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TEXTURAL PROPERTIES OF DATE PASTES AS INFLUENCED BY DATE CULTIVAR

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ABSTRACT

Textural properties including firmness (hardness), cohesiveness, adhesiveness, chewiness, elasticity and resilience, were determined for pastes of eight selected Saudi date cultivars, namely *Barhi, Khudari, Khlass, Serri, Sukkari, Suffri, Saqie*, and *NubotSaif*. The hardness values for the pastes of dates varied from 394.65 N (*Suffri*) to 38.04 N (*Khalas*). The cohesiveness values ranged from 0.69 (*khalas*) to 0.33 (*Suffri*). The adhesiveness values varied from 181.48 (*NubotSaif*) to 29.93 (*Khalas*). The chewiness values varied from 92.82 (Suffri) to 20.58 (*Khalas*). The elasticity values varied from 1.0 (*Barhi*) to 0.69(*Suffri*). The resilience Values varied from 0.15 (*Nubot Saif*) to 0.07 (*Sukkari*).

KEYWORDS: Textural properties, Hardness, Chewiness, Elasticity, Date Paste, Date Cultivars

INTRODUCTION

The date fruits of the palm tree (*Phoenix dactylifera* L.) represents a foundation stone of the economy in many producing countries, especially in North Africa and the Middle East (El Hadrami and Al-Khayri, 2012). The date fruit is a good source of fiber, carbohydrates, minerals and vitamins (Mohamed, 2000; Vayalill, 2002; Al-Farsi, 2005; Ishurd& Kennedy 2005; Baloch *et al*., 2006). Different date cultivars vary considerably in their chemical and mechanical properties, which have a major influence on their structural, sensory and texture characteristics (Rahman & Al-Farsi, 2005, Al-Abdoulhadi*et al*., 2011).

The mechanical properties of agricultural materials and food in general play an important role in the harvesting, handling, trading, processing, quality control and development of new products. Mechanical properties are considered to be one of the four most important parameters that reflect the quality of the food material (Bourne, 2002). These parameters include texture, firmness and chew ability. Texture can be influenced by many factors, including the moisture content andwater activity in addition to the chemical composition.

Texture in fruits depends on several anatomical features, such as tissue layers and cell size, resulting in a combination of different sub-phenotypes, such as firmness, gumminess and juiciness. Firmness, so far, is determined mainly by the skin cell size and the shape of the underlying pericarp cell layers (Klima Johnson et al., 2011). Fruit texture is related to the cell wall structure and to the architectural changes occurring during the development and ripening phases (Costa et al., 2011; Giongo et al., 2011).

The absence of scientific information on the fundamental mechanical properties of dates and their pastes has a significant impact on quality during manufacturing (e.g. distorted and injured tissues) and also during handling and treatment, which affects the stability and quality during storage and marketing. To ensure access to optimized conditions for the design and operation of handling, processing and manufacturing steps; the mechanical properties of dates must be

identified (Messina and Jones, 1990).

Determination of the textural properties of pastes of dates has many benefits such as development of standard specifications and quality control to enhance their marketing both locally and internationally; design of systems and mechanisms for handling, processing. manufacturing and design and selection of systems for the production of pastes of dates forusing them in the bakery and other food industries.

The textural properties of foods, which govern the appropriate selection of the method and device used for testing, can be divided into basic properties i.e. hardness (firmness), cohesiveness, elasticity (springiness) and adhesiveness, as well as secondary (derivative) properties. chewiness and gumminess (Szczeniak, 1966).

