J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 6 (9): 1125 - 1132, 2015

INFLUENCE OF SOFTENING PROCESS ON QUALITY OF DATES FRUITS

El Ashmawy, N.M. ; K. A. M. Ahmed* and M. S. El Marazky
Agricultural Engineering Research Institute (AEnRI) , Giza, EGYPT.
***Corresponding author: Khaled A. M. Ahmed; kamahmed63@yahoo.com**

ABSTRACT

As food-engineering processes affecting fruit quality, the influence of softening process on date fruit texture was the aim of this experimental study. Annual production of dates in the Arabic countries is about 65.23% of the world production, which commonly used consumed in Tamr stage (fresh fruits) where fruit moisture content becomes less than 30%. Three different temperatures (50, 60 and 70ºC) and five different exposure time (15, 30, 60, 120 and 180 s) were used to study and examine their effect on texture profile analysis (TPA) characteristics of date fruit (*Sukkari*). The obtained results showed that, the exposure time had more effect on the total color difference than the softening temperature. The obtained data also revealed that, the results of TPA characteristics tests were significantly affected by exposure time than softening temperature except adhesiveness and cohesiveness.

INTRODUCTION

Date fruits (*Phoenix dactylifera L.*) are considered one of the most important fruit in Middle-East region for its social, religion and economic issues. Approximately 65.23% of the world production is produced in Arabic countries (FAOSTAT, 2014). In addition to the fact of that date fruits have significance as a stable food, their use in date products and industrial applications have been increased. Saudi Arabia takes the third place in the world production with 1 031 082 tons, which represents approximately 37% of those goes to manufactures (Calculated from Indicators of the Dates industry in Saudi Arabia 16th Issue). As a result, studying engineering processes on date fruits is essential from either quality point of view or design and performance point of view. Variation in characteristics of date fruits lead to differences of their quality. Date quality is determined based on physical properties (color, size, shape ... etc.) and mechanical properties which characteristics absence of defects or damages (Ait-Oubahou and Yahia, 1999).

Softening process is one of those vital processes in dates industry, were fruits exposed to a stream of hot air can affect the texture and fruit color. Typically, force–deformation curves have been used to illustrate textural attributes of food materials and processed food products as well (Myhara et al., 2000).

Many studies were conducted on the texture of many food and food products, but few of them are available on the texture of dates. The firmness of dates as a function of maturity has been studied by Myhara et al. (2000),

they reported that firmness decreases with mature increase. Instrumental texture profile analysis (TPA) for date flesh was performed as a function of moisture content (Rahman and Al-Farsi, 2005; Hassan et al., 2005; Vandita et al., 2013 and Abdullah Alhamdan et al., 2014a,b,and c). Those works studied are focusing on the effect of engineering processes on date quality, therefore, this research work aims to study the influence of softening process on dates fruit quality by mean of total color difference, texture profile properties and sensory attributes.

MATERIALS AND METHODS

The experimental work was carried out during the production season of 2013 at College of Food and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia. Seventy-five batches (50 kg each) of Sukkari cultivar were used in a pilot scale date fruits packaging line as shown in Fig. (1).

Descriptions of softening process

The date fruits were initially cleaned using air stream on vibrated belt then sorting was manually done according to its condition and size to produce homogenous quality and size where the dates is sorted. The rotten ones were separated and the rest was further passed on via conveyor belts to the next washing step. In washing section the dates passes through washing drums with water showering nozzles. The water was then automatically drained through the small pores in the conveyer belt. Then the fruits conveyed to softening section when the fruits exposed to hot air stream for a period of time. Three different temperatures of 50, 60, and 70°C were utilized during this research work using a control panel of temperature. Five different exposure times of 15, 30, 60, 120 and 180 seconds were employed in this study. The exposure times was controlled by changing the speed of belt conveyer.

Fig (1): Pilot scale packaging line

Color measurements

The color of date fruits were measured using a Hunter color-measuring instrument (LabScan XE by Hunter Associates Laboratory, Inc., USA). The CIE Lab co-ordinates (L*, a* and b*) was displayed and recorded the data by software program. In this coordinate system, L* is a measure of lightness ranging from zero (black) to 100 (white); a* positive values indicate amounts of red while negative values indicate amounts of green, and b* positive values indicate amounts of yellow while negative values indicate amounts of blue. The total color difference (ΔE) was estimated from the following equation:

$$\Delta E = [(L_o^* - L^*)^2 + (a_o^* - a^*)^2 + (b_o^* - b^*)^2]^{0.5}$$

Where: L_o^*, a_o^* and b_o^* are the basic values of the color parameters.

