Drying Characteristics of Potato Slices and Quality Parameters

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Abstract

Preservation of potato when the market price is low has been considered as a means of improving farmer income. Dehydration of potato as slices is an alternative method for preserving it. The re-hydrated product should be a replacement to fresh potato used in preparation of food items. This study was conducted to understand the drying characteristics of potato slices and re-hydration properties for the variety Desiree.

Slices having thickness of 3, 5 and 7 mm were considered with or without combinations of heat and chemical treatment. Drying temperature was maintained at 60 °C at initial 100 min. and then reduced to 50°C for the rest of drying. The air velocity was maintained between 5.64 m/s and 5.46 m/s. The drying characteristics of potato slices can be expressed by the exponential function $Y = ae^{bt^2}$.

The lowest drying time was required by the samples of 3mm thick, which is the smallest thickness considered in the experiment. Potato slices subjected to blanching and dipping in potassium metabisulphite resulted in the highest acceptability in colour and shape. The rehydration property varied with the thickness and other heat and chemical treatments. The highest rehydration ratio was shown by the 3 mm thick sample with 1 min. blanching.

Further studies are recommended to investigate the effects of other slice thicknesses, nutritional aspects and also the effect of other varieties.

Introduction

Potato (Solanum tuberosum) is an annual herbaceous, decotyledonous plant, which produces tubers as economic yield. In Sri Lanka, the local production and the imports from neighbouring countries meet the annual requirements. The consumption of it is mainly in the form of traditional dishes. In other parts of the world, potato is used in many preparations as value added products. But, in Sri Lanka, very little attention has been paid to develop technology for potato based products.

The price of potato in the local markets varies throughout the year due to seasonal supplies of Sri Lankan farmers or imports. Imports by the private sector prior to the impending harvest have resulted in very low farm gate prices. The ensuing effect has been the farmers refraining from potato cultivation.

Storage of the crop and development of value added products are some steps that can be taken by the farmers (Fennema et al, 1975). Storage of potato crop as fresh produce is necessary for even supplies during off-seasons. Development of technology for converting (processing) to other products is necessary to ease the drawbacks on potato farming in Sri Lanka.

This study was conducted to investigate the drying characteristics of potato slices. Drying time requirement and re-hydration properties are the important parameters in establishing a process for production. Satisfactory re-hydration is necessary in preparation of dried products for consumption as a moistened food. An understanding of potato drying

characteristics is also necessary in designing the processes and processing equipment. The specific objectives of the study were to investigate:

1. effect of thickness, steaming and potassium metabisulphite treatment on drying rate and quality parameters, and
2. re-hydration characteristics.

Materials and Methods

An experimental dryer was constructed at the Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya. It consisted of a drying chamber, a heating unit, a blower and an air temperature regulator unit.

Initially, potato slices of 3, 5 and 7 mm thick (variety-Desiree) were dried at three different temperatures of 50, 60 and 70°C in three tests. Drying at 70°C resulted in potato slices with poor appearance while tests at 50°C and 60°C were satisfactory. Therefore, further testing at 70°C temperature was not done. It was observed that the drying rate became equal after 100 minutes of drying irrespective of the temperatures tested at 50 and 60°C. Therefore, in all tests, the drying temperature of 50°C was maintained after a drying time of 100 minutes.

An axial flow blower used in the experimental dryer produced an air stream at 0.51m/s velocity at ambient conditions. The air velocities were measured at different drying temperatures.

Since the experiment was designed to study effects of steaming and treatment of potassium metabisulphite (KMS) on slices, it consisted of five treatments including a control as given below.

TREATMENT	PROCEDURE
T1	Potato sample without any treatment
T2	Sample was subjected to steaming for 1 min.
T3	Sample was subjected to steaming for 2 min.
T4	Sample was dipped in KMS 1.5 g of KMS/kg of potato (personal communication, 1996) for 2 min. Then it was steamed for 1 min.
T5	Sample was dipped in KMS 1.5 g/kg of potato, solution for 2 min and then steamed for 2 min.

These five treatments were repeated for three slice thicknesses of 3, 5, and 7mm.

