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EFFECT OF PRETREATMENTS, DRYING THICKNESSES AND METHODS ON DRYING CHARACTERISTICS OF ONION SLICES

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Abstract

The research was conducted with a greenhouse type solar dryer to develop dehydrated onion slices to provide the onion slices during off season. Fresh onion slices were pre-treated with KMS and NaCl in the ratio of water 1:4. A 2 factor-factorial experimental design was used for statistical analysis. During the experiment different thicknesses (2mm 4mm and 6 mm) of onion slices were applied under greenhouse type solar dryer and open drying. It was observed that when temperature rise then drying rate increases and drying time decrease. Under open sun drying the drying time was 540 min for KMS treated, 570 min NaCl treated and 630 min for untreated samples for different thickness. On the other hand, samples treated by greenhouse type solar dryer took lesser time when it treated by KMS throughout experiment (480 min, 510 min and 540 minutes respectively at 2mm, 4mm and 6mm thickness). The final moisture content changed from 4.45 % to 6.98 % (d.b.). The statistical analysis revealed that all selected variables were significant effects on the quality attributes of the samples.
Keywords: Open Sun Drying, Greenhouse type Solar Drying, Pre-treatment of Onion Slices, Thickness of Onion Slices

Introduction

India is the second largest producer of onion, at 21.56 million tonnes per year after china. India exports onions to Bangladesh, Malaysia, UAE, Sri Lanka and Nepal (Horticultural of statistics, 2017).

Onion (*Allium cepa* L.) is considered an important vegetable of great economical and nutritional importance across the globe (Majid *et al.,* 2018). Onion is vital commodity of masses and used as salad and cooked in various ways in curies, fried, boiled, baked and used in soup making and pickles. Besides fresh consumption, onion provides very good raw material for processing industry as it is processed in the form of dehydrated powder, rings, shreds and onion in vinegar or brine (Devi *et al.*, 2018). Onion is rich in nutritive and medicinal properties which play an important role in prevention of various diseases (Srivatsava *et al.*, 2015). Green onion lowers the blood pressure and cholesterol level, reduces the risk of ischemic heart disease and prevents the formation of blood clots (Memon *et al.*, 2018). Various ether soluble fractions as well as insoluble fractions of dried onion powder show anti-hyperglycemic activity in diabetic rabbits. Administration of a sulfur containing amino acid from Allium cepa, S-methyl cysteine sulphoxide (SMCS) (200 mg/kg for 45 days) to alloxan induced diabetic rats significantly controlled blood glucose as well as lipids in serum and tissues and normalized the activities of liver hexokinase, glucose 6- phosphatase and HMG Co A reductase. When diabetic patients were given single oral dose of 50 g of onion juice, it significantly controlled post-prandial glucose levels (Modak, 2015).

Drying is one of the most frequently used processing methods to prolong the shelf life of fruit and vegetables. Drying of material with high moisture content involves a complicated process of simultaneous heat and mass transfer. Using thin layer drying the sample is dried in a single layer, which results in faster removal of moisture (Garba *et al.,* 2015; Garba and Kaur, 2014; Qadri *et al.,* 2019). Drying is an industrial preservation method in which water content and activity of the fruits and vegetables are decreased by heated air to minimized biochemical, chemical and microbial deterioration (Doymaz and Pala, 2003). Several drying techniques are available as commercial options for dehydration, including freeze drying, convective drying and vacuum drying. Research has been conducted on effect of different drying techniques on various quality aspects of fruits and vegetables (Rafiq *et al.,* 2019). The technique of drying is probably the oldest method of food preservation practiced by mankind for the extension of food shelf life. The use of artificial drying to preserve agricultural commodities is expanding, creating a need for more rapid drying techniques and methods that reduce the large amount of energy required in drying processes. New and innovative techniques that increase drying rates and enhance dried onion quality are receiving considerable attention (Mongpraneet and Tsurusaki, 2002). Drying is dependent on the two fundamental processes of heats and mass transfer, in which heat has to be transferred into the fresh products and moisture simultaneously removed from the products. The drying rate depends on the drying conditions (viz. drying bulb temperature, relative humidity, air velocity and the rate of heat transfer) and the food properties which are the moisture content, surface volume ratio area of cut surface, surface temperature and rate of moisture loss (Mota *et al.*, 2010).

Engineering properties are important in fabrication and operation of processing equipment for an agricultural material. Temperature, density and moisture content affect these properties, and adequate knowledge of their relationships is necessary for data generation as input required for the design, fabrication and operation of driers for the handling and processing (Kehinde *et al.*, 2019).

Preservation of fruit and vegetables are essential now a days, and it has become a part of our life .From ancient times fruits, vegetables and other eatables were kept to dry in the sun in order to preserve them .This is one method by which we can preserve our food items, the other method of food preservation is solar dryer (Wandra *et al.,* 2015). A greenhouse is a growth chamber which offers the possibilities of year-round utilization. These are effective solar collectors. These can also be geared to the needs of the rural, urban and sub urban populations. A greenhouse designed in a truly passive solar collection manner with a well-applied heat store, may also provide much of the required winter heat. Solar greenhouses are relatively easy to build with simple technology and low-cost materials. Greenhouse for crop production is so designed that it loses most of the heat it gains to avoid overheating during the day. A solar greenhouse optimizes the received sunlight and heat while reducing heat losses to a practical minimum with the object of providing increased heat for crop drying. Many innovative ideas have been incorporated into the greenhouse designs. Both passive and active methods separately or in combination are made use of for meeting the energy needs of greenhouses (Rai, 2004). High energy consumption and cost is a major problem associated with drying fruits and vegetables. Utilization of solar energy provides an alternative to drying fruits and vegetables since it is less expensive and uses a clean source of energy (Maisnam *et al*., 2017). The study of Chauhan *et al*., 2015, concluded that these selected methods: Sun drying, microwave drying and freezing have a significant impact on the physicochemical, nutritional and phytochemical properties. Compare to fresh and freezing, drying method would be used to produce good quality dried fruit in terms of protein, carbohydrates, ash content, dietary fiber (ADF, NDF, cellulose, hemicelluloses, pectin), anti-nutritional content (tannin, alkaloid, and minerals).

Comparative studies are very few about high moisture vegetables under the natural and mechanical drying. Considering the advantages of greenhouse type solar dryer, its performance evaluation for drying the onion slices should be studied. On the basis of available information, a greenhouse type solar dryer (5m x 3m) under study the drying characteristics of onion slices with different pretreatments and thickness under the sun and greenhouse type solar drying systems.

Materials and Methods

Sample Preparation

The matured, fresh onions, medium size, free from diseases and insects, were procured from the local market of Meerut and used for the present investigations. The onion bulbs then thoroughly cleaned then sorted cleaned onions were peeled and cut into selected thickness by a hand operated slicer. The uniform thickness of 2.0, 4.0 and 6.0 mm was prepared by adjusting the opening of the slicer. Among with these control and treated samples to identify the difference in drying phenomena for brining.

