Estimation of Energy Requirements for Air Drying of Fresh and Blanched Pumpkin, Yams, and Sweet Potato Slices.

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Introduction

- Fresh foods contain high moisture content
- Sweet potato (*Ipomoea batatas* L.), yams (*Dioscorea spp*), Pumpkin (*Cucurbita maxima*)
- Common preservation method include sun drying, packaging and rehydration or reconstitution
- Sweet potato and yam tubers are blanched, sliced, dried and milled into flours.
- Problems associated with sun drying of agricultural materials are well documented in literature (Doymaz, 2004; Doymaz, 2005)

Introduction contd

- Effective means of overcoming these problems - suitable pretreatment prior to air drying.
- Blanching involves the application of a short heat treatment, usually in hot water or steam.
- Blanching

  - storage life extension,

  - preservation of flavour and colour,

  - minimization of nutrients loss,

  - elimination of enzyme activity

  - form of pregelatinization of part of the starch in root commodities

Introduction contd

- Dehydration increases stability of foods through the reduction of the water content and water activity
- Removal of water in foods by air involves the use of energy (*i.e.* E_a).
- E_a could be calculated by combining Fick's second diffusion model and analogous Arrhenius equation
- Thus, the objective of this study was to estimate the energy required to initiate mass diffusion during the drying of fresh and blanched sweet potato, yams and pumpkin.

Methodology

- Source of raw materials – sweet potato, yams and pumpkin.
- Preparation of samples
- Experimental procedures
- Drying characteristics – assumptions

  - mechanism of moisture migration

  - the system is isotropic

  - the final moisture content is equal to its equilibrium moisture content

Methodology contd.

- For long drying time

$$MR = \frac{8}{\pi^2} \exp\left[\frac{-\pi^2 D t}{4L^2} \right]$$

- Correlation between the drying conditions and the values of the effective moisture diffusivity using Arrhenius type equation