Texture profile analysis (TPA) measurements

After softening treatment, the samples were allowed to cool for 2 h at room temperature (22±1°C), and the texture profiles analysis were measured. A texture analyzer (Model TA XT2i, Stable Micro Systems, Surrey, England) was used to measure the force-time curve using two-cycle compression test as explained by Rahman and Al-Farsi (2004). The Texture Analyzer software provided with the instrument automatically controlled all tests. For each softening treatment, 15 individual fruits were subjected to the TPA test.

As explained by many researchers (Rahman and Al-Farsi, 2004; Fadel et al., 2006; Kader and Hussein, 2009), six attributes were determined from the force-time curve which were; hardness, cohesiveness, chewing, elasticity, brittleness (N) and adhesiveness.

Statistical analysis

The effect of temperature and exposure time on TPA and color attributes were statistically studied using Statistical Analysis System software (SAS, version 10, SAS Institute, Inc., Cary, NC). In all analyses, the differences within the levels under each variable were tested at 95% level of confidence using the least significant difference (Duncan's) method of comparison of means.

RESULTS AND DISCUSSION

Color change

The desired color of the Sukkari is the more in lightness, redness, and yellowness (Al Hussien et al., 2015). The mean values of the color parameters after softening process treatments are listed in Table (1). The temperature did not affect (L*) at 50°C, 60°C, and 70°C. A similar trend was observed in the (b*) values. The measured (a*) values indicated that, the redness component ranged from 10.10 to 13.71; however, (a*) increased with temperature increases. Consequently, (a*) was affected by temperature. All color components (a*), (b*) and (L*) at the softening temperatures were affected by the exposure time. The minimum changes for the three-color components occurred at a low temperature of 50°C and 15 s of exposure time. On the other hand, the total color deference (TCD) ΔE based on the fruits before softening could be used to distinguish changes in fruit color.

Three different intervals were used to distinguish changes in color values depending on ability of the human eye to appreciate differences in color: ΔE< 1, invisible to the human eye; 1.0 < ΔE < 3.3, invisible only by a skilled person; and ΔE > 3.3, easily observed (Al Hussien et al., 2015). Using this scale and the obtained results listed in Table (1), most of the color changes during this study were greater than 3.3, thus, they are easily observed. The results revealed that at softening temperatures of 70°C at 60 and 120 s of exposure, the changes to TCD were minimal and not recognized easily except by trained people. The fruit color was remarkably degraded, especially at 70°C for 180 s exposure times. Thus, softening at this level of temperature and exposure time might not be a good choice.

Texture profile analysis (TPA)

The effect of the softening temperature and expuser time on the six TPA attributes after each softening treatment compared with that before treatment is revealed in Fig. (2). The statistical significance of each property was determined using 15 replicates and all pair-wise comparisons were performed by Duncan method with a confidence interval of 95%. The results revealed that all texture properties were affected under certain conditions by the softening temperature and exposure time as compared with the fruits before softening process, the process increase all properties.

Table (1): Basic properties of whole date fruit of Sukkari cultivar at Tamr stage of maturity before and after softening process.