For the treated samples after cutting in to required sizes the slices were dipped into a solution of 5% Sodium chloride (NaCl) and 0.2% Potassium metabisulfite ($K_2S_2O_5$) for 15 minutes at room temperature. The ratio of sliced onion pieces and chemical was 1:4 (w/v). The temperature in the range of 34.45-46.90ºC in opens sun drying and 44.12 to 63ºC in green house type solar drying. The temperature available in the month of May 34.45 to 46.90ºC for open sun drying and 44.12 to 63.00 ºC in solar drying was taken for the present study. The dried onion slices were packaged in polythene bags (film thickness 95-micron, density 0.922), sealed air tight and stored at room temperature for further analysis. A process flow chart for the research is show by Figure-I.

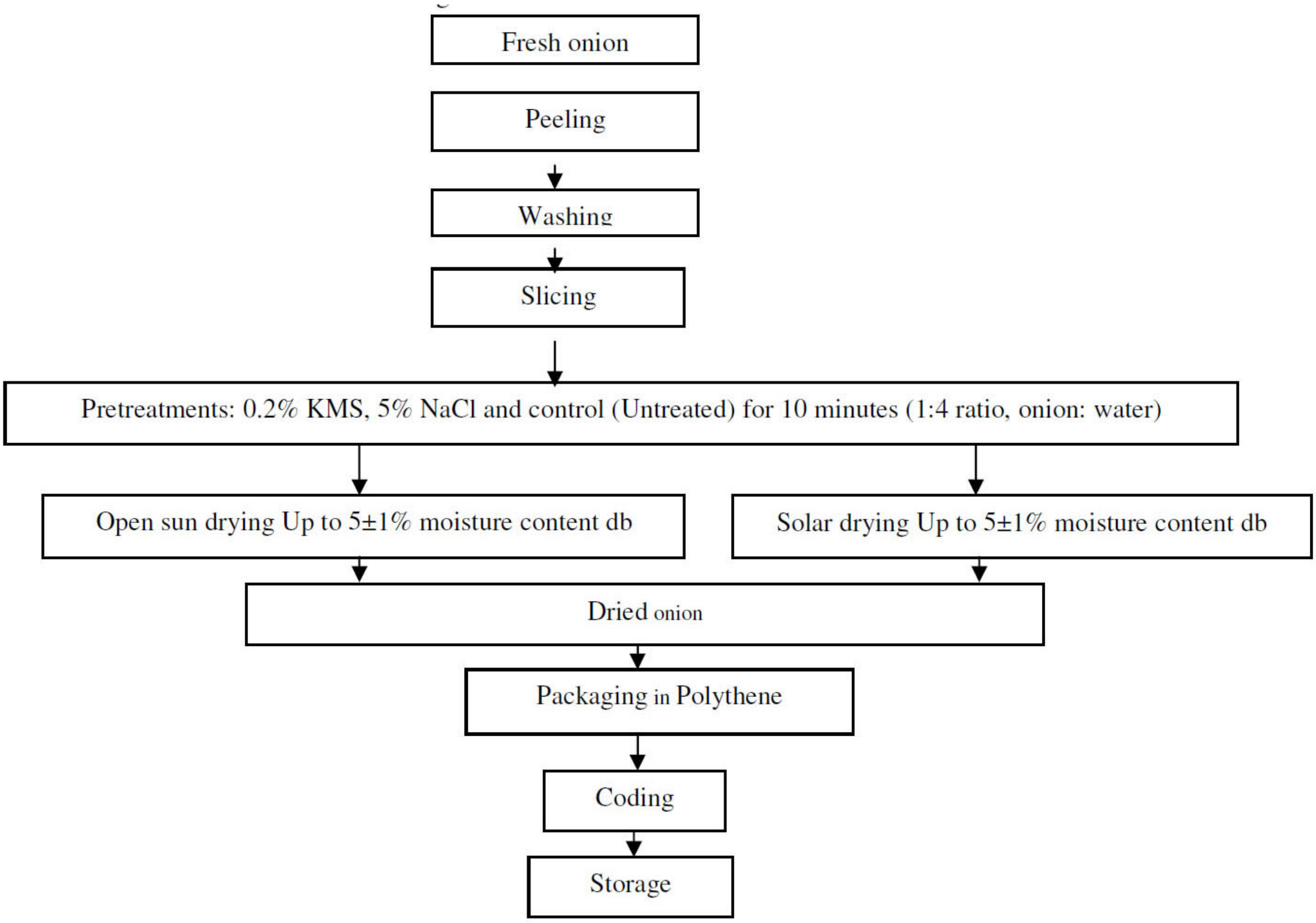

Fig. I : Process flow chart of dehydrated onion

Equipments/Instruments

Following types of equipment were used to complete this research:

Hot Air Oven

Electronic Balance

Temperature measurement:

Relative humidity measurement

Determination of various parameters of drying kinetics

Moisture content during drying experiment

Moisture content of the samples during drying was calculated through mass balance. For this purpose, weight of the sample during drying was recorded at predetermined time interval. The following formulae were used to calculate the moisture content according to the (Dey *et al.,* 2019; Singh *et al.,* 2011).

$$MC = \frac{W - W_d}{W_d} \times 100 \quad ...(1)$$

Where

M.C. = moisture content, % (dry basis)

W = weight of sample, g

Wd′ = weight of bone dry material, g

Moisture ratio and drying rate

Moisture Ratio (MR) was calculated followed by (Ranganna, 2001).

$$MR = \frac{M - Me}{Mo - Me} \quad ...(2)$$

Where,

M = moisture content, % (dry basis)

Mo= moisture content, % (dry basis) at zero time.

Me= equilibrium moisture content, % (dry basis).

Drying rate

During thin layer drying, the drying rate is represented as followed by (Ranganna, 2001).

$$\frac{dm}{dt} = \frac{M_2 - M_1}{\Delta t} \quad ...(3)$$

Where

M1 = moisture content % (dry basis) at time t1

M2 = moisture content % (dry basis) at time t2

Δt = difference in time

Results and Discussion

Effect of moisture content under drying time with different thickness of slices

The drying behavior of treated and untreated onion slices, subjected to different drying methods and thicknesses were statically analyzed. The change in moisture content with drying time for treated and untreated samples are plotted in Fig. 1 to 6. From these figures it is observed that the moisture content decreases with increase in time for different thickness.

