Effects of packaging on dehydrated onion products

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Abstract: This study was conducted to select the best packaging material for dehydrated onion products in respect to weight ratio (WR)/moisture gain. Three types with five different thickness packaging materials were used for the study. The weight ratio of sulphited and 25% salt osmosed dehydrated onion were calculated at 15 days interval at room temperature (RT: 25-28^{0}C) and refrigerated temperature (RFT, 5^{0}C) for a period up to 360 days. The data were analysed as per first order reaction kinetics and weight ratio was plotted against time in semilog coordinate. RFT products in all films (polypropylene- PP, high density polyethylene- HDPE and ALF) bags and at RT only two ALF gained very little moisture with resultant low rate constant compared to those at RT may be related to dependence of rate constant as well as permeability constant on temperature. In fact these constants have exponential relationship with temperature as per well-known Arrhenius equation.

Key words: Onion**,** Packaging, aluminium foil, polypropylene, high density polyethylene.

Introduction

The shelf-life of dehydrated products depends on many deleterious reactions, which in turn depend on the specific nature of food materials, storage condition and nature of packaging. The undesirable changes that occur are due to off flavours, browning and loss of pigments and nutrients. Proper information of the causes of these reactions is highly necessary to improve the shelf life of the dehydrated products.

In the industrialized world less than 2% of food spoils between production and consumption, whereas in developing countries, 30-50% of all food is wasted, largely due to inadequate packaging (Rahman and Labuza 1999).

Villota and Hawkes (1980) in their review on the storage stability of dehydrated foods, discussed the factors mainly responsible for deterioration, that is, moisture, storage temperature and period, oxygen and light. They compiled the literature data on storage stability of several dehydrated products, which included dehydrated fruits, vegetables and their powder, based on method of drying, additional treatment, storage conditions, time required for appearance of earliest defects and the state of other factors at times of unacceptability.

The primary purposes of packaging are containment and protection. Containment refers to holding goods in a form suitable for transport, whereas protection refers safe keeping goods in a way that prevents significant quality deterioration.

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Materials and Methods

Summer onions were procured from Spices Research Center (SRC) of Bangladesh Agricultural Research Institute (BARI) and brought to the department of Food Technology and Rural Industries of Bangladesh Agricultural University (BAU), Mymensingh. Uniform size samples were first sorted to remove infested ones and then washed in running tap water thoroughly. The samples were peeled manually with stainless steel knife and sliced in cross-section wise using electric slicer. The sliced samples were divided into two parts. One part soaked in 1500 ppm sodium metabisulphide solution for 20 min. and another was soaked in 25% salt solution for 24 hr. After removing from solution the pretreated samples were spread on trays and dried in a mechanical drier at 60^{0}C until 6-10% mc (wb). The dehydrated onion slices were packed in Aluminum foils, ALF (130, 120 and 65µm), high density polyethylene, HDPE (60µm), polypropylene, PP (60µm). These packets were stored at room temperature (RT) (15-25^{0}C) and refrigeration temperature (RFT) (5±2^{0}C) at RH of 50-90% up to 360 days for storage study.

The weight of different dehydrated onion was determined gravimetrically at different time interval and weight ratio (W_t/W_o) was calculated by dividing sample weight at any time (W_t) by the samples initial weight (W_o).

Results and Discussion

The weight ratio (W_t/W_o) of 25% salt osmosed and sulphited dehydrated onion packed in different ALF with variable thickness such as 130 µm (T_1), 120 µm (T_2) and 65 µm (T_3); HDPE 60 µm (T_4) and PP 60 µm (T_5) was estimated at 15 days interval at RT (20-25^{0}C) and RFT (5^{0}C) for a period up to 360 days. The data were analysed as per first order reaction kinetics (Villota and Hawkes, 1992) and the weight ratio was plotted against time in semilog coordinate (Figs. 1- 3). The results are given and the following regression equations were developed (1 to 12).