Much research has been published on the texture of many food products, such as meat and dairy products and most types of fruit and vegetables, but very few reports are available on the texture of dates. The firmness of dates as a function of maturity has been studied (Myhara*et al*., 2000). At 103 days after pollination, the force required to penetratethe dates was 186 × 104 Pa. As the dates matured, this firmness decreased to 53.6 × 104 Pa at 152 days after pollination (corresponding to the Rutab stage of maturity). Immediately after the Rutab stage, the firmness increased temporarily to 89.8 × 104 Pa before reaching a minimum of 28.2 × 104 Pa at 170 days after pollination. Instrumental texture profile analysis (TPA) for date flesh was performed as a function of moisture content (Rahman and Al-Farsi, 2005). Although various uses for dates have been realized, pertinent data on the design of systems and mechanisms for harvesting, handling, processing and manufacturing dates are lacking. Thus far, there seems to be limited research on the mechanical properties of dates, including textural properties. Therefore, the present study was undertaken to determine some of the basic textural parameters (hardness, cohesiveness, elasticity and adhesiveness) beside the secondary (derivative) parameters (chewiness and resilience) for pastes of eight selected Saudi date cultivars.

MATERIALS AND METHODS

Sample Preparation

Pastes of eight popular Saudi date cultivars, *viz*. *Barhi*, *Khudari*, *Khlas*, *Serrie*, *Sukkari*, *Suffri*, *Saqie* and *NubotSaif* were used in all experiments. The dates were obtained from the educational farm of King Saud University. Dates were sorted to discard the damaged fruits, and immediately kept for less than 24 h in a cold store at 5 ºC. The moisture content in the flesh of dates was determined using AOAC procedures (AOAC, 1995). Pastes were made fromthe eight date cultivars at Tamer stage of maturity in cylindrical shape (30 mm diameter * 30 mm hight) after removing pits and turn it to homogenous pastes using minced machine.

Instrumentation

A texture analyzer (TA-HDi, Model HD3128, Stable Micro systems, Surrey, England), together with a 75-mm-diameter disk plunger (# P 75), was used to conduct stress relaxation tests. The texture analyzer was interfaced with an IBM-compatible PC and a software package called Texture Expert Exceed, version 2.05, that was supplied by the same company. This package enabled the acquisition of data in Excel format. The software can determine the gradient of the curve between any two specified locations and the area under the curve. All experiments were conducted at room temperature (23°C). The instrument was calibrated with 50-100 kN force with a linearity better than 1%. The contact areabetween the plunger disk surface and each tested fruit surface was determined experimentally.

Textural Profile Analysis Test

The experiments were conducted using cylindrical samples of pastes of the eight cultivars, which were placed horizontally as cylindrical samples (30 mm diameter *30 mm height). The force was measured by Compacting the sample with a rod velocity of 1.5 mm/s to a depth of 5 mm. The compression process included two bites to obtain the TPA properties, which included basic properties (hardness, cohesiveness, elasticity and adhesiveness) and secondary properties (chewiness, gumminess and resilience).

Statistical Analysis

All needed statistical analyses were performed using the IBM SPSS software package (IBM Corp. Released 2010. IBM SPSS Statistics for Windows, Version 19.0 Armonk, NY: IBM Corp.). Experimental data were analyzed by means of analysis of variance (ANOVA). The Least significant difference (LSD) multi-comparison test was carried out to establish statistical differences between the calculated means andsignificant differences were reported at $P \leq 0.05$.at the 0.05 level.

RESULTS AND DISCUSSIONS

Moisture Content and Water Activity

The mean values of moisture content (w.b) and water activity**(**a_w**)** of the eight date cultivars at the tamer stage of maturity are shown in Table 1. The moisture content and water activity ranged from 11.6% and 0.636 for (*Saquie*) to 6.9 %and 0.385 for (*Barhi*), respectively. The variation in moisture content and water activity between cultivars beside other chemical changes has great effect on their physical and mechanical properties including viscoelastic behavior. It is generally accepted that water activity (a_w) is more closely related to physical, chemical, and biological properties of foods and other natural products than to its total moisture content(Alhamdan and Hassan, 1999).

Textural Profile Analysis

The textural profile analysis curves for the cylindrical samples of pastes of the eight studied cultivars were shown in figure 1. The curves clearly indicated the existence of the adhesiveness property in all tested pastes. The curves also show the high values of the maximum force (hardness). The might be due to the relatively large size of the cylindrical samples, in addition to its cohesiveness resulting from the regular formation process.