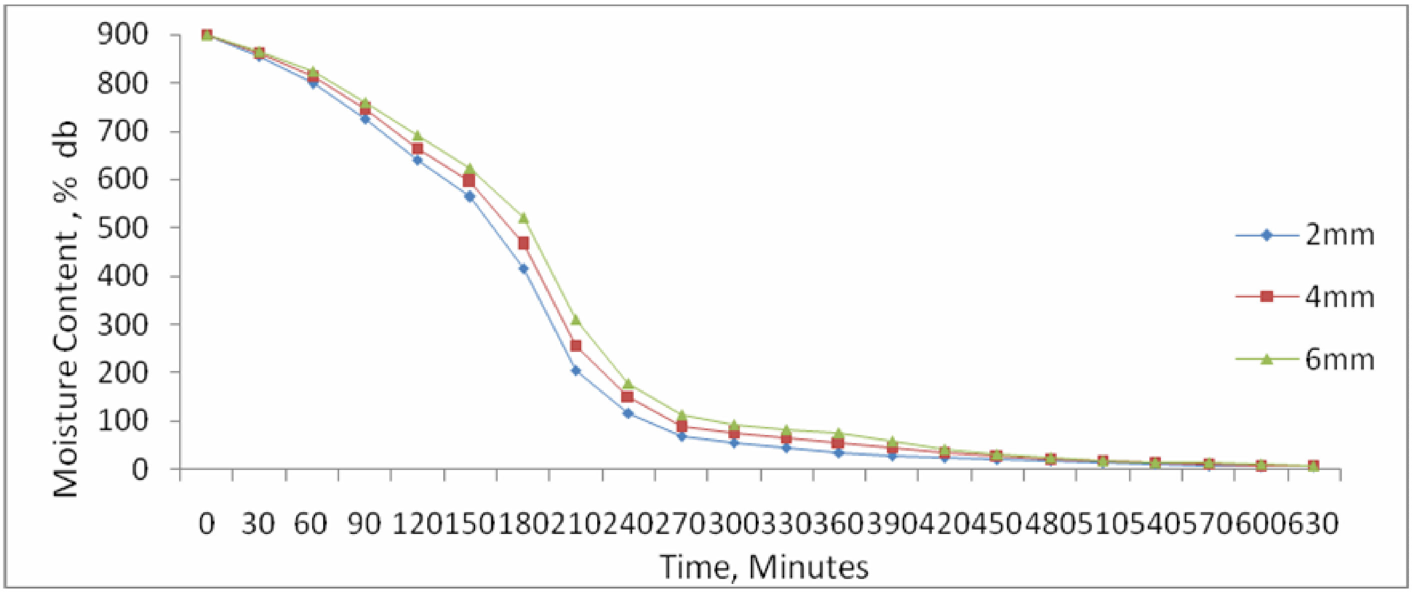

Fig. 1: Moisture content of control sample with drying time under open sun drying

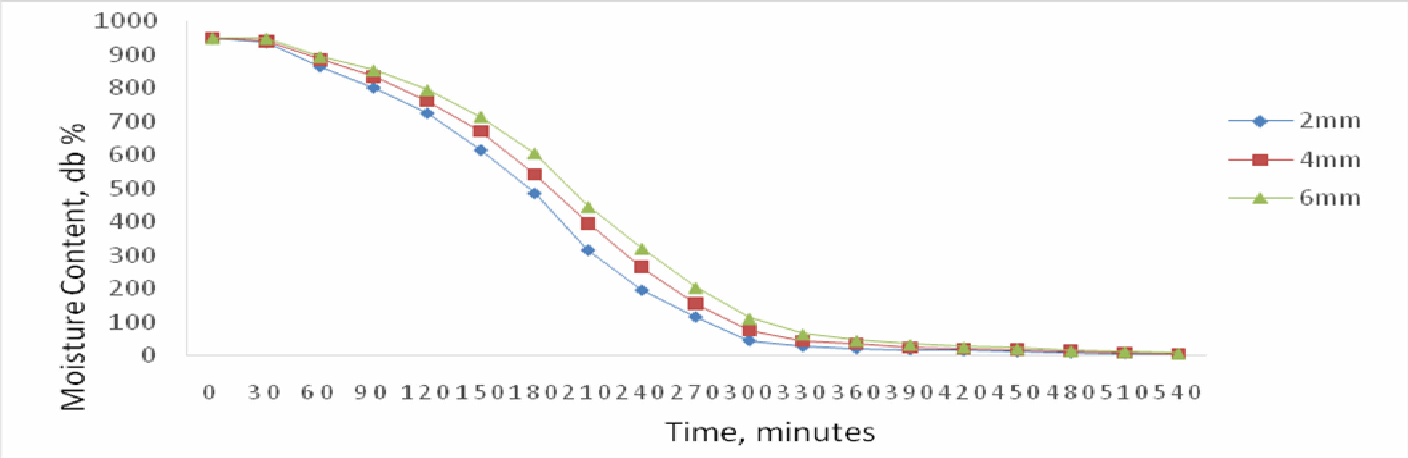

Fig. 2 : Moisture content of KMS treated samples with drying time under open sun drying

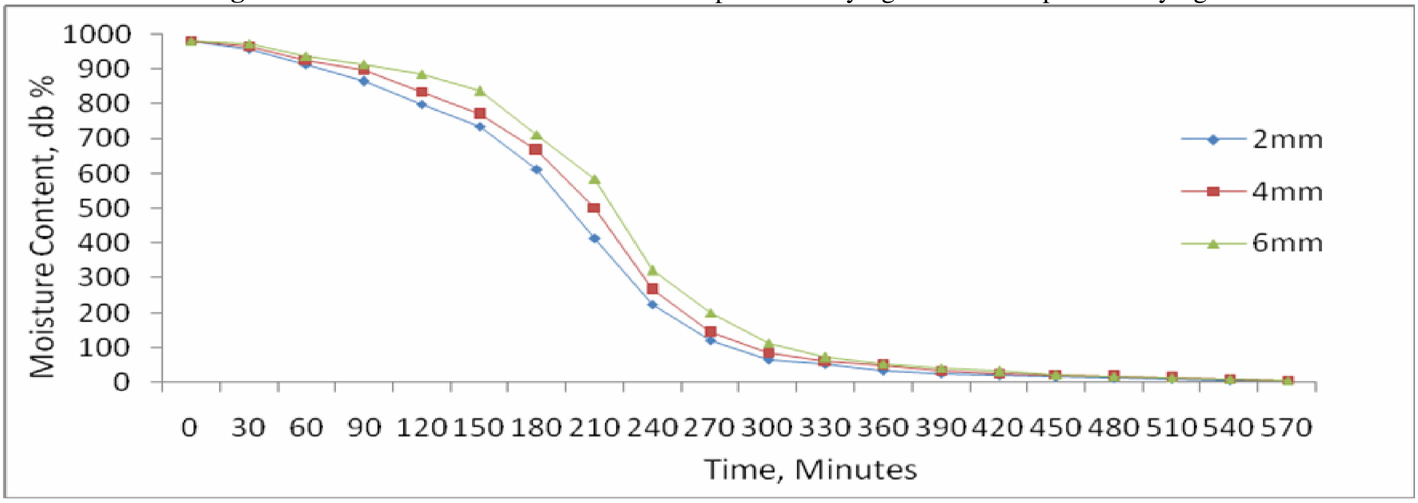

Fig. 3: Moisture content of NaCl treated samples with drying time under open sun drying

