DRYING OF DATES BY USE OF KLIN DRYER AND INVESTIGATING OF DRYING PROCESS

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Abstract
Since moisture is the most important cause of food spoilage, moisture reduction is one of the most commonly methods for foods storage and extending their shelf life. Drying process extends the shelf life of products while causing great organoleptic changes in food affecting its texture even aroma, and taste. So, drying conditions must be thoroughly examined and controlled in order to keep the quality of products and provide proper acceptability. Dates are valuable dietary sources being produced worldwide. They rapidly develop microbial spoilage due to their high nutritional value and high water content. Kiln drier is industrial drier applied commonly for fruits drying. As shown in this study, this drier may effectively reduce the moisture content of date samples thereby preventing their spoilages. The aim of this study was to dry dates by using kiln drier at different air speeds (1, 2 and 3 m/s) and temperatures (65, 75, 85 and 95°C) and to investigate the drying process for 5 h and at time intervals of 1 h. The results showed application of high speed and temperature may accelerate drying process being more noticeable for shorter drying times and data showed that the moisture of samples exhibited a falling trend as the temperature, time and speed of the drier increased whereas longer drying time resulted in decreased rate of moisture reduction.

Keyword: kiln drier, dates, moisture content, processing.

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1. INTRODUCTION

The most important cause of foods spoilage, is moisture namely foods aw. Thus, moisture reduction is one of methods for preservation of foods and extending their shelf life. If foods moisture content is reduced, not only different microorganisms are unable to grow and develop spoilage but many chemical reactions diminishing foods quality are reduced. However, drying extends the shelf life of products while causing great organoleptic changes in food affecting its texture even aroma, and taste. So, drying conditions must be thoroughly examined and controlled in order to keep the quality of products and provide proper acceptability (Bondaruk *et al*, 2007). In general drying is performed in two forms natural and industrial. Natural methods are very low cost and easy but resulting in a product with poor quality. In contrast industrial driers require more cost and technology while providing various benefits e. g. less contamination, higher output controlled drying conditions and maintained quality of final product (wang *et al*, 2005). Drier kiln is among commonly used industrial driers being widely applied for drying foods especially fruits. In this on which foods are placed as a thin layer and then air is blown into the drier at specified speed and temperature. The major factors affecting the final quality are the applied speed and temperature. (Mugabi *et al*, 2009) Dates are among highly valuable food products consumed worldwide. However they may

rapidly develop microbial spoilage due to high moisture content. (Falade *et al* ., 2007)
For this reason dates are late harvested for the produces to lose a part of their moisture. Nevertheless the remaining moisture may also cause spoilage.
Therefore, the moisture is reduced through various ways to improve the handling and shelf life. (Kulkarni *et al*, 2008)The objective of this study was to dry dates by using kiln drier at different speeds and temperatures and to investigate drying process.

2. MATERIALS AND METHODS

Dates were obtained in wood containers province Khuzestan, Iran. Then, they were sorted and dried by drier kiln applying certain speed and temperature. The air temperatures applied in this study were 65, 75, 85 and 95°C and the its speeds included 1, 2 and 3 m/s. the samples were dried for 5 h and the moisture was measured at 1 h intervals by using oven (Memmert, Western Germany) according to National standard (ISIRI, 2003).

3. RESULTS AND DISCUSSION

The results of moisture variations during drying are given in Tables 1-3. Initial moisture average was 37.21% (Twb). At all applied temperatures the samples moisture reduced significantly over time, as expected. Moisture variations with air speed (1 m/s) are presented in Table 1. After drying for 1 h moisture contents at 65, 75, 85 and 95°C were 34.91%, 35.01%, 32.22% and 32.41 respectively. At all applied temperatures upon processing for 1 h at 1 m/s a significant difference was observed between the samples and control, however there were no significant difference between dates moisture contents at 65 and 75°C as well as 85 and 95C (1 st drying hour). At all studied times did not show any significant difference between moisture content of samples at 65 and 75 °C while when drying time was proceeding a significant difference was noticed between dates moisture content at 85 and 95C as the final moisture content upon 5 h drying reached 23.10 and 21.17% at 85° C and 95°C, respectively.

Table 1: Effect of air temperature and speed on moisture content of dates

Q =1 m/s	Air temperature			
Time	65	75	85	95
1	34.91±2.01^{aA}	34.01±7.21^{aA}	32.22±6.74^{bA}	32.41±2.51^{bA}
2	33.12±3.14^{aA}	32.71±5.69^{aB}	31.41±5.21^{abA}	30.93±6.71^{bB}
3	30.12±5.18^{aB}	30.42±4.01^{aC}	28.93±6.05^{bB}	27.14±2.68^{bC}
4	27.43±2.84^{aC}	26.12±3.15^{abD}	25.17±2.13^{bC}	23.24±3.65^{cD}
5	25.18±3.65^{aD}	24.12±2.78^{abE}	23.10±3.62^{bD}	21.17±1.28^{cE}

$^{a-c:}$Means in same row with same superscript are not significantly (P<0.05) different.
$^{A-E}$Means in same colum with same superscript are not significantly (P<0.05) different.