Rehydration characteristic, which is an indication of cells damaged during drying was studied by boiling in distilled water for 5 min. A sample of known weight was boiled and then kept in a buchner funnel until dripping of water from the funnel was over. Then the sample weight was taken. The rehydration ratio was calculated with the following equation (Perera, 1994).

$$\textit{Rehydration ratio} = W_r / W_d.$$

where, W_r = drained weight of the rehydrated sample, and

W_d = weight of the dehydrated sample which is used for the test.

Results and Discussion

The drying behaviour was represented by variation of moisture content (wet basis) of the potato samples with time. Drying rates were studied for different thicknesses of potato slices and different treatments to which the material was subjected.

Effect of thickness of potato slices on drying time

Drying time was observed when the moisture content (wet basis) reduced from 75% to 6%. To determine the relationship between the drying time and the drying rate, statistical analysis was performed on the data set that contained 30 observations on moisture contents with time as the dependent variable.

The results from the analysis of variance procedure show that the probability >F value is lower than the standard probability value of 5% significant level. Therefore, thickness effect on drying time is significant. When the thickness is increased, interior moisture removal is restricted due to higher number of cell layers. Therefore, the total drying time will increase with the increased slice thickness. R^2 value of 0.937810 shows that 93.78% of the variation can be explained by thickness effect.

Effect of treatments of potato slices on drying time

Statistical analysis was done on data containing drying time and moisture contents (wet basis) between 6% and 75% in different treatments. The number of observations in the data set was 30. The drying time as the dependent variable, the Analysis of Variance procedure was performed. The probability > F value is more than the standard probability value of 5% significant level. Therefore, treatment effect on drying time is not significant. This may be due to blanching treatment. Blanching time is an important factor that influences the drying rate. But, the time should be varied with the thickness of potato slices.

In this experiment, equal blanching times were used for all thickness values of potato slices. Therefore, samples of low thickness may be over blanched and higher thicknesses may be under blanched. This may result in different degree of starch gelatinization during blanching.

Interactive effect of thickness and treatment on drying time

Statistical analysis was performed on drying time for changes in moisture content (wet basis) from 75% to 6%. No. of observations in the data set was 30. The dependent variable was time. Results from the analysis of variance procedure were obtained. Probability > F value was more than the standard probability value 5% significant level. Therefore, interaction effect is not significant.

Effect of thickness and treatment of potato slices on rehydration ratio.

Three treatments and three thicknesses were tested for rehydration properties. The number of observations made was 18. According to the Analysis of Variance procedure, results were obtained with dependent variable as rehydration ratio. Probability > F value for, treatments, thicknesses and interaction are less than the standard probability value 5% significant level. Therefore, treatment effects, thickness effects and interaction effects are significant.

Mathematical formula

For the drying process, the remaining moisture content (wet basis) % with time (h), are plotted to obtain the drying curve. The study was conducted on five levels of treatments, and three levels of thicknesses. Almost all the drying curves were in the same pattern (Figure 1). Therefore, by using the Sigma Plot software package, curve fitting was done for non-linear relationships. The ensuing function is shown in Equation (1).

$$Y = ae^{-bt2} \quad (1)$$

Where,

Y = Moisture content (wet basis) %
t = time (h)
a , b = constants

Linear regression was performed to find the unknowns a and b with the following linear model.

$$ln\ Y = ln\ a - bt^2$$

This regression procedure was followed for all data sets, and found the a and b values for each case. According to these values, a is the initial moisture content of the sample. But, the values b changed with the thickness. Statistical analysis was done by using b values, to find out whether there is an effect of treatments or thickness or both on b values. - With the 15 observations in data set and the b value as dependent variable, the Analysis of Variance procedure was performed. The results showed that the probability > F value for treatment was more than the standard probability value 5% significant level. Therefore, the treatment effect is not significant.

The probability > F value for thickness was less than the standard probability value 5% significant level. Therefore, the thickness effect is significant.

Then the mean values of b were found for different thicknesses as given below.

For 3mm thickness; b = 0.398
5mm thickness; b = 0.179
7mm thickness; b = 0.045

The drying rate function was obtained by taking the first derivative of Equation (1). The resulting drying rate function is shown in Equation (2).

$$dY/dt = -2abte^{-bt} \quad (2)$$

Equations (1) and (2) can be used to predict the drying function of potato slices which are within the sizes considered in the experiment. If the drying function is known, the drying time can be predicted.

