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Research Article

Effect of Drying Temperature and Natural Preservatives on Reducing Aflatoxins in Solar Dried Persimmon (*Diospyros kaki* L)

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Abstract: Experiments were conducted in 2013-14 to study the effect of drying temperature and natural preservatives for reducing aflatoxins in dried persimmons. Persimmons were dried using a flat plate solar collector connected to a drying chamber at a temperature range of 40 to 60°C and less than 10% relative humidity. Persimmons dried at 40°C took 22, at 50°C 19 and at 60°C 17 hours to minimize moisture from 76% to less than 9% under an average drying rates of 0.11, 0.12 and 0.13 $g_{H2O}.g_{d.m}^{-1}$ respectively. After drying the samples were studied for aflatoxins. Analysis of variance was done using two factorial completely randomized design. The analysis of variance (ANOVA) showed that both the factors significantly ($\alpha \leq 0.01$) affect the aflatoxin deposition in dried persimmons. Maximum aflatoxins of 31.7 µg kg−1 was recorded in persimmons treated with Aloe vera and dried under a temperature of 40°C with B1 and G1 type of aflatoxins while minimum of 7.1 µg kg−1 was recorded in persimmons treated with honey and dried under a temperature of 60°C with G1 type. It was concluded that increase in temperature of the drying system decreased the contamination by fungus up to 22%. Also the overall performance of honey was good as compared to aloe vera gel used as natural preservatives for reducing aflatoxins in dried persimmons.

Keywords: Persimmon, solar drying, moisture, drying rate, aflatoxins

1. INTRODUCTION

Persimmon (*Diospyros kaki* L) is native to China and is a seasonal fruit grown in many countries like Korea, India, Iran and Pakistan. They have a good demand and good market all over the world, but due to its short availability time and shelf life they are dried and preserved for future consumption. The dried persimmons are delicious and rich in nutrients and are popular worldwide [1]. They are in high demand due to their aroma, taste and medicinal values. Quality dried Persimmons have high demand in international market. The best quality indicator is the minimum pathogenic attacks on the persimmons during drying that is, the minimum amount of aflatoxins in the dried persimmons [2].

In most cases the quality of dried persimmons is affected by the presence of afltoxins in the product. Aflatoxins (AFs) are chemicals generated by fungus [3]. They are a serious threat to human health if its consumption exceeds the minimum limit (ML). The ML for AFs in dried fruits is 10 µg kg−1. If the ML level increases, it may be dangerous for health and may cause serious problems like ulcer, cancer and other diseases [4]. Once aflatoxins are deposited on the dried food it is very hard to remove. The best option is preserved before drying [5]. Many chemical preservatives are used to stop fungus attacks during drying, but as we know, chemicals are not good for human health so natural or bio preservatives are the best choice for preserving dried fruits [6].

Several genera of fungus attack on dried persimmons during and after drying, causing AFs deposition in which Aspergillus is the main fungus attacking the persimmons during drying. Scientists

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and researchers are using different natural preservatives to minimize the fungal attacks on the dried fruits [7]. Aloe Vera (*Aloe barbadensis* M) gel at different concentrations can minimize the AFs in dried persimmons. If used, Aloe Vera gel is best remedy for the problem of AFs contamination in dried fruits [7, 8]. Honey is a natural preservative for dried persimmons which can reduce AFs significantly [2]. The purpose of the study was to examine the effect of temperature and natural preservatives (Aloe Vera gel and honey) for minimizing AFs in dried persimmons for quality assurance.

2. MATERIAL AND METHODS

2.1 Preparation of Solutions

The gel was extracted from fresh leaves of Aloe Vera. The gel extracted was mixed with distilled water to prepare 5% solution. Good quality honey was added to distilled water to prepare 5% solution. Also a mixture of both Aloe Vera gel solution and honey solution were mixed to prepare a mixture of both the solutions [2, 6].

2.2 Persimmon Processing and Drying

Persimmons were peeled by the peeler, blanched for two minutes in water having a temperature of 80^{o}C and were soaked in the prepared solutions for two minutes. After soaking they were put on a clean tray and were dried in the solar collector (Fig. 1) till their moisture became less than 9% (recommended to minimize microbial attacks). The temperature of the solar collector was regulated using a regulator to control the flow of the fan. The drying curves were then developed for the persimmons [9, 11].

2.3 Extraction and Determination of Aflotoxins

Each of the samples was tested to extract and determine the presence of AFs [6, 7].