Property	time, s	Softening Temperature		
		50°C	60°C	70°C
L*	15	$29.87^{a,A}$±3.37	$32.48^{a,A}$±2.33	$31.51^{a,A}$±1.01
	30	$30.05^{ab,A}$±1.50	$30.07^{ab,A}$±1.49	$30.51^{ab,A}$±1.68
	60	$30.18^{ab,A}$±1.90	$30.44^{ab,A}$±1.58	$30.60^{ab,A}$±1.42
	120	$29.02^{b,A}$±1.14	$28.52^{b,A}$±1.23	$29.03^{b,A}$±1.05
	180	$30.33^{ab,A}$±1.24	$29.87^{ab,A}$±1.14	$30.11^{ab,A}$±1.52
a*	15	$11.59^{a,A}$±1.25	$13.71^{a,AB}$±1.09	$13.44^{a,B}$±1.05
	30	$13.11^{a,A}$±0.98	$12.69^{a,AB}$±1.20	$12.71^{a,B}$±1.05
	60	$11.92^{b,A}$±0.54	$11.84^{b,AB}$±0.98	$11.35^{b,B}$±0.62
	120	$10.13^{b,A}$±1.25	$10.59^{b,AB}$±0.78	$12.05^{b,B}$±0.92
	180	$10.10^{b,A}$±0.28	$10.47^{b,AB}$±1.02	$12.11^{b,B}$±1.12
b*	15	$16.79^{a,A}$±3.95	$18.56^{a,A}$±2.30	$17.73^{a,A}$±1.66
	30	$18.03^{a,A}$±2.04	$17.08^{a,A}$±1.60	$17.29^{a,A}$±1.98
	60	$17.28^{a,A}$±2.12	$17.40^{a,A}$±1.90	$17.72^{a,A}$±1.75
	120	$14.25^{b,A}$±1.12	$14.84^{b,A}$±1.16	$14.91^{b,A}$±1.87
	180	$14.01^{b,A}$±1.35	$15.84^{b,A}$±1.42	$15.12^{b,A}$±1.42
Δ E	15	$4.83^{ab,A}$±2.89	$4.02^{ab,A}$±1.98	$5.30^{ab,A}$±1.70
	30	$3.23^{b,A}$±1.87	$5.40^{b,A}$±1.99	$3.07^{b,A}$±1.07
	60	$5.21^{b,A}$±2.45	$3.97^{b,A}$±2.30	$2.84^{b,A}$±1.33
	120	$7.20^{ab,A}$±1.46	$4.64^{ab,A}$±1.48	$2.74^{ab,A}$±1.87
	180	$6.52^{a,A}$±1.74	$4.78^{a,A}$±1.35	$9.15^{a,A}$±1.87

Note: Data are expressed as means ± standard deviation for 15 replicates. Values in the same column having the same lowercase letter (a, b, c, d or e) for each parameter are not significantly different at p < 0.05, and values in the same row having the same uppercase letter (A, B, and C) for each parameter are not significantly different at p < 0.05.