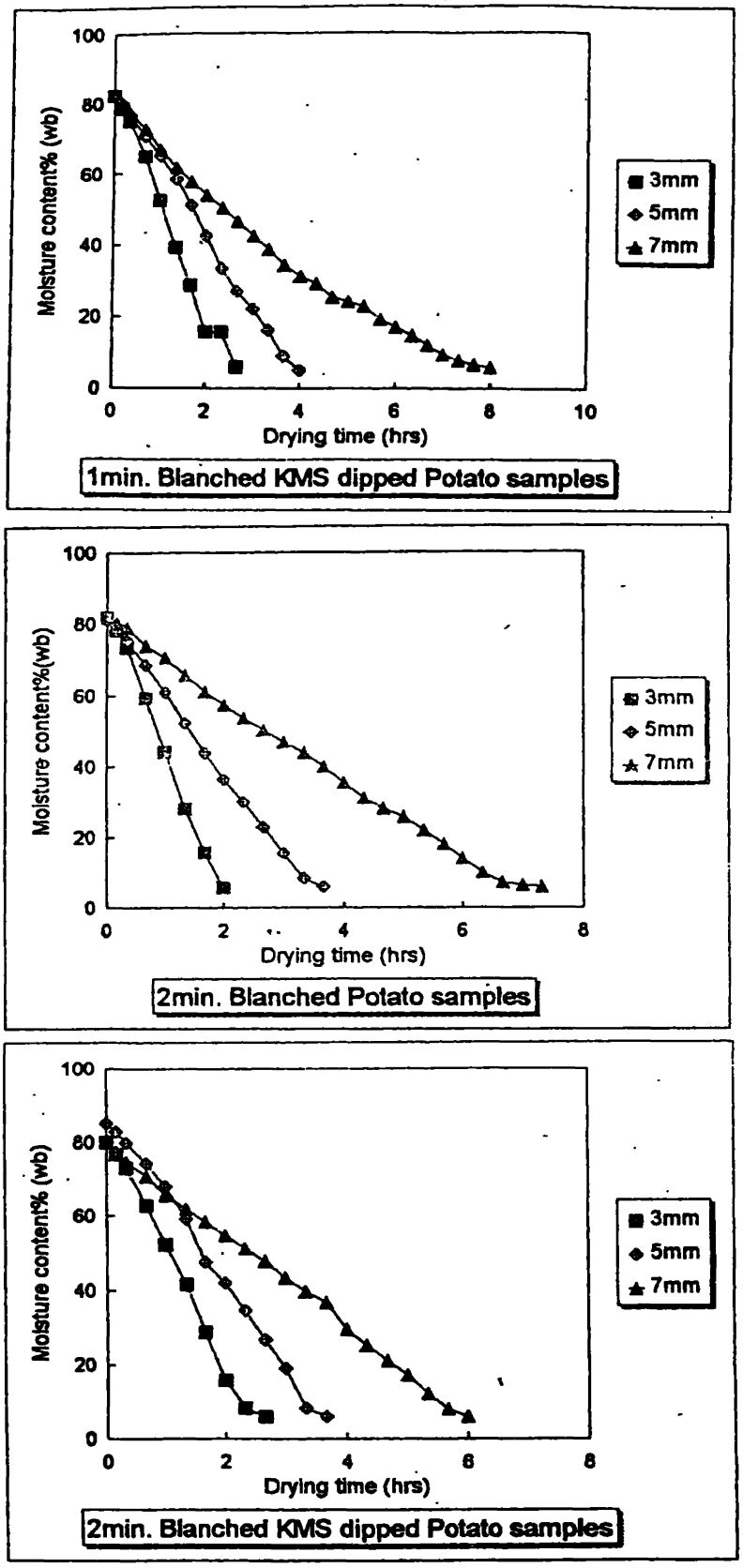
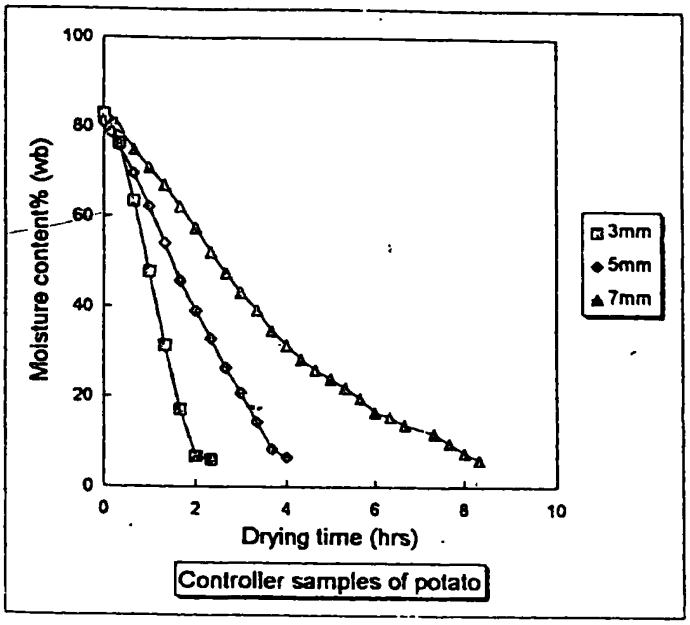