Effect of packaging on the weight ratio in dehydrated osmosed onion during storage

It is seen in Fig. 1 that for 25% salt osmosed dehydrated onion, weight ratio increases with time except product packed in ALF-130 µm and 120 µm (i.e sample T_1 and T_2) and that after 360 days of storage period the highest WR (1.216) was found in T_5 (PP-60 µm) followed by T_4 (HDPE -60 µm) with WR 1.194 and T_3 (ALF 65 µm) with 1.13 while sample T_2 (ALF-120 µm) and T_1 (ALF-130 µm) did not show any weight gain. It is also seen that with almost similar thickness 65 µm vs 60 µm (sample T_4 & T_5), ALF 65 µm (T_3) gave quite low WR indicating better performance of ALF compared to HDPE and PP. The rate constant values (equations 1 to 5) such as $3x10^{-6}$/day for T_1 and T_2, $3x10^{-4}$ /day for T_3, $4x10^{-4}$/day for T_4 and $5x10^{-4}$ /day for T_5 also indicated that ALF 130 µm and 120 µm (T_1 and T_2) give negligible weight gain and is followed by T_3, T_4, while highest water uptake is given by T_5 for the storage period (i.e 1 year). From fig. 2 and equations (6 and 7), it is seen that during refrigeration storage samples T_1, T_2, T_3 , T_4 and T_5 show very little moisture gain (WR) and samples T_2, T_3, T_4 and T_5 gave similar rate constants ($2x10^{-6}$), while sample 1 (ALF-130 µm) gave only slightly lower rate constant ($1x10^{-6}$ day^{-1}). Comparing storage at