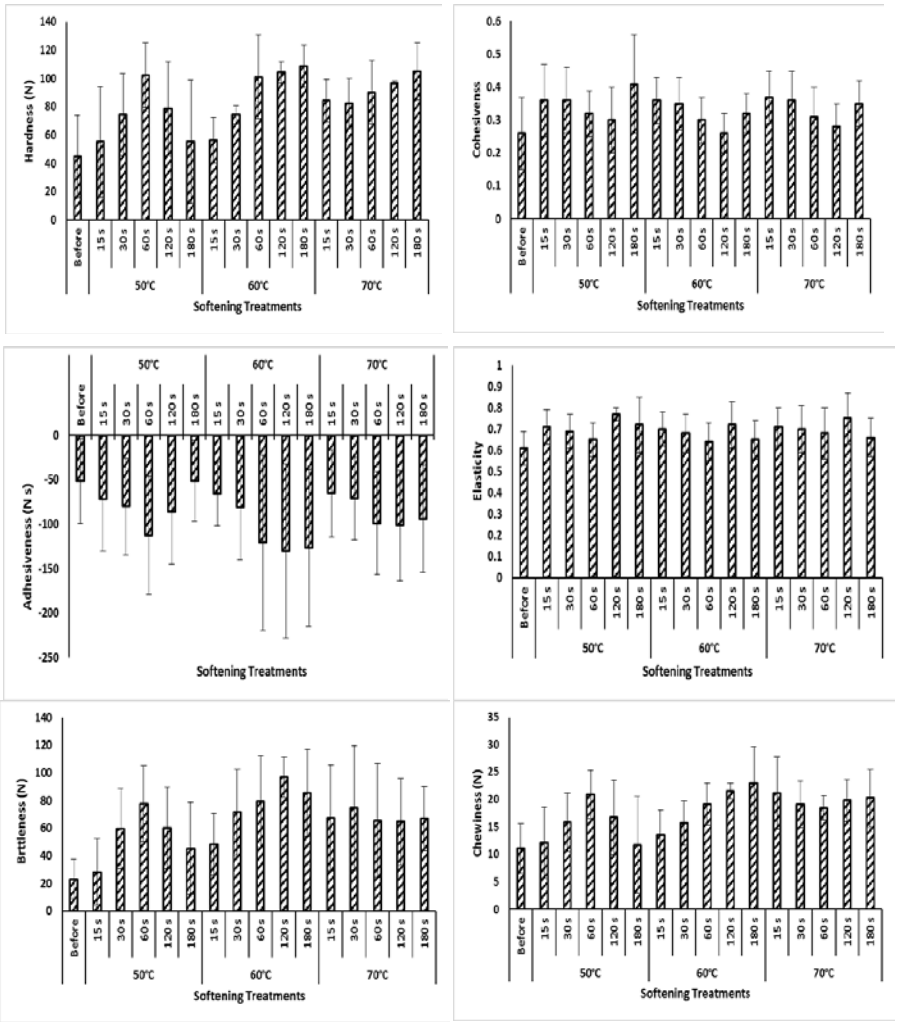

Fig. (2): TPA properties of Sukkari fruits before and after each softening treatment. Vertical error bars represent 95% confidence intervals.

The range of hardness of the soften fruits was 11.92:130.62 N, their brittleness was 4.03:119.41 N. The cohesiveness and elasticity were not affected greatly in most cases by softening conditions and the ranges of these properties were 0.15:0.56 and 0.53:0.87, respectively. In general, the softening conditions increase these properties relative to those of the fruits before softening. These changes reflect reductions in the internal forces binding the fruits constituents (cohesiveness), the rate in which the fruit retains its original state after the release of an exerted force (elasticity). Generally, high adhesive forces between the fruit and the compression disk occurred for fruits soften at a temperature of 60°C and exposure time of 120

or 180 s, likely because some of the date syrup diffused to the surface of the fruit skin. Sticky date syrup covered some of the date fruits during certain experiments (Al Husien et al., 2015). The chewing property, which returns to the force required for chewing the solid flesh of the date fruit to be ready for swallowing, ranged between 2.97 and 29.61 N for the dried fruits. The TPA properties of whole date fruit of Sukkari cultivar at Tamr stage of maturity before and after softening process are summarized and listed in Table (2).

Table (2): TPA properties of whole date fruit of Sukkari cultivar at Tamr stage of maturity before and after softening process.

Property	time, s	Softening Temperature		
		50°C	60°C	70°C
Hardness (N)	0	c, A	c, A	c, A
	15	bc, B	bc, B	bc, A
	30	ab, B	ab, B	ab, A
	60	a, B	a, B	a, A
	120	a, C	a, B	A, A
	180	ab, C	ab, B	ab, B
Cohesiveness	0	b, A	b, A	b, A
	15	a, B	a, B	a, A
	30	a, B	a, B	a, A
	60	ab, B	ab, B	ab, A
	120	ab, C	ab, B	ab, A
	180	a, C	a, B	a, A
Chewiness (N)	0	b, A	b, A	b, A
	15	ab, B	ab, B	ab, A
	30	a, B	a, B	a, A
	60	a, B	a, B	a, A
	120	a, C	a, B	a, A
	180	a, C	a, B	a, A
Elasticity	0	b, A	b, A	b, A
	15	ab, B	ab, B	ab, A
	30	ab, B	ab, B	ab, A
	60	a, B	a, B	a, A
	120	a, C	a, B	a, A
	180	ab, C	ab, B	ab, A
Brittleness (N)	0	b, A	b, A	b, A
	15	ab, B	ab, B	ab, A
	30	a, B	a, B	a, A
	60	a, B	a, B	a, A
	120	a, C	a, B	a, A
	180	a, C	a, B	a, A
Adhesiveness (N s)	0	a, A	a, A	a, A
	15	a, B	a, B	a, A
	30	a, B	a, B	a, A
	60	a, B	a, B	a, A
	120	a, C	a, B	a, A
	180	a, C	a, B	a, A

Note: In the same column, the same lowercase letter (a, b, c, d or e) for each parameter are not significantly different at $p < 0.05$, In the same row, the same uppercase letter (A, B, and C) for each parameter are not significantly different at $p < 0.05$.

CONCLUSION

Both TPA and color attributes were affected by the exposure time of whole date fruits of the *Sukkari* cultivar in softening process. The effects of softening temperature and exposure time on the color of whole fruits were quantified from experimental measurements of basic color parameters L*, a*, and b*and the TCD (ΔE). The effect of exposure time was more noticeable than that of temperature. As expected, the minimum changes of the three basic color components of the soften dates from those of just before softening occurred at the lowest temperature of 50°C, whereas the greatest changes occurred at the highest temperature of 70°C. The TCD (ΔE) relative to the color of the fruits just before softening was considered an indicator of the variation in the total fruit color after softening. The drying conditions affected the properties of the TPA of soften dates in comparison to those of fruits prior to softening. As expected, the huge variation in the fruits properties before softening, the attributes will behave improperly. In brief, enlargement of sample size and good grading can make different results.