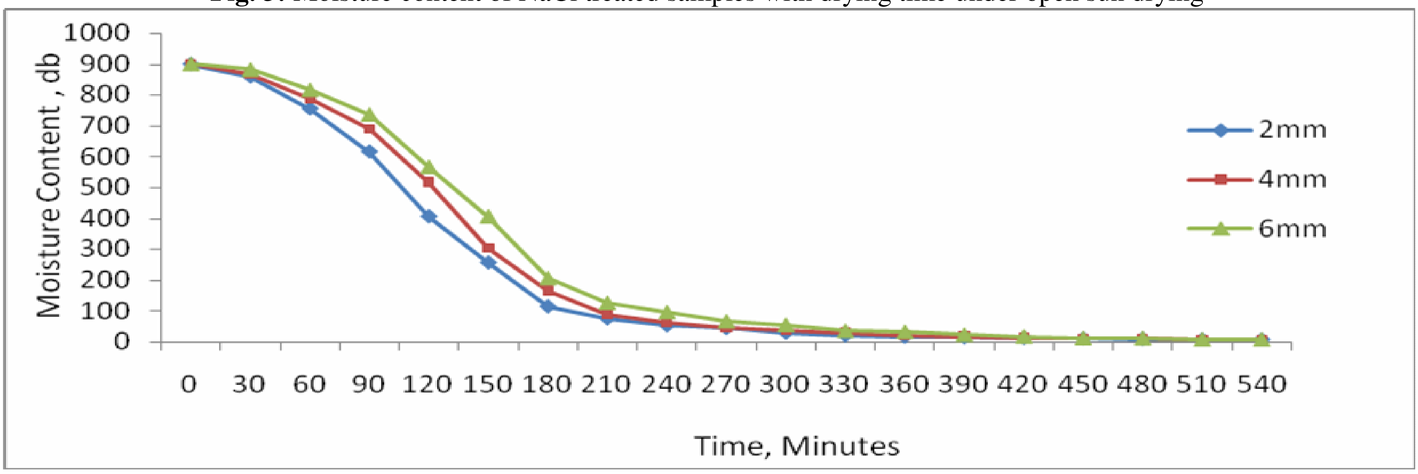

Fig. 4: Moisture content of control samples with drying time under greenhouse type solar dryer

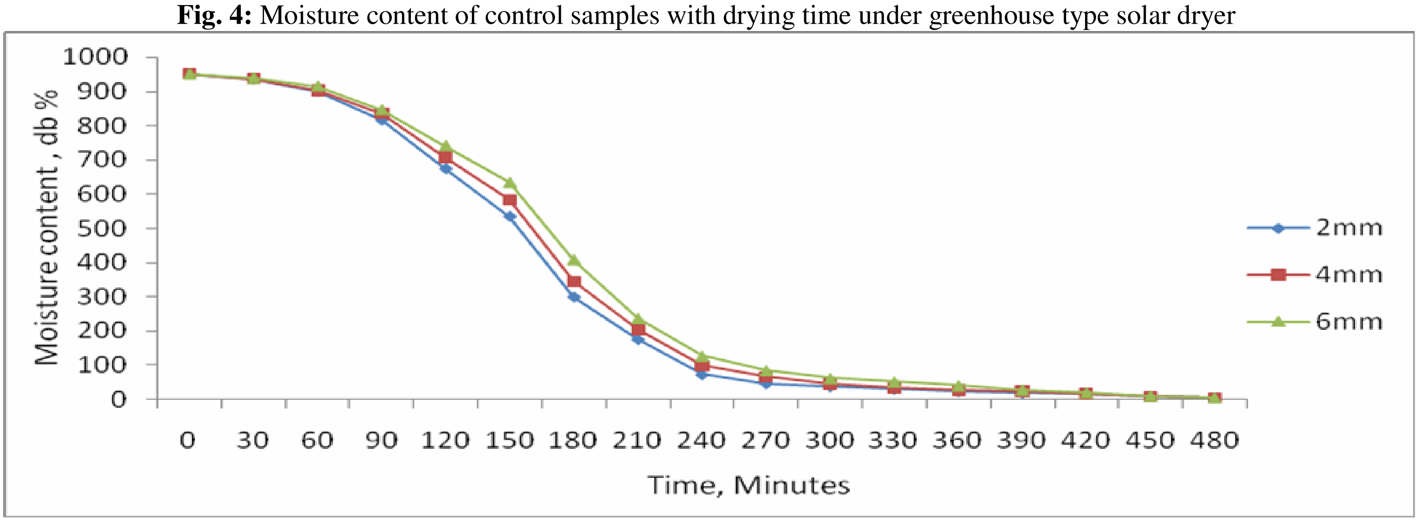

Fig. 5 : Moisture content of KMS treated samples with drying time under greenhouse type solar dryer

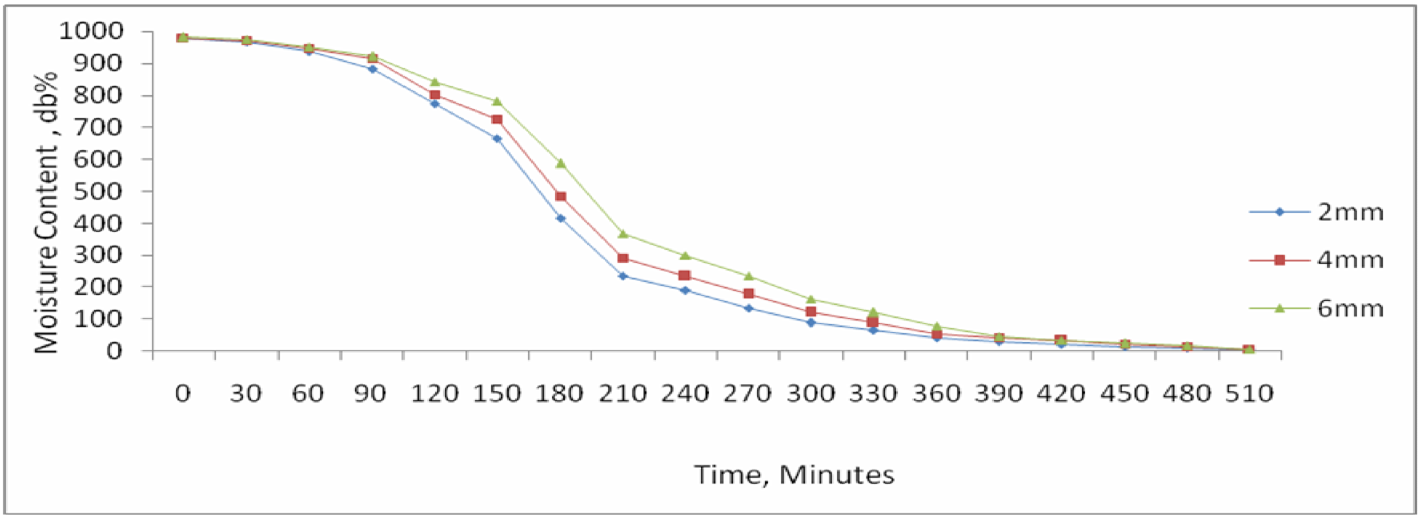

Fig. 6 : Moisture content of NaCl treated samples with drying time under greenhouse type solar dryer

Drying rate

Average drying rates were calculated from the observed data by estimating the change in moisture content occurred in each consecutive time interval. As expected, the rate of drying was affected by temperature, thickness and pre-treatments. The drying rate was faster at higher temperatures i.e. under greenhouse type solar dryer (Fig. 10 to 12) as compared to open sun drying (Fig. 7 to 9). Drying rate was quite low during first hour because of lower air temperature and air velocity initially, in the morning. Drying rate was higher at higher temperature (i.e. under greenhouse type solar dryer), as normally expected. But few points there was unexpected interactions of curves and this was due to experimental variations.