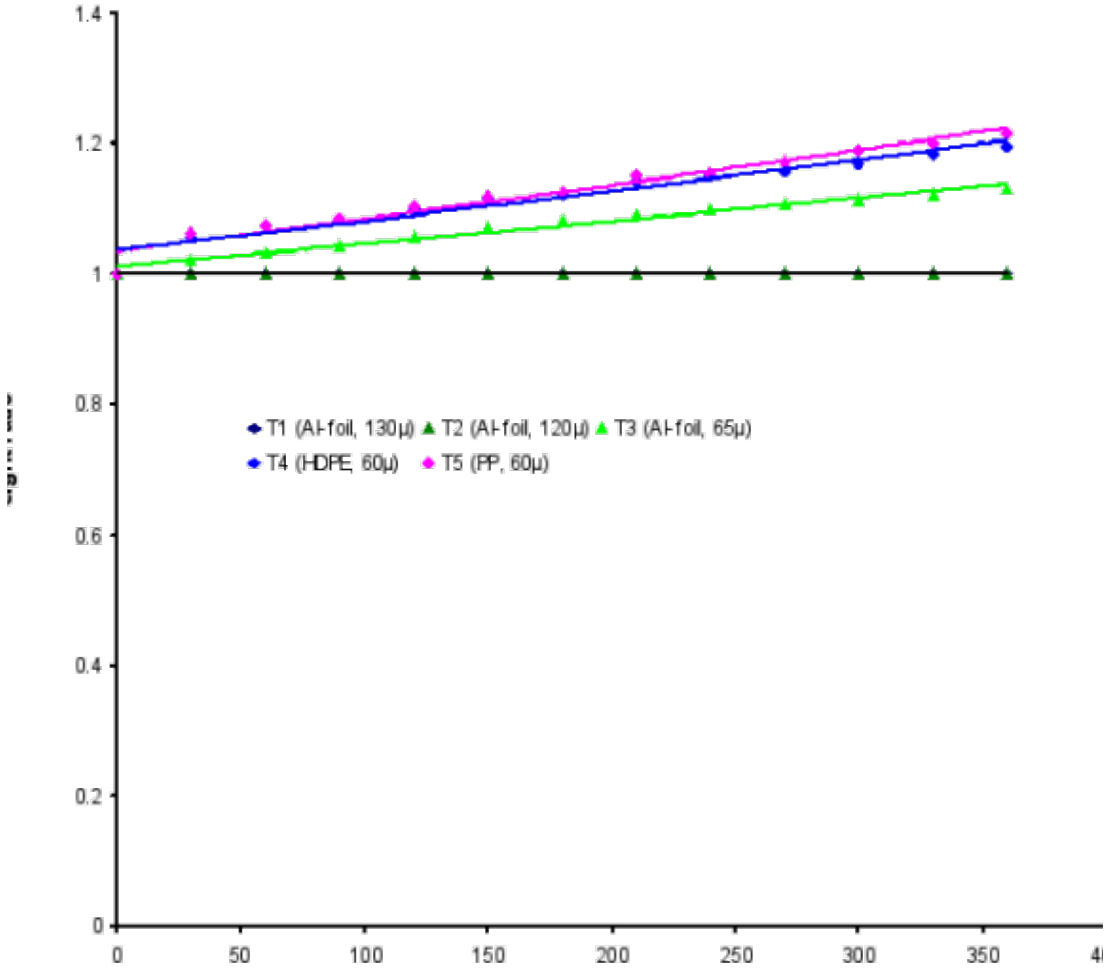

Fig.1. Osmosed (25% salt solution) dehydrated onion at RT

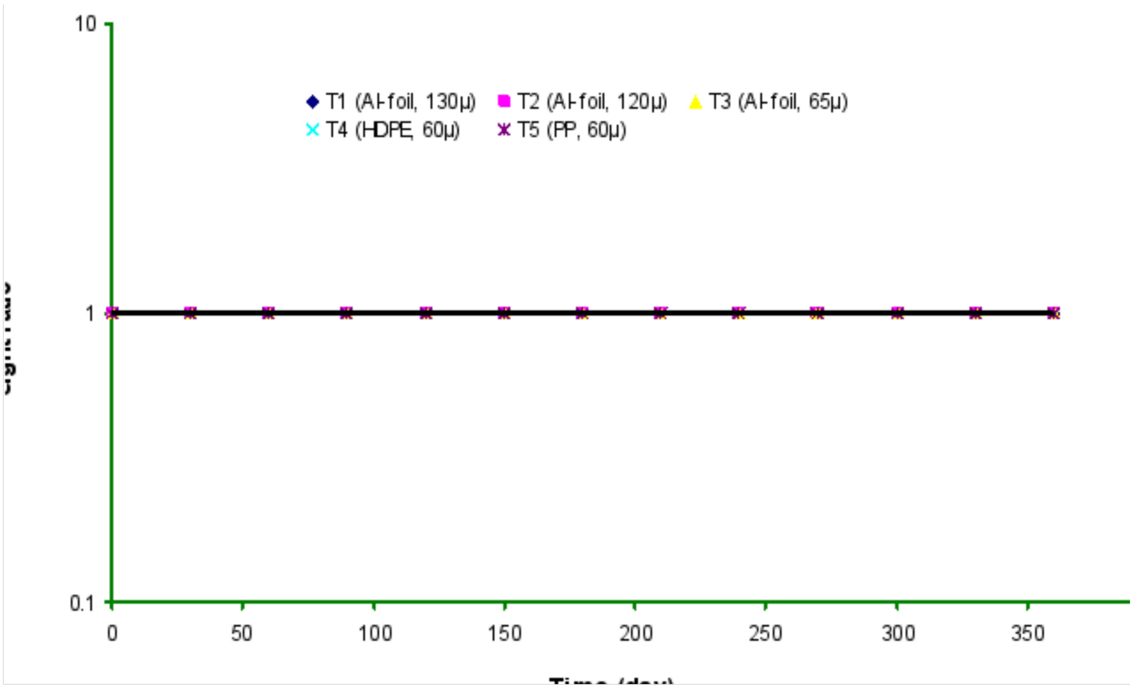

Fig. 2. Osmosed (25% salt solution) dehydrated onion at RFT

RT and RFT it is seen that rate constants are much higher at RT for a given packaging material (such as $3x10^{-6}$ at RT vs $1x10^{-6}$ at RFT for ALF 130 µm (T_1); $3x10^{-4}$ at RT vs $2x10^{-6}$ at RFT for ALF 65 µm (T_3).

For RT storage: Y_1= o.9999e $^{0.000003x}$, (R^2 =0.992 For T_1) .... (1), Y_2= e $^{0.000003x}$, (R^2 =0.996 For T_2)..............(2), Y_3= 1.0123e $^{0.0003x}$, (R^2 =0.997 For T_3) ....(3), Y_4= 1.0356e $^{0.0004x}$, (R^2 =0.937 For T_4) .... (4), Y_5= 1.0354e $^{0.0005x}$, (R^2 =0.952 For T_5) ....(5).