2.4 Statistical Analysis

The experiment was laid out as a completely randomized design The factors and their levels are as given below:

Factor A (Temperature of drying chamber) T1 = 40^{o}C, T2 = 50^{o}C and T3 = 60^{o}C

Factor B (Natural Preservatives) P1= 5% Honey solution, P2= 5% Aloe Vera solution, P3= P1+P2 combination

The data collection was replicated three times. ANOVA was computed using 18 treatments by the standard procedure. The means of AFs were compared using Least Significant Difference (LSD) test [12].

3. RESULTS AND DISCUSSION

3.1 The Drying Curves of Persimmons

The drying curves of persimmons on wet basis are shown in Fig. 2 and on dry basis are shown in Fig. 3. The data in the Fig. 2 show that increase in drying temperature decreases the drying time. The initial moisture content of persimmons was 76%, which was reduced to less than 9%. Persimmons dried at 40^{o}C took 22, at 50^{o}C took 19 and at 60^{o}C took 17 hours to minimize moisture content from 76% to less than 9% respectively. Two term exponential model was applied to the curves to find the correlation between drying time and moisture lost. The results showed a strong correlation between drying time and moisture lost with an R^2 value of -0.993. These results are in accordance with the findings of Kim et al [2] and Hanif et al [10]. The data in Fig. 3 shows a persistent constant and falling rate drying by the persimmons. The drying rate increased with increase in drying temperature. The average drying rate of Persimmons dried at 40^{o}C was 0.11, at 50^{o}C was 0.12, and at 60^{o}C was 0.13 g H_2Og dm^{-1}, respectively. Two term exponential model was applied on the drying rate curves to find the correlation between with drying time. The results showed a strong correlation between drying time and drying rate with an R^2 value of -0.995. These results are in argument with the findings of Hyun and Woo [1], Yong- Seo et al [13] and Hanif et al [10, 11].

3.2 Aflatoxins Deposition on Dried Persimmon

The analysis of variance (Table 1) showed that drying temperature and natural preservatives as well as their interaction have a significant effect ($\alpha \leq 0.01$) on reducing the AFs in dried persimmons. The data of AFs extracted on each sample are given in Table 2. The maximum amount of 31.7 μg kg^{-1} AFs was found in samples treated with aloe vera gel and dried under a temperature of 40^{o}C while the minimum of 7.1 μg kg^{-1} was found in samples treated with honey and dried under a

temperature of 60°C. The means comparison of temperature taken as a main factor showed that the higher AFs of 21.5 µg kg^{-1} was recorded under a temperature of 40°C followed by 16.8 µg kg^{-1} recorded under a temperature of 50°C and the lowest in 9.7µg kg^{-1} was recorded under a temperature of 60°C. The means comparison of natural preservatives showed that the higher AFs of 23.8 µg kg^{-1} was recorded in persimmons treated with aloe vera followed by 14.8 µg kg^{-1} recorded in the dried persimmons treated with aloe vera and honey while the low of 9.4 µg kg^{-1} AFs was recorded for persimmons treated with honey. This is due to the reason that the honey was having strong concentration and power reduced mycoflora germination. That is why the samples treated with honey showed reduced AFs levels as compared to aloe vera. Fungal growth was minimum on dried persimmons treated with honey. These results are in accordance with the findings of Hyun and Woo [1], Kim et al [2], Najmus [5] and Karina et al [7] who reported the same results for aloe vera and honey for reducing AFs in dried persimmons.

Fig. 1. Front view of the flat plate solar air heater used in the experiment.