Moisture content% (wb)
Drying time (hrs)
3mm
5mm
7mm
1min. Blanched KMS dipped Potato samples
Moisture content%(wb)
Drying time (hrs)
3mm
5mm
7mm
2min. Blanched Potato samples
Moisture content% (wb)
Drying time (hrs)
3mm
5mm
7mm
2min. Blanched KMS dipped Potato samples

Figure 1



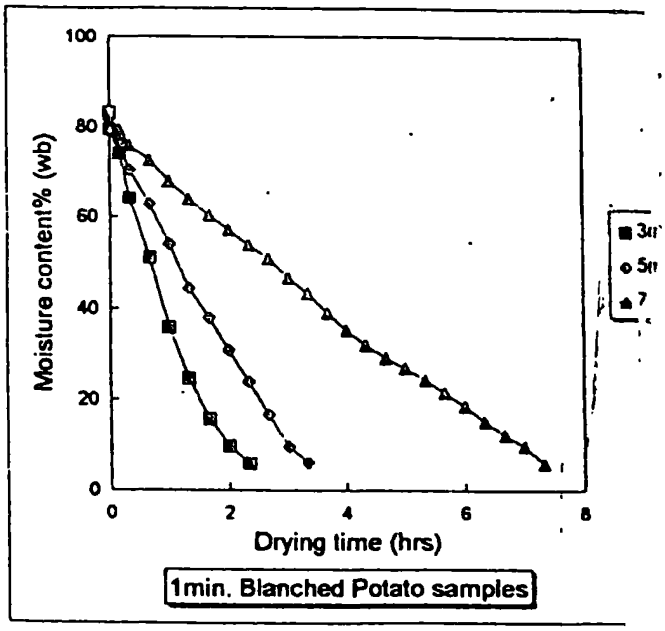


Figure. II

Conclusion

The following specific conclusions can be drawn from the results obtained in the study.

1. Drying characteristics of potato slices can be explained by using the exponential function, $Y = ae^{-bt}$, in the drying temperature range of $60^0C - 50^0C$ and air velocity of 5.64 - 5.46 m/s. Drying rate is given by $dY/dt = -2abte^{-bt}$ (Y= moisture content (wet basis) %, t =drying time in hours, a = initial moisture content of the sample, b = factor which changes with thickness of the slice).

   For different slice thicknesses, the mean values of b was found to be

   for 3mm thickness; $b = 0.398$
   for 5mm thickness; $b = 0.179$, and
   for 7mm thickness; $b = 0.045$.

2. For drying conditions given above, the suitable treatment and thickness are 2m blanching of 3mm thick slices of potato.

3. Treatment with KMS (potassium metabisulphite) and blanching results in a acceptable colour of potato slices.

4. The thickness of 3mm gives minimum deformation in dried slices.

5. The 3mm thickness with 2min. blanching treatment produces high rehydration ratio dried slices.

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