It can also be seen from the drying rate figures, that the constant rate period was not observed in drying the onion slices samples. The drying process took place in a falling rate period except short accelerating period at the beginning. During the falling drying rate period, the predominant mechanism of mass transfer is that of internal mass transfer.

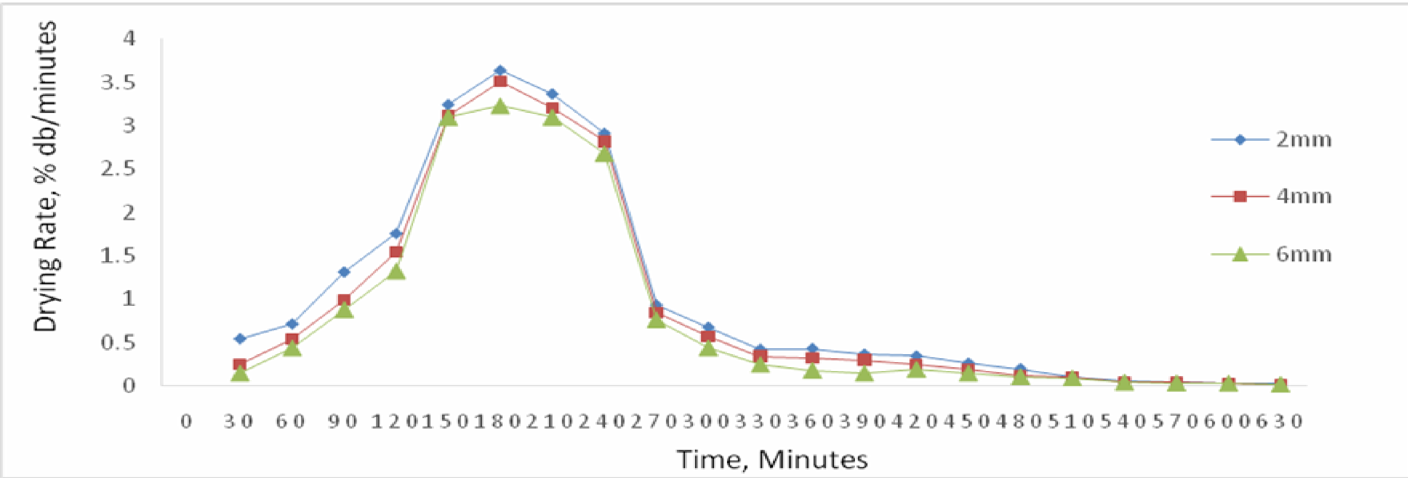

Fig. 7 : Drying rate of control sample under natural drying with different time and thicknesses

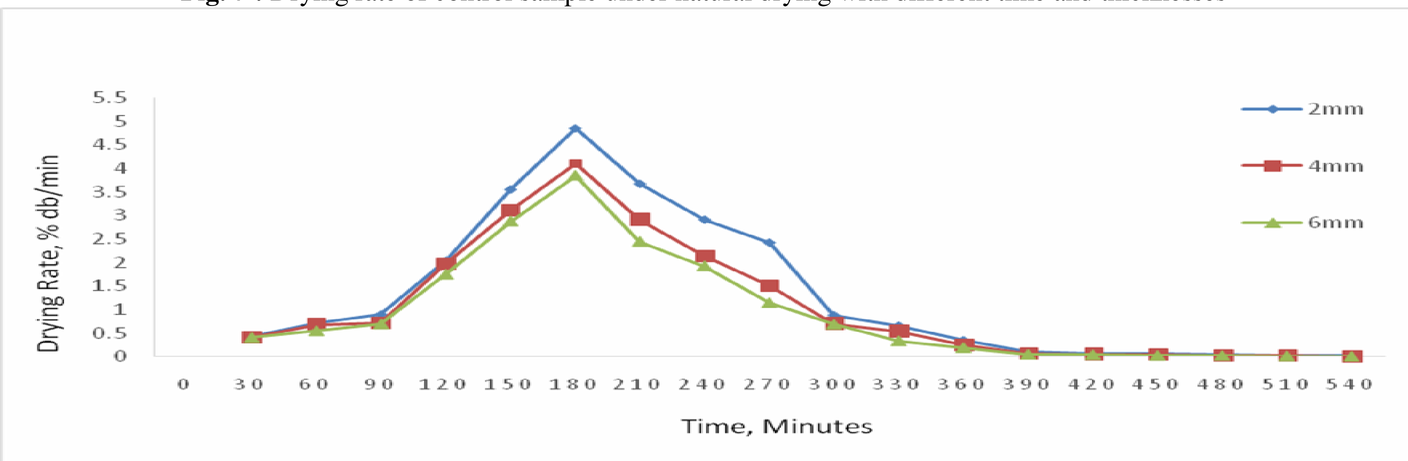

Fig. 8 : Drying rate of KMS treated sample under natural drying with different time and thicknesses

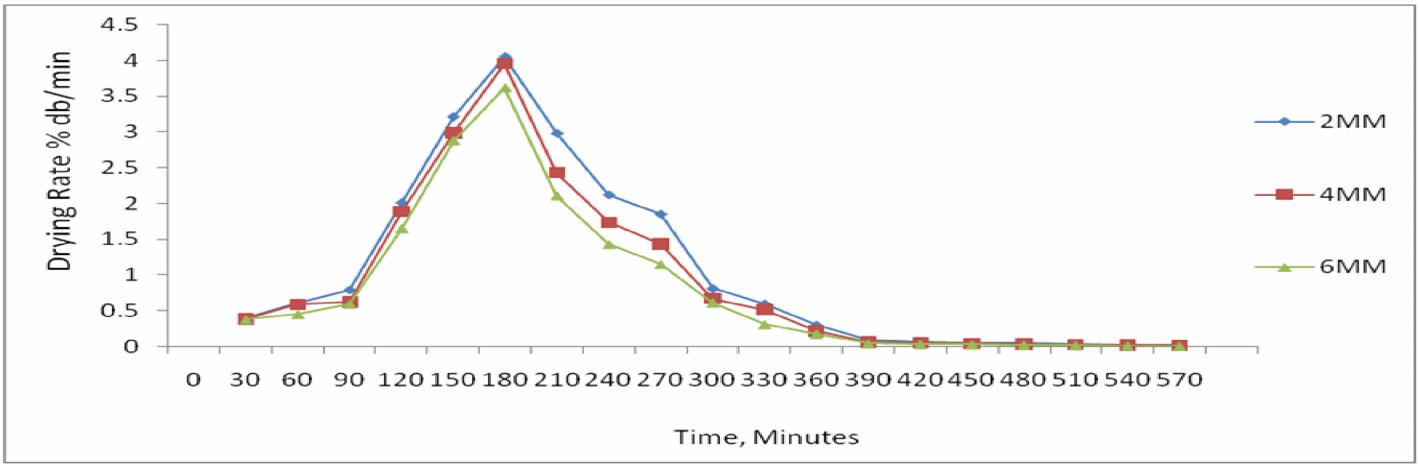

Fig. 9: Drying rate of NaCl treated sample under natural drying with different time and thicknesses