For RFT storage: Y_1= 0.9999e $^{0.000001x}$, (R^2 =0.973 For T_1) ....6), Y_2= e $^{0.000002x}$, (R^2 =0.990 For $T_{2,}$ $T_{3,}$ T_4 and T_5) ....(7).

Effect of packaging on the weight ratio in dehydrated sulphited onion during storage: Y_1= 0.9999e $^{0.000003x}$, R^2 =0.975 (For T_1) .... (8), Y_2= 0.9999e $^{0.000003x}$, R^2 =0.972 (For T_2) .... (9), Y_3= 1.007e $^{0.0003x}$, R^2 =0.992 (For T_3) .... (10), Y_1= 1.023e $^{0.0004x}$, R^2 =0.975 (For T_4) .... (11), Y_1= 1.031e $^{0.0005x}$, R^2 =0.963 (For T_5) .... (12).

The results from Fig. 3 it is seen that after 360 days of storage the highest weight ratio (1.24) was given by sulphited and dried onion in PP-60 µm (T_5) and successively followed by sample in HDPE-60 µm (T_4) with 1.20 WR, ALF- 65 µm (T_3) with 1.138 WR, ALF -120 µm (T_2) and ALF 130 µm (T_1) with 1.00 WR. It is also seen that from equations (8 to 12) rate constant values confirms the above behaviour. The highest rate constant value is found for T_5 ($5x10^{-4}$) which was successively followed by T_4 ($4x10^{-4}$), T_3 ($3x10^{-4}$), T_2 and T_1 ($3x10^{-6}$). Comparing these results for blanched + sulphited + dried product with those of salt osmosed +dried (Fig.1 vs Fig. 3 and relevant equations) it is seen that rate constants are similar for both types of product in identical packaging material.

The weight ratio thus also moisture gain in T_5 (60 µm PP) as well as rate constant was the highest due to lower resistance to vapour transmission or higher permeability constant compared to HDPE (T_4) and ALF (T_3, T_2 and T_1). Farall (1976) found that water vapour transmission rate (0.5-0.6 and 0.3-0.6 g/24hr/100 sq.in.) and permeability (3.8-10.5 and 2.0-5.0 cm^2/sec/atm) for PP and HDPE respectively. Foil of low thickness (T_3-65 µm) might have microscopic discontinuities (pinholes) and allow limited diffusion of gases and vapours. The thicker aluminium foil such as ALF-120 µm (T_2) and ALF-130 µm (T_1) have low water vapour permeability constant. Karel (1975) reported that at 100^0F and 95% vs 0% R.H (relative humidity) 0.00035 inch ALF and 0.0014 inch ALF give 0.1 to 1.0 and <0.1 permeability constant (g mil 24 hr^{-1} 100 in^2) respectively. Thus permeability constant varies with composition of packaging material and the higher the thickness, the lower is the constant. The variations of K-values determined from kinetic approach also justifies the above principles of permeation. In fact, it has been previously shown that K or m (rate constant) for absorption and desorption has an inverse relationship with thickness (Islam, 1980). The observation that at RFT products in all films (PP, HDPE, ALF) bags gained very little moisture with resultant low rate constant compared to those at RT may be related to dependence of rate constant as well as permeability constant on temperature. In fact these constants have exponential relationship with temperature as per well-known Arrhenius equation (Karel *et al.*, 1975, Villota *et al.*, 1992). Graf and Saguy (1998) also observed that generally at higher temperature the quality of food products drops significantly and that the higher the temperature the higher is the activation energies of those films, so that the permeability rates rise.

The observed behaviour that rate constant are similar for two sample (salt osmosed and sulphited dehydrated onion) due to identical packaging material may be attributed to similar initial water activity (a_w) of the two products and similar environmental conditions.

Due to improper packaging during transportation, distribution and storage, different physical and mechanical injuries occur which causes quality losses in dehydrated onion products. Appropriate packaging and storage may reduce such problems with the quality products. Therefore it is recommended that for long time storage at RT both ALF-130 µm (T_1) and ALF-120 µm (T_2) can be used as packaging material and on the other hand for storage at RFT all films can be used.