$$D = D_o \exp\left(-\frac{E_a}{RT_{abs}} \right)$$

Results

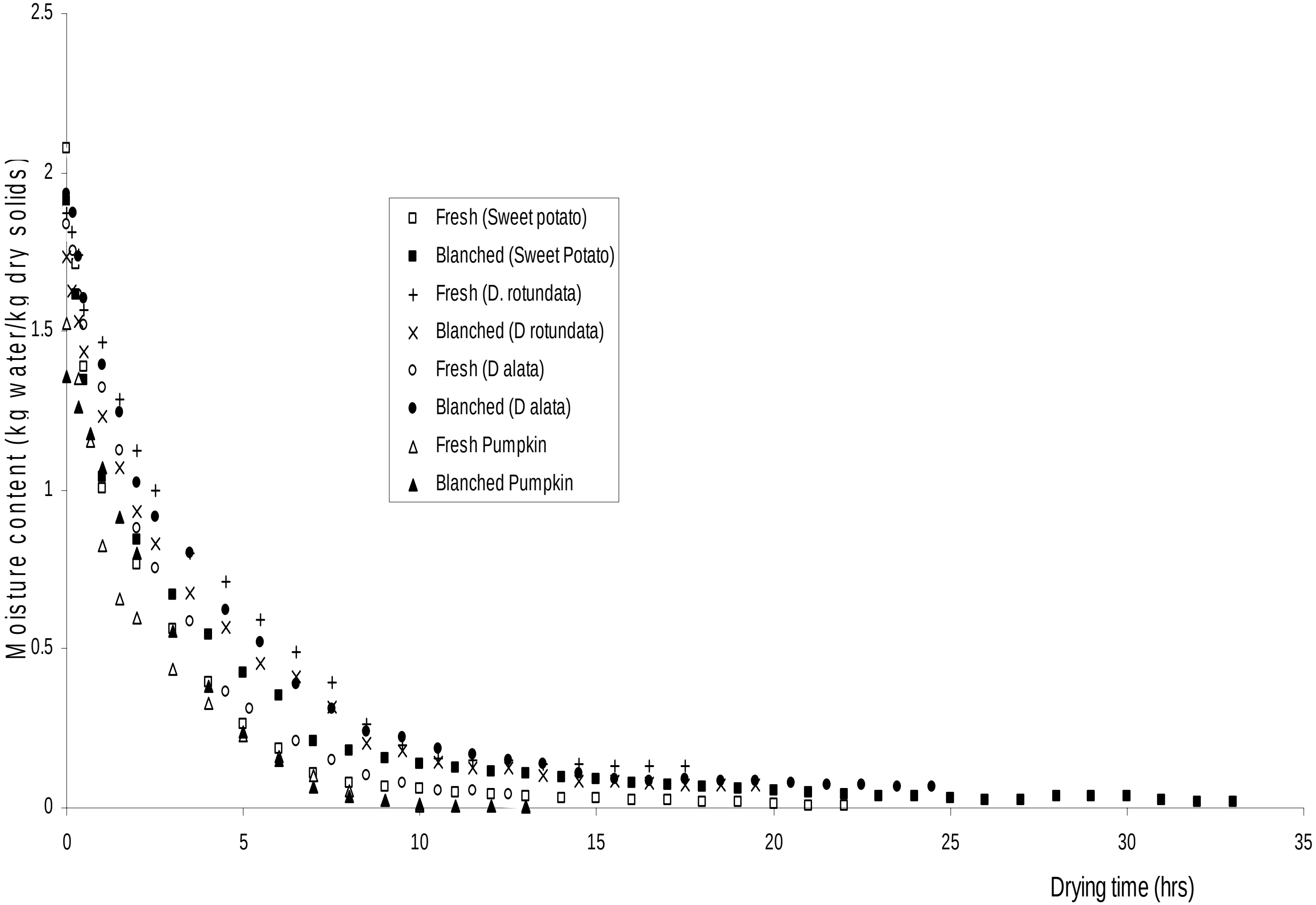

Fig. 1. Moisture content of sweet potato, yams and pumpkin air dried at 60°C.

Results contd

- Generally, blanched commodities showed higher moisture content during drying
- Moisture ratio of blanched *commodities* were higher than fresh (unblanched).
- Drying time required to reduce the moisture from the initial moisture content to desired moisture content for fresh (unblanched) sample is shorter than blanched samples.
- Differences in the drying profile and time of slice fresh and blanched commodities could be due to change in nature of the starches as a result of heating