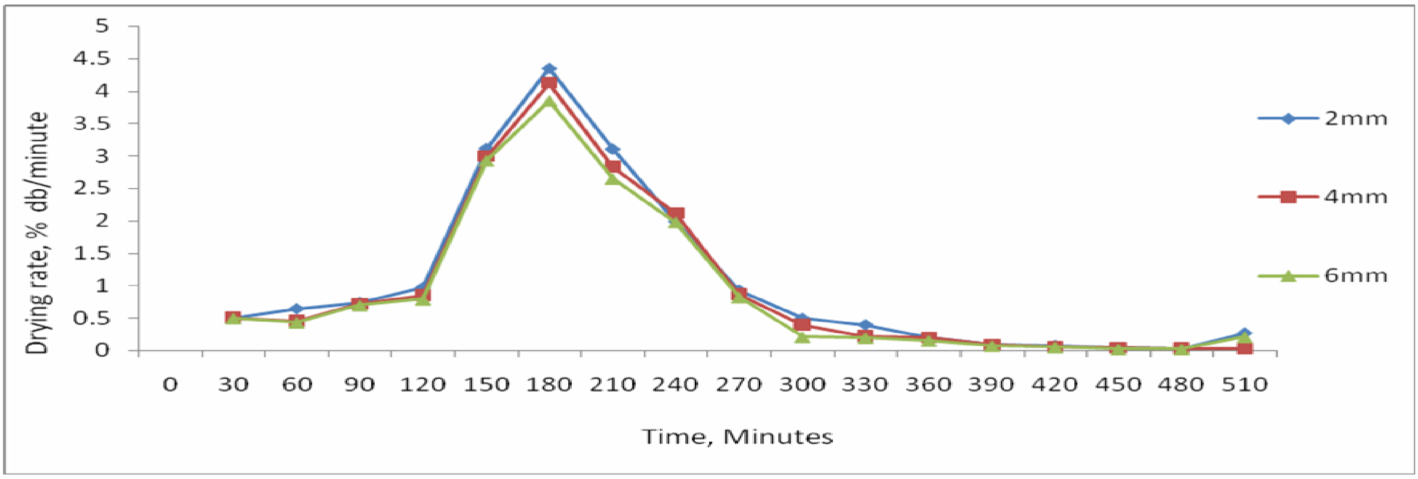

Fig. 10 : Drying rate of control sample under solar dryer with different time and thicknesses

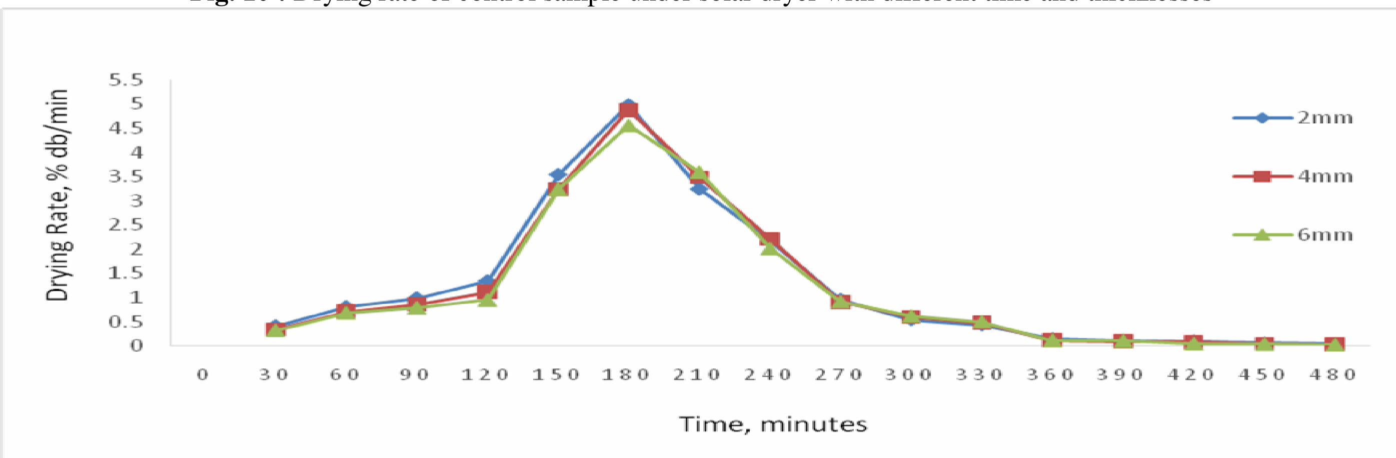

Fig. 11 : Drying rate of KMS treated samples under solar dryer with different time and thicknesses

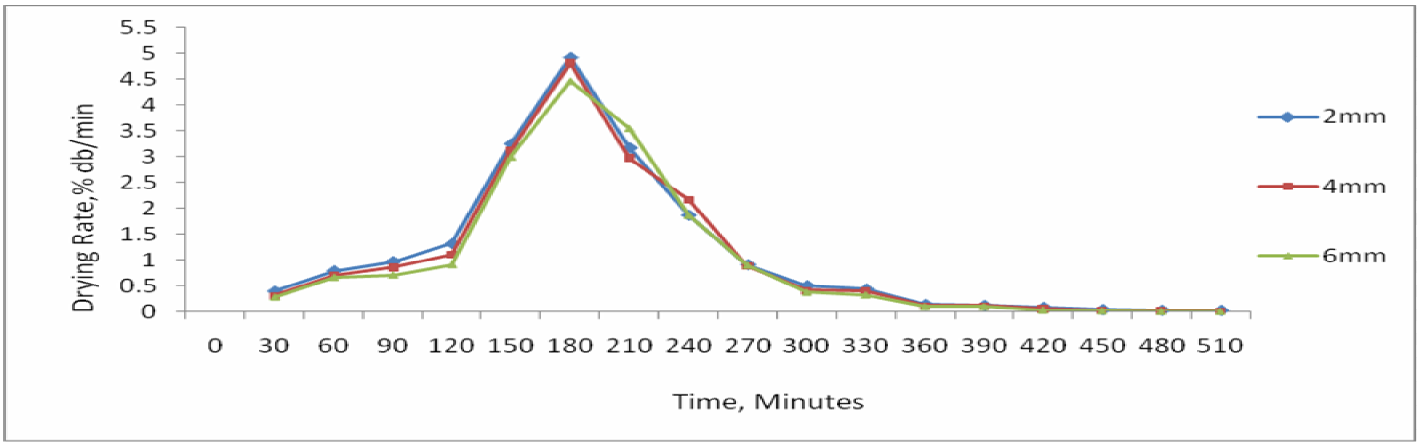

Fig. 12: Drying rate of NaCl treated sample under solar dryer with different time and thicknesses

Moisture Ratio

The change in moisture ratio with time for experimental range of temperatures (44.12–63^{0}C) under greenhouse type solar dryer and (34.45–46.90^{0}C) under open sun drying are shown in Fig 13 to 18.