Acknowledgement

This study was fully funded by Research Chairs Program, Vice Rectorate for Graduate Studies and Scientific Research, King Saud University, Saudi Arabia.

REFERENCES

Abdullah A.; Hussain S.; Diaeldin A.; and Mahmoud Y. (2014a) "Viscoelasticity of the Bulk Quantities of Eight Saudi Date Cultivars" Acta Advances in Agricultural Sciences Volume 2 (2014), Issue 6, 01-10

Abdullah A.; Hussain S.; Diaeldin A.; and Mahmoud Y. (2014b) "The mechanical properties of different cultivars dates at three maturity stages" International Journal of Research in Engineering & Technology Vol. 2, Issue 3, Mar 2014, 51-60.

Abdullah A.; Hussain S.; Diaeldin A.; and Mahmoud Y. (2014c) Texture profile analysis of date flesh for some saudi date cultivars" International Journal of General Engineering and Technology. Vol. 3, Issue 3, May 2014, 1-10

Ait-Oubahou, A., Yahia, E. M., (1999) "Post-harvest handling of dates" Post-harvest News and Information 10, 67Ne74N

Fadel M. A. ; Kurmestegy, L.; Rashed, M.; and Rashed, Z. (2006) "Fruit Color Properties of Different Cultivars of Dates (Phoenix dactylifera, L.)" Agricultural Engineering International: the CIGR E journal, Manuscript FP 05 005. Vol. VIII. March 2006.

Food and Agriculture Organization of the United Nations, FAOSTAT database (FAOSTAT, (2014), available at http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor

Hassan, B. H., Alhamdan, A. M., Elansari, A. M., (2005) "Stress relaxation of dates at Khalal and *Rutab* stages of maturity" Journal of Food Engineering 66, 439–445.

Kader, A. A. and Hussein, A. (2009) "Harvesting and post-harvest handling of dates" ICARDA, Aleppo, Syria. iv + 15 pp.

Myhara R. M., A. A., Karkalas J. and Taylor M. S. (2000) "Sensory and textural changes in maturating Omani dates" Journal of the Science of Food and Agriculture, 80, pp. 2181–2185

Rahman, M.; and Al-Farsi, S.A. (2004) "Instrumental texture profile analysis (TPA) of date flesh as function of moisture content" Journal of Food Engineering 66, 505e511

Rahman, M.S. and Al-Farsi S.A. (2005) "Instrumental Texture Profile Analysis (TPA) of date flesh as a function of moisture content" J. Food Eng. 66: 505-511.

Vandita S.; Nejib G.; Ahmed A.; Michel C.; and Mohammad S. R. (2013) "Instrumental texture profile analysis (TPA) of date fruits as a function of its physico-chemical properties" Industrial Crops and Products 50 (2013) 866– 873

تآثير عملية التليين على جودة ثمار التمور

ناصر مصطفى العشماوى ، خالد محمد أحمد و محمد سعيد المرزقى
معهد بحوث الهندسة الزراعية – الدقى – الجيزة

تؤثر عمليات التصنيع الغذائي المختلفة على جودة الفواكه، ويهدف هذا البحث دراسة تأثير عملية التليين أثناء صناعة التمور على التمر صنف السكري. كما إن الإنتاج السنوي من التمور في البلدان العربية هو ٦٥.٢٣ % من الإنتاج العالمي، وتستهلك تلك الكمية في مرحلة نضج تسمي التمر ويكون المحتوى الرطوبي أقل من ٣٠%. في هذه الدراسة استخدمت ثلاث درجات للحرارة وخمس أزمنة تعرض لدرجة الحرارة وذلك لمعرفة تأثيرهما على خصائص التحليل القطاعي والفارق اللوني الكلي. وقد أظهرت نتائج البحث أن تأثير زمن التعرض أكثر وضوحا عن تأثير درجات الحرارة في الفارق الكلي للون الثمار عما كانت قبل عملية التليين. وقد أظهرت نتائج خواص التحليل القطاعي لقوام الثمار فيما عدا خاصتي الإلتصاق والتماسك أنها أكثر تأثرا بزمن التعرض لدرجة الحرارة عن التغير في درجة الحرارة.