The data obtained from the texture profile analysis properties, i.e, firmness, cohesiveness, elasticity, adhesiveness, chewiness, and resilience, for thepastes of the eight cultivars are plotted and shown in Figure 2.

The mean hardness values were clearly high for*Suffri* (394.65 N), *Khudari* (186.59 N) and *Sukkari* (140.31 N) cultivars compared to the other cultivars. Table 2 shows the existence of significant differences ($P \leq 0.05$) between the hardness values for the pastes of the testedcultivars. These differences could be attributed to the disparity in the tissue structure of the eight date cultivars at the Tamer stage of maturity, in addition to the variation of their content of water, sugars, pectin and cellulose materials leading to a clear change in their hardness after converted into a homogeneous paste. It should be noted here that the existence of the phenomenon of hardened pastes of dates produced by dates factories and their tendency to for drying (stiffness) with time. The problem of stiffness of pastes of dates in terms of the changes that occur in their water activity which is closely associated with their moisture content have been investigated (Alhamdan and Hassan, 1999).

The mean cohesiveness values varied from (0.69) for *Khalas*to (0.33) for *Suffri*. It can be noted that the date pastes which showed highest hardness values their cohesiveness values are the least, i.e., pastes of *Suffri* (0.33), *Khudari*(0.40) and *Sukkari*(0.42) cultivars. This could be explained by that the pastes of the mentioned cultivars need high force (high hardness) during the first bite and getting large area under the curve (A1), which weaken the second bite and getting a small area under the resulting curve (A2) leading to low values for cohesiveness property (A2 / A1).

The adhesiveness property was clear and relatively high for all date pastes samples that have been tested. The mean adhesiveness values varied from 181.48 N.s (*NubotSaif*) to 29.93 N.s (*Khlass*). Table 2 displays that there were no significant differences at the level of $P \leq 0.05$ between the adhesiveness values for the pastes of *Barhi*, *Khudari*, *Seri*and*Saquie*cultivars also for*Khlass*and*Suffri*cultivars. However, there were significant differences between the adhesiveness values of the pastes of the above mentionedcultivarsin addition to *Sukkari*and*NubotSaif*cultivars.

Similarly, the values of the chewiness property of the all tested date pastes were clearly high. And its values ranged between 92.82 N (*Suffri*)to 32.88 N (*Saquie*). As shown in Table 2 there were no significant differences at the level of $P \leq 0.05$ between the chewiness values of the pastesof *Khudari*and*Sukkari cultivars* and between *Khlass and Saquie*cultivars. Besides, there were significant differences between the samples of the cultivars of the above mentioned cultivars and *Barhi, Seri, Suffri and, NubotSaif*cultivars.

The elasticity properties values were relatively high and varied between 0.97 for the paste of *Barhi*cultivarto 0.69 for *Suffri*cultivar. The results of analysis of variance (Table 2) showed that there were no significant differences between the values of the elasticity property for the pastes of *Khudari* and *Saqie* cultivars, and likewise between its values for the pastes of *Sukkari*and*NubotSaif*cultivars. Table 2 demonstrate that there were significant differences between the values of the elasticity propertyof the two above mentioned groups in addition to pastes of *Barhi, Khlass, Serri* and *Suffri*cultivars.

The resilience property values of the tested date pastes were relatively low and varied in the range of 0.151 (*NubotSaif*) to 0.074 for *Sukkari*cultivar paste. The results of analysis of variance revealed that there were no significant differences in the values of the resilience for *Barhi* and *Suffri* cultivars and *Khudari* and Serri cultivars (b) and *Khlass* and *Saqie*cultivars, whereas, there were significant differences between the cultivars of the three groups with each other, in addition to the *Sukkari* (d) and *NubotSaif*(a) cultivars.

CONCLUSIONS

The results of the textural profile analysis of the date pastes of the tested eight date cultivars at the Tamer stage of maturity is the first serious research results on the date fruits undertaken at the global level. These results is hoped to be pioneer for intensive research on the dates and their products using the latest textural profile analysis devices as an objective method to find pertinent textural properties automatically which can be compared to sensory evaluation results and find mathematical models for them.

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