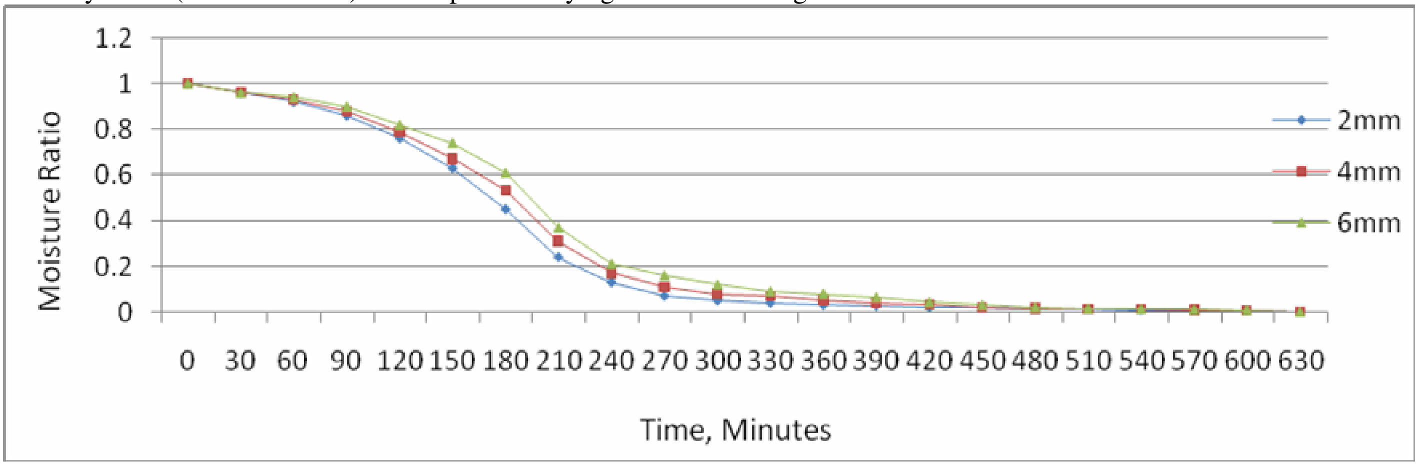

Fig. 13 : Moisture ratio of control sample with time under open sun drying

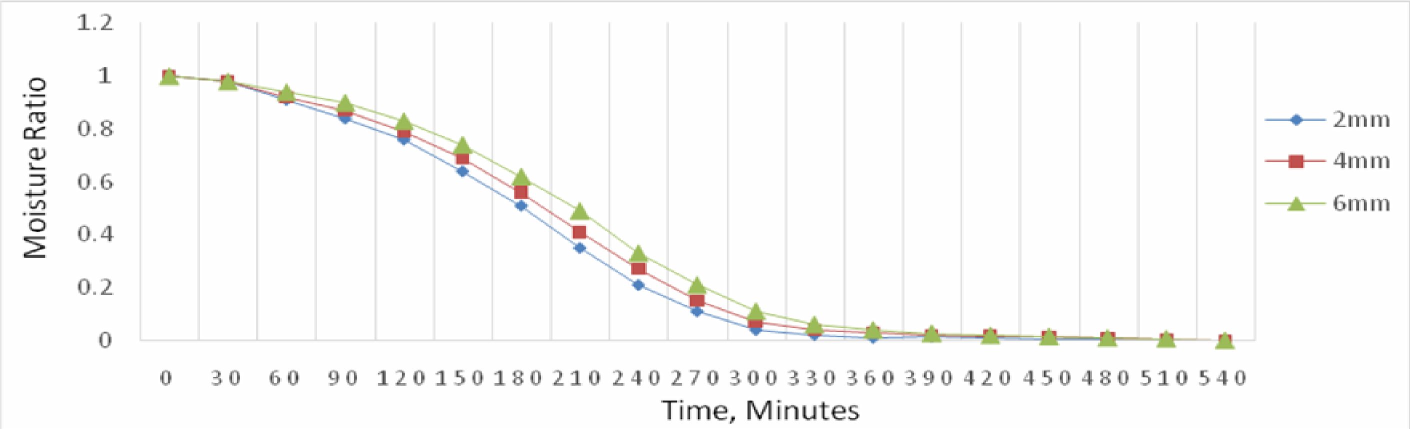

Fig. 14 : Moisture ratio of KMS treated sample with different time and thicknesses under open sun drying