Table 2: Effect of air temperature and speed on moisture content of dates

Q =2 m/s	Air temperature			
Time	65	75	85	95
1	32.51±5.23^{aA}	32.67±2.54^{aA}	31.04±3.65^{abA}	30.21±2.61^{bA}
2	31.08±6.24^{aA}	31.11±6.21^{aA}	28.52±1.26^{bB}	27.71±3.45^{bB}
3	29.79±2.13^{aB}	29.12±2.87^{aB}	27.42±3.62^{bB}	25.91±5.07^{cC}
4	26.92±3.62^{aC}	26.04±3.96^{aC}	24.51±2.69^{bC}	23.18±3.28^{bD}
5	24.89±2.84^{aD}	23.02±2.48^{bD}	23.03±3.48^{bC}	20.01±2.15^{cE}

$^{a-c:}$Means in same row with same superscript are not significantly (P<0.05) different.
$^{A-E}$Means in same colum with same superscript are not significantly (P<0.05) different.

Table 3: Effect of air temperature and speed on moisture content of dates

Q =3 m/s	Air temperature			
Time	65	75	85	95
1	32.11±3.14 ^{aA}	32.07±1.89 ^{aA}	31.41±3.61 ^{abA}	30.12±1.29 ^{bA}
2	31.01±2.63 ^{aAB}	29.71±3.14 ^{bB}	26.21±2.91 ^{cB}	25.73±2.63 ^{cB}
3	30.05±6.14 ^{aB}	28.12±2.63 ^{bB}	25.41±2.84 ^{cBC}	24.12±4.28 ^{cB}
4	26.15±2.36 ^{aC}	25.73±3.91 ^{abC}	24.17±6.31 ^{bC}	22.11±3.62 ^{cC}
5	24.88±3.91 ^{aD}	23.11±3.69 ^{bD}	22.81±4.20 ^{bD}	19.43±1.39 ^{cD}

$^{a-c:}$Means in same row with same superscript are not significantly (P<0.05) different.
$^{A-D}$Means in same colum with same superscript are not significantly (P<0.05) different.

Table 2 shows moisture variations of date samples at different time intervals and temperatures at the speed of 2 m/s. Like previous result (Table1) after drying for 1 h all samples showed significant difference from control.

At 65° and 75°C all samples statistically had similar moisture contents within 1 st 4 h drying while within 5 th h, there was a significant difference between dates moisture content dried at 65 and 75 °C as their moisture amounts reached 24.89 and 23.02%. While air temperature reached to 95°C there was always a significant difference between samples moisture contents as compared to that of samples dried at 65°C and 75 °C.

Comparing with 85 and 95°C upon drying for 1, 2 and 4 h, there were no significant difference between samples whereas the samples showed significant difference after drying for 3 and 5 h as the moisture contents of dates dried at 85°C and 95 °C after 5 h were 23.03 and 20.01% respectively.

The results of moisture variations of date samples dried at different temperatures at the speed of 3 m/s are presented in Table 3. Apposite of previous result (Table 1, 2) There was considerable difference between samples dried at 65 °C and 75 °C regarding percentage of moisture (drying for 2 and 3 h), and so significant variations were observed at higher temperatures and durations as upon drying for 4 and 5 h at 85 °C and 95°C and moisture contents reached 22.81 and 19.43% respectively.

In comparing drying speed, moisture reduction rate increased as an increase occurred in the speed of drying at all studied times since with increasing speed of air, dry air with low moisture content would rapidly surround the samples, it means the rate of disappearing boundary layer of moisture between the samples is accelerated.

These variations however were insignificant for higher drying durations. For instance upon drying for 5 h at 65 °C samples moisture contents were 25.18 , 25.11 and 24.88% at the speed of 1, 2 and 3 m/s, respectively being statistically insignificant. With increasing temperature, moisture content reduction was increased.

For example after processing for 5 h at 95C samples moisture contents reached 21.17, 20.01 and 19.43% at the speed of 1, 2 and 3 m/s, respectively.

Drying within a short time resulted in accelerated moisture reduction, as upon drying for 2 h at 95 C, samples moisture contents were 30.93, 27.71 and 25.73% at the speed of 1, 2, 3 m/s respectively being statistically significant.

Regarding the samples moisture content over time, in most cases as expected a significant difference was observed being less significant when drying time was prolonged, because the samples contained low water caused them hardly to lose their moisture. The result of this study was agreed with Afshari Joibari in 2013 , who reported that with increasing the speed and temperature of air the rate of drying will be increased and with increased the time of drying the rate of drying was reduced. (Afshari Joibari *et al.,* 2013)

3. CONCLUSIONS

Since moisture is the most important cause of food spoilage, moisture reduction is one of the most commonly methods for foods storage and extending their shelf life. Kiln drier is industrial drier applied commonly for fruits drying.

As shown in this study, this drier may effectively reduce the moisture content of date samples thereby preventing their spoilages.

As the results show application of high speed and temperature may accelerate drying process being more noticeable for shorter drying times.

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