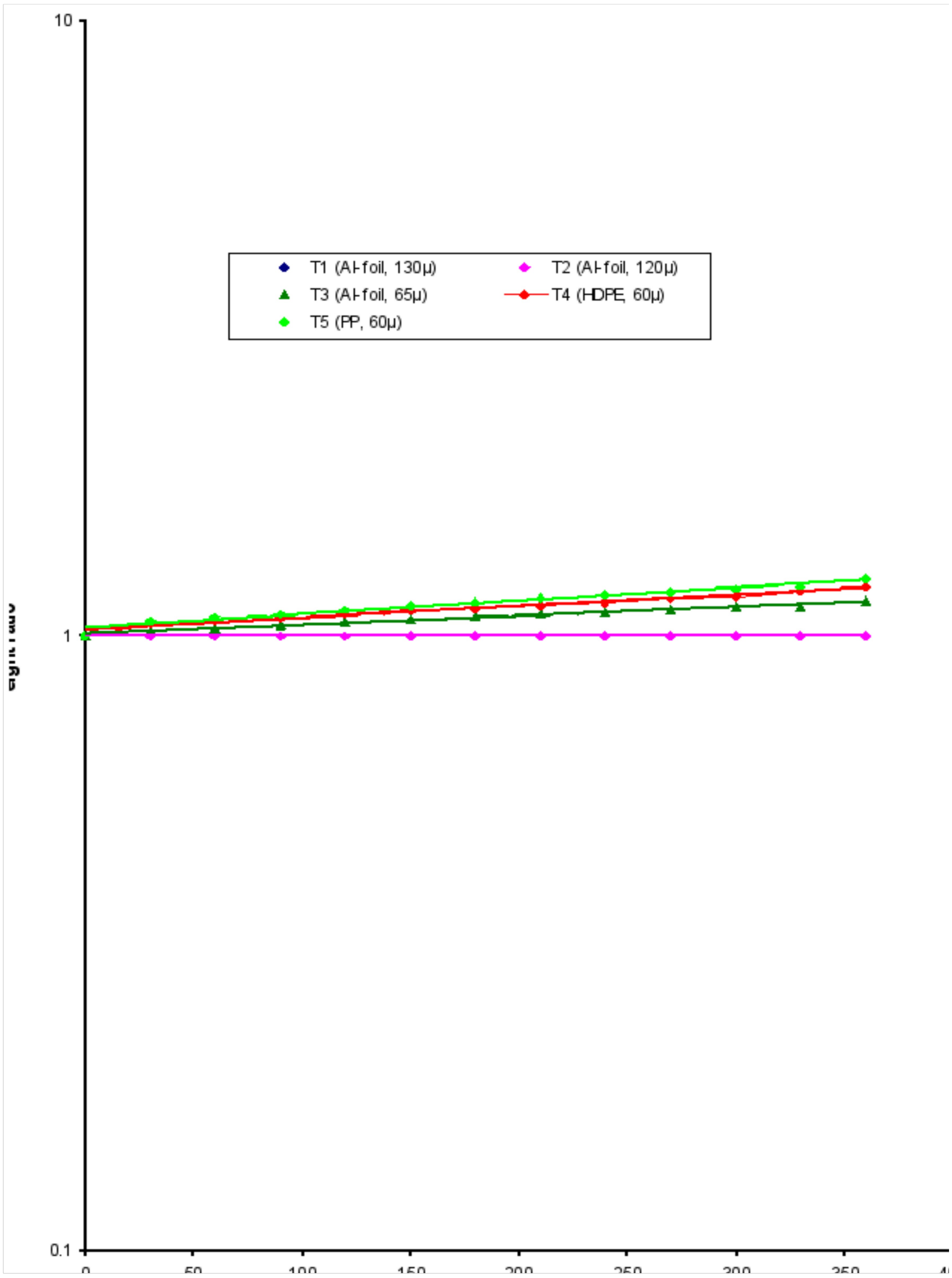

Fig. 3. Blanched and sulphited dried onion at RT

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