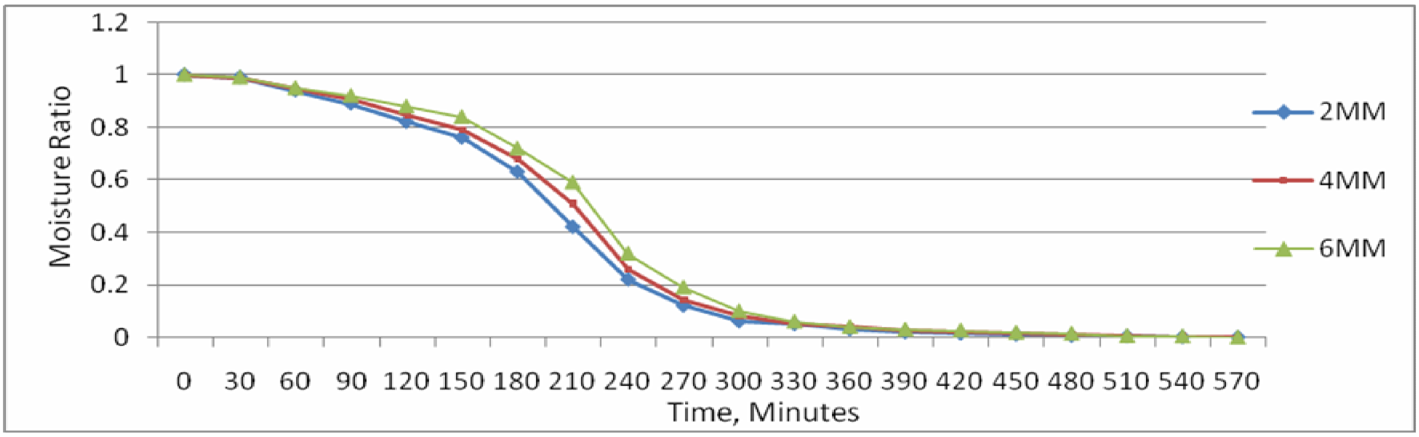

Fig. 15 : Moisture ratio of NaCl treated samples for open sun drying

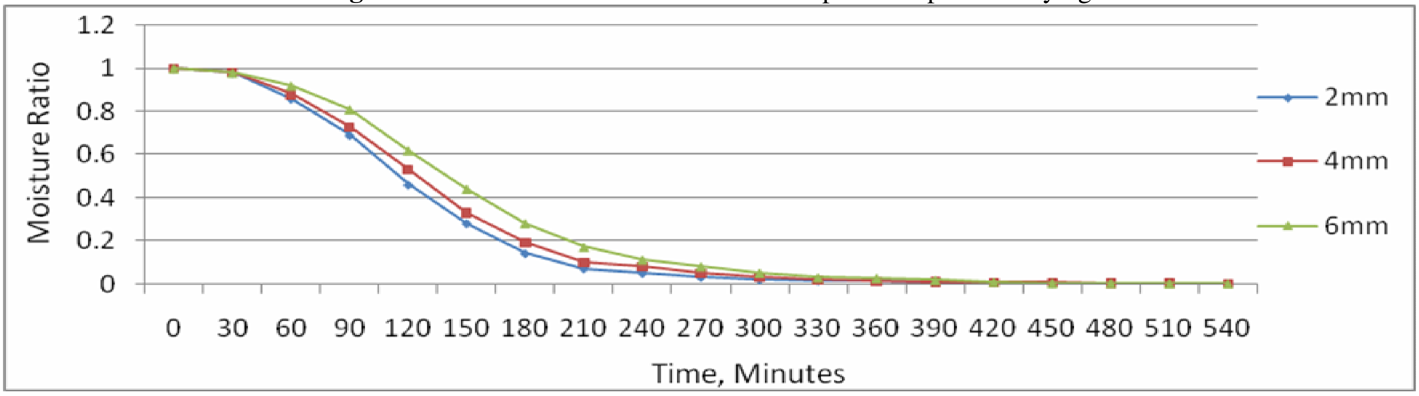

Fig. 16 : Moisture ratio of control sample with different time and thickness under greenhouse type solar dryer

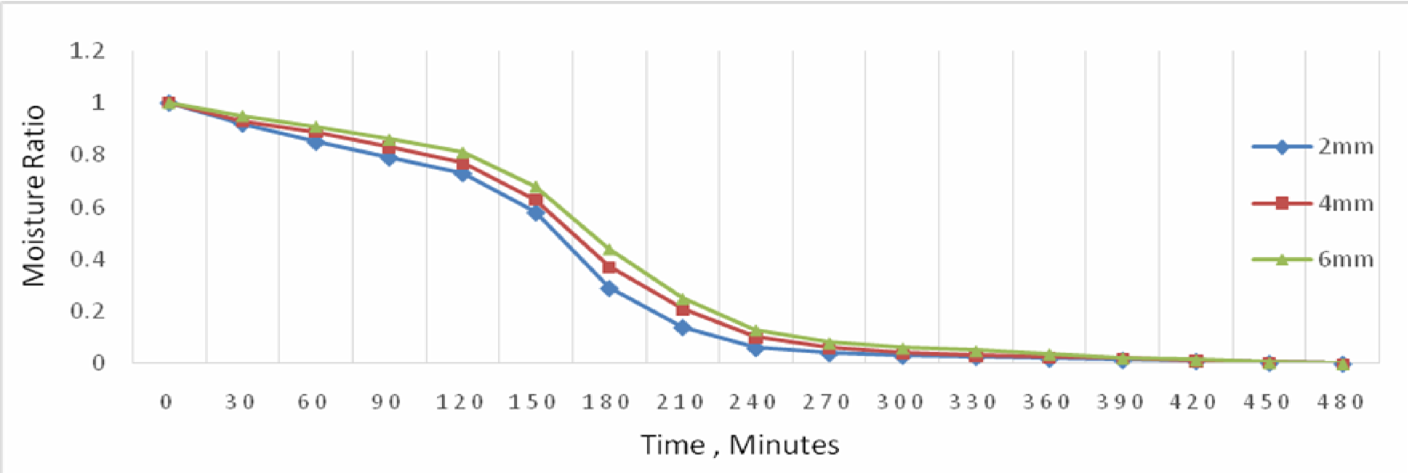

Fig. 17 : Moisture ratio of KMS treated samples with time under greenhouse type solar dryer

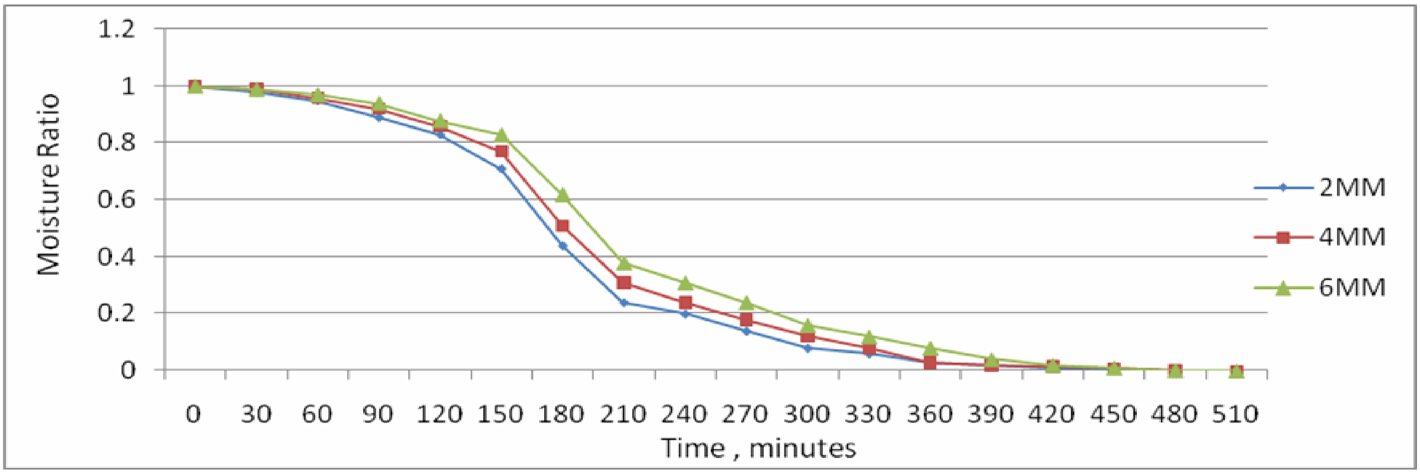

Fig. 18 : Moisture ratio under greenhouse type solar dryer (NaCl treated samples)

Conclusions

Drying rate showed a positive correlation with temperature and decreasing trend with increasing thickness. The effects of the individual variable pretreatments, onion slice thickness and moisture removed were statistically analyzed. The analysis indicated that, the onion slice thickness is the significant parameter affecting on drying rate. The average drying rate increased with increase in temperature and decreased with increase in time and thickness. Moisture content and moisture ratio decreased with increased in temperatures and time. Chemical treated (KMS and NaCl) samples dried under greenhouse type solar dryer took average drying time of 8 hours which was 2.50 hours lesser than drying time of untreated samples under open sun drying. The greenhouse type solar drying method was found to suitable in drying of onion slices.

Table 1: Design of experimental Plan

Variable Parameters	Range/ Particulars	Levels
Pre-treatments	T1; solution of 0.2% KMS T2; solution of 5 % NaCl T3; control sample	3
Thicknesses	2mm, 4mm and 6mm	3
Drying Conditions	Green house type solar drying and Open Sun drying	2

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