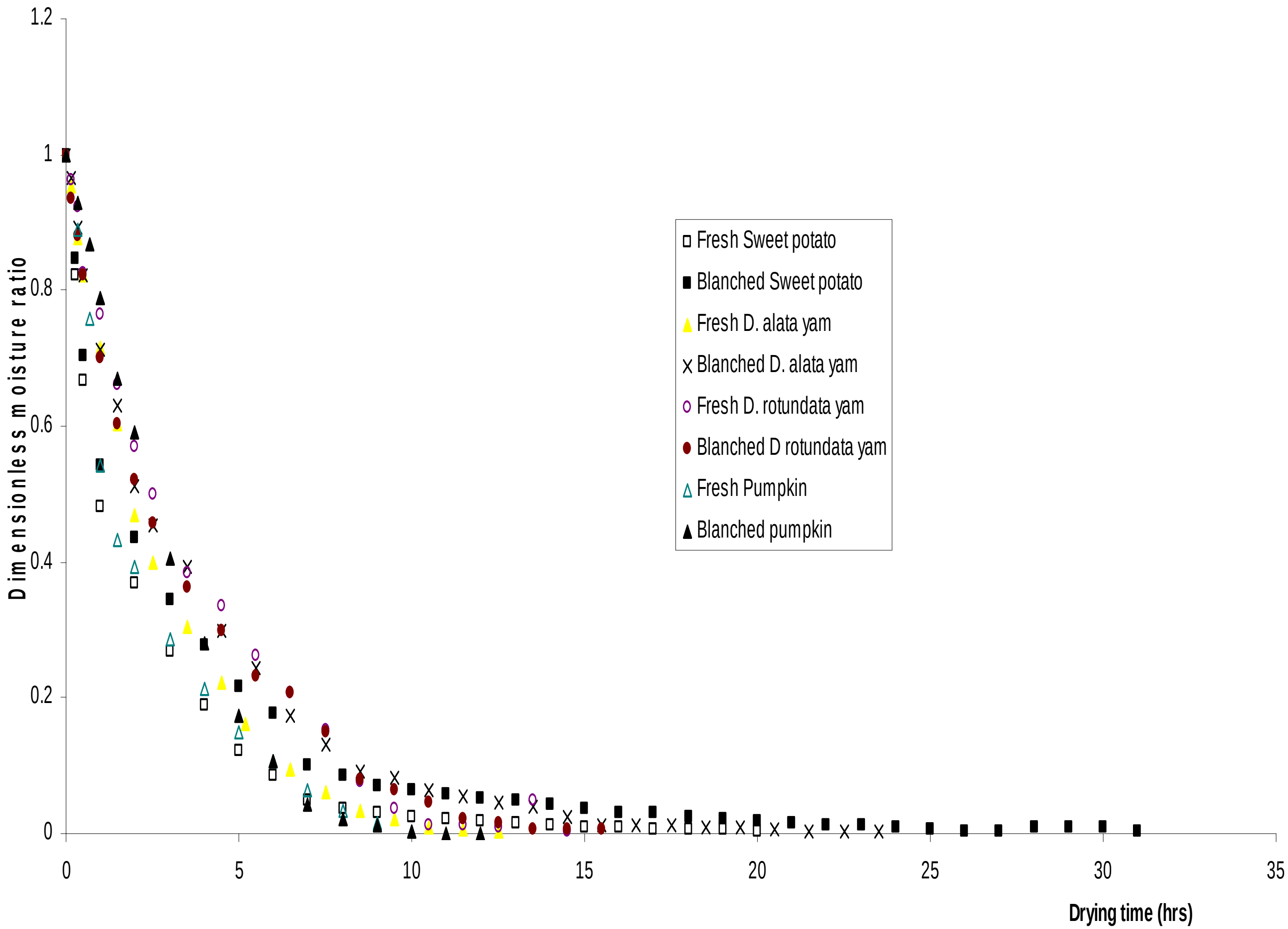

Fig. 2. Moisture ratio of fresh and blanched sweet potato, yams (*D. alata* and *D. rotundata*) and pumpkin during air drying at 60^{o}C.

