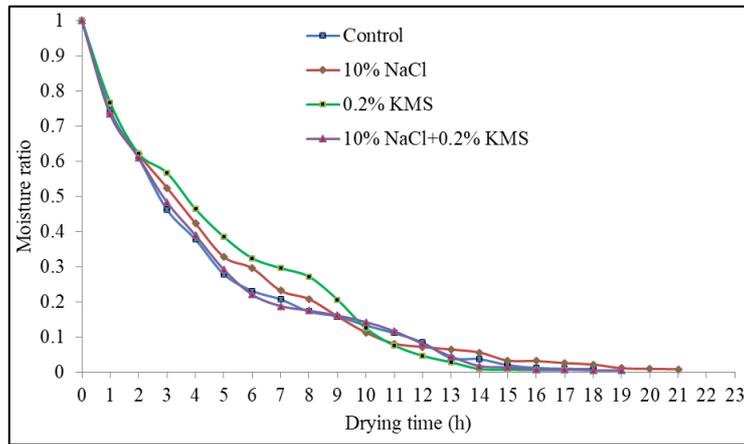


Fig 5: Effect of different pre-treatments on moisture ratio of *Arka kalyan* (Red) onion dried under open yard sun drying

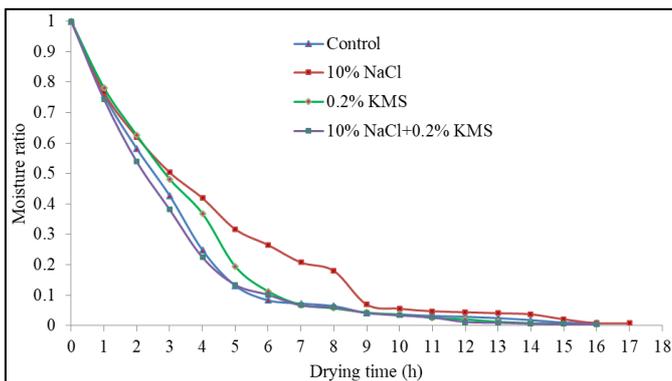


Fig 6: Effect of different pre-treatments on moisture ratio of *Arka kalyan* (Red) onion dried under solar tunnel dryer

It was evident from the graph that moisture ratio followed an exponential decrease with time. The rate of change of MR with time i.e. the slope of the curve $d(MR)/dt$ or $(1/M_i)d/dt$ changes continuously from the instant of commencement of drying. As the drying continued the surface moisture receded gradually and the moisture inside the product tried to diffuse to the surface. The same behaviour of drying was reported by earlier researchers Akgun and Doymaz (2005)^[1] for drying of olive cake and Jena and Das (2007)^[11] for drying of coconut presscake.

4. Conclusion

The drying characteristics of *Arka kalyan* onion in two drying methods with different pre-treatments were investigated from the present investigation. It is concluded that the onion dried in STD was of good quality over OYSD. The time required for drying onion from initial moisture content in the range of 545.16-774.13% (d.b.) to final moisture content of 4.95-5.21% (d.b.) was 17-21 and 15-17 hours for OYSD and STD, respectively.

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