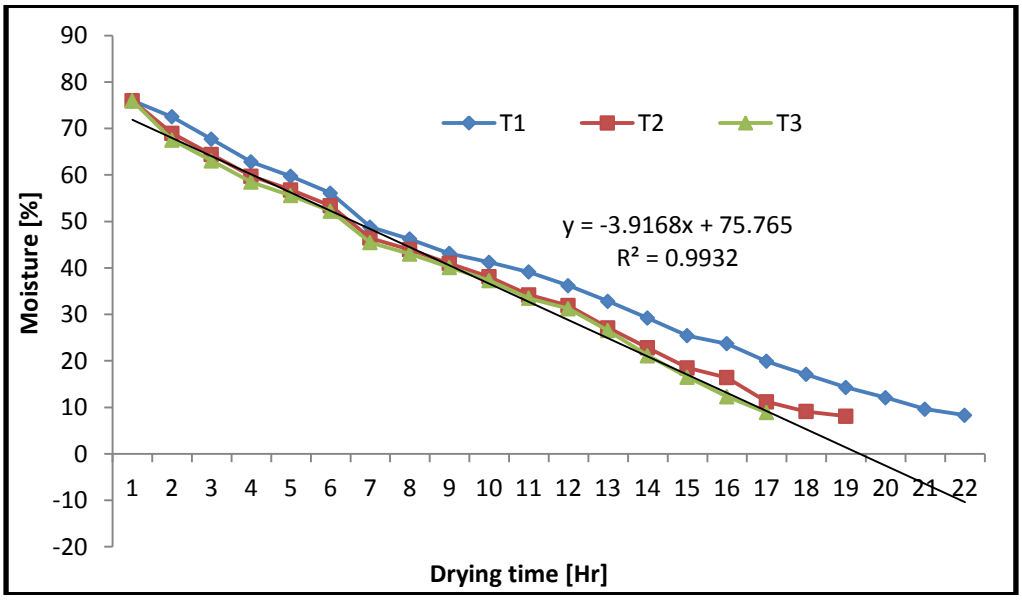

Fig. 2. Moisture losses on wet basis.

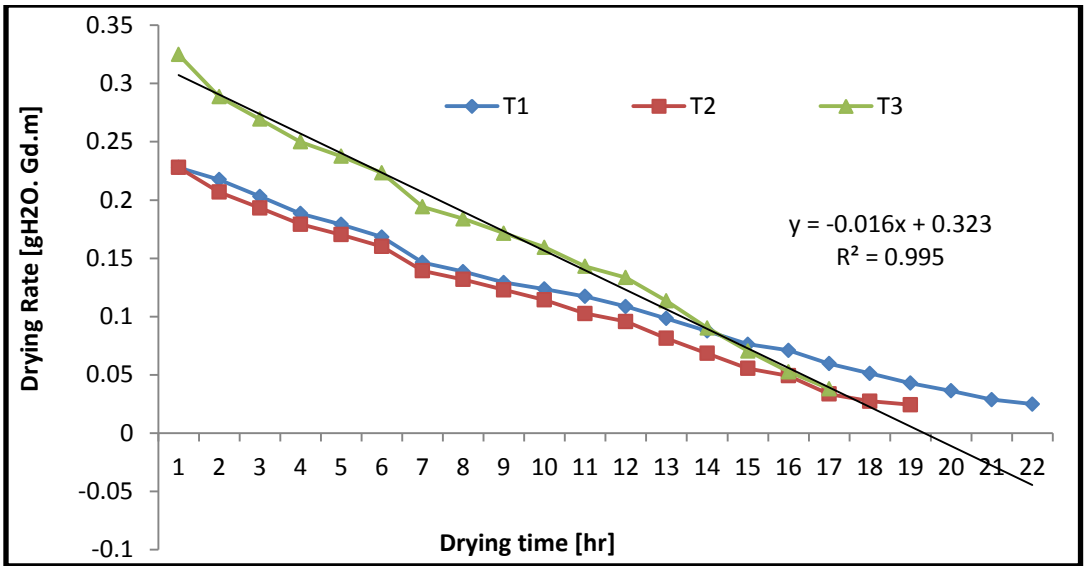

Fig. 3 Moisture losses on dry basis.

Table.1. Analysis of Variance Table for AFs.

Source	DF	MS	P	
A	2	107.053	5.99	**
B	2	159.303	9.55	**
AXB	4	58.0753	12.93	**
Error	9	71.547	17.887	
Total	17	604.260		

Table. 2. Means Comparison of Drying Temperature and natural preservatives on the aflatoxins (µg kg−1) deposition on dried persimmons @ 1% confidence interval **.**

Natural Preservative	Drying Temperature			
	T1	**T2**	**T3**	**Mean**
P1	$31.7^{\alpha,\beta}$	$27.1^{\alpha,\beta}$	12.6^{α}	**23.8a**
P2	11.3^{α}	9.7^{α}	7.1^{α}	**9.4b**
P3	21.6^{α}	13.6^{α}	9.3^{α}	**14.8ab**
Mean	**21.5a**	**16.8ab**	**9.7b**	

LSD= 2.103
α stands for AFs G1 type and β for B1
Means followed by different alphabets are significantly different from each other ($P \leq 0.01$)

4. CONCLUSIONS

It was concluded from the results that drying persimmons at 60°C treated with honey solution to minimize the Mycoflora attacks on them so that minimum AFs is deposited on them. It is recommended that AFs contamination in persimmons requires further investigation, monitoring and routine analysis. Proper harvesting, drying, handling, storage and transport conditions need to be employed on persimmons to reduce AFs in persimmons. Furthermore, different concentrations of honey and aloe vera gel must be tested to achieve more appropriate results.

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