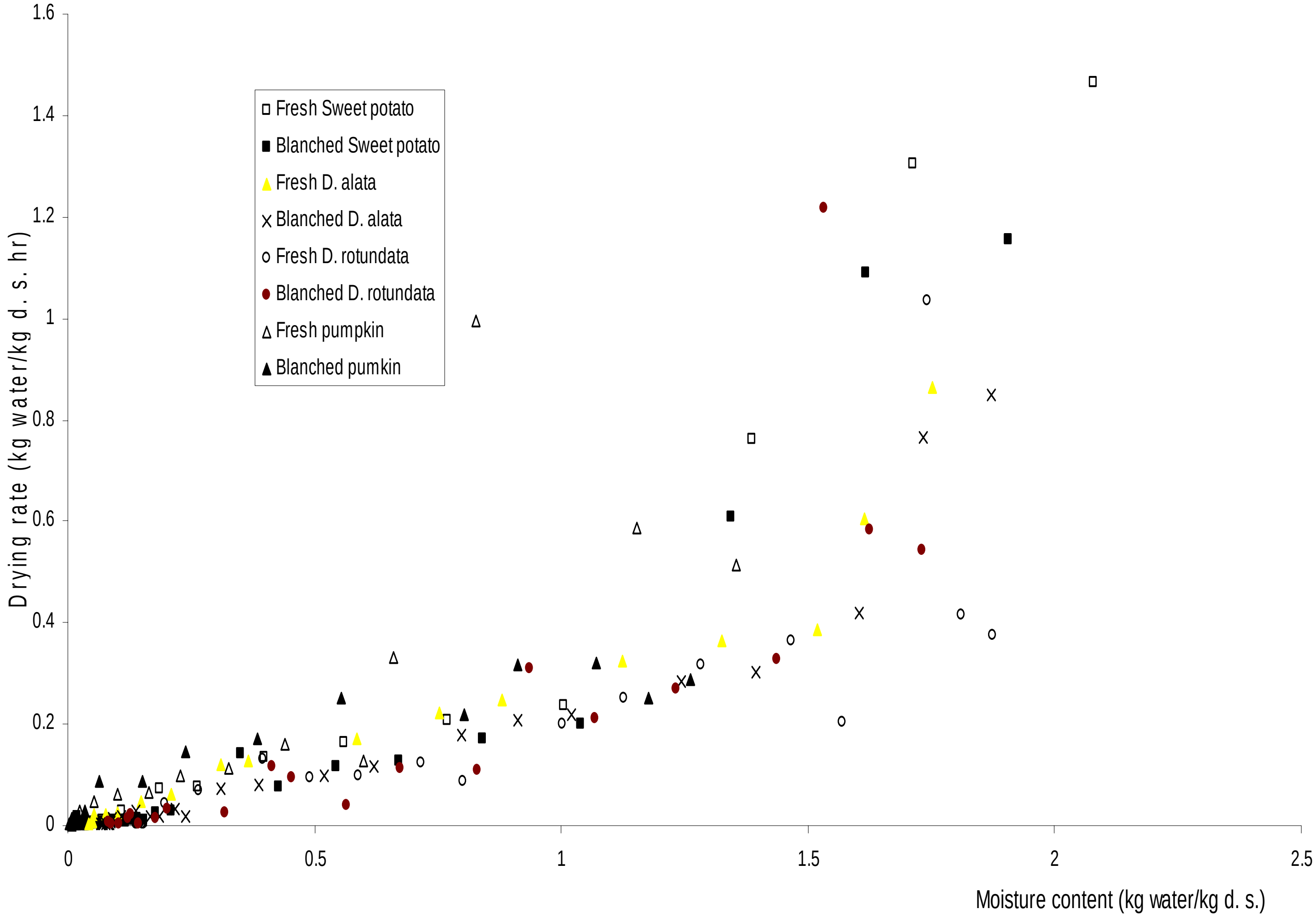

Fig. 3. Drying rate vsmoisture content of sweet potato, yams (*D. alata* and *D. rotundata*) and pumpkin.

Results contd

- Sweet potato, yam and pumpkin slices did not show a constant rate period of drying
- Drying rate was predominantly in the falling rate period, indicating that moisture removal was governed by diffusion
- Drying rate decreased with decreased moisture content of the commodities slices.
- Initially, blanched slices showed higher drying rates compared to fresh (untreated).
- Subsequently, drying rates of the blanched slices were lower than the fresh (unblanched) slices.
- At lower moisture contents (<0.2 g water/g d. s.) differences in drying rate tended to become small and obscure

Results contd

- Temperature dependence of the diffusivity coefficients was described by an Arrhenius-type relationship
- Calculated effective moisture diffusivity (D_{eff}) increased with increasing air drying temperature for both fresh and blanched commodities.
- Blanched commodities showed lower D_{eff} values compared to the unblanched samples.
- Moisture diffusivity increased with increased drying temperature
- Moisture diffusivity increased rapidly from 50 to 70^{o}C but with a marginal increase between 70 and 80^{o}C

Results contd

Table 1. Moisture diffusivity (m^2/s) of fresh and blanched sweet potato, yam (*D. alata* and *D. rotundata*) and pumpkin.

Drying temp. (°C)	Sweet potato		*D. alata*		*D. rotundata*		Pumpkin	
	Fresh	Blanched	Fresh	Blanched	Fresh	Blanched	Fresh	Blanched
50	6.47 E-10	5.67 E-10	1.11 E-07	9.21 E08	1.21 E06	1.39 E06	7.48 E10	9.96 E-10
60	8.86 x E-10	4.83 E-10	1.92 E-07	1.23 E-07	2.87 E-06	2.55 E-06	1.32 E-09	1.65 E-09
70	1.09 E-09	7.86 E-10	1.93 E-07	1.41 E-07	4.91 E-06	5.12 E-06	1.92 E-09	2.17 E-09
80	1.25 E-10	8.78 E-10	4.00 E-07	2.84 E-07	8.03 E-06	1.04 E-06	2.42 E-09	2.13 E-09

Results contd

Table 2. Activation energy for drying of 10 mm fresh and blanched sweet potato, yams and pumpkin.

Commodity	Activation energy (Ea) for mass diffusion	
	Fresh	Blanched
Sweet potato	20.4 (35.5)	12.7 (11.1)
Yam (*D. alata*)	43.0	25.3
Yam (*D. rotundata*)	59.9	63.1
Pumpkin	37.1	24.5

Results contd

- Activation energy for drying is the energy required to initiate mass diffusion from a wet food material during drying (Mittal, 1999).
- Blanched slices showed lower activation energy than the fresh (unblanched) samples.
- Blanching of the commodities resulted in a decrease in the activation energy require for mass diffusion during air drying
- A clear indication that blanched slices have lower energy requirement than unblanched slices during the subsequent air drying operation

Conclusion

- Drying of sweet potato, yams and pumpkin took place in the falling rate drying period.
- Drying characteristics of the commodities were affected by air temperature and blanching pretreatment.
- Increase in the air temperature and blanching caused a decrease in the drying time and an increase in the drying rate, respectively.
- Over the range of temperature, moisture diffusivities varied from 6.50 x 10-10- 2.45 x 10-9, 9.92 x 10-8 to 1.298 x 10-5, 6.36 x 10-11 - 9.75 x 10-9m^2/s for pumpkin, yams, sweet potato respectively.
- Ea of moisture diffusion during dehydration of pumpkin, yam and sweet potato were 24.49-43.27, 25.25-72.47, 11.1-30.4kJ/mol respectively

- Thank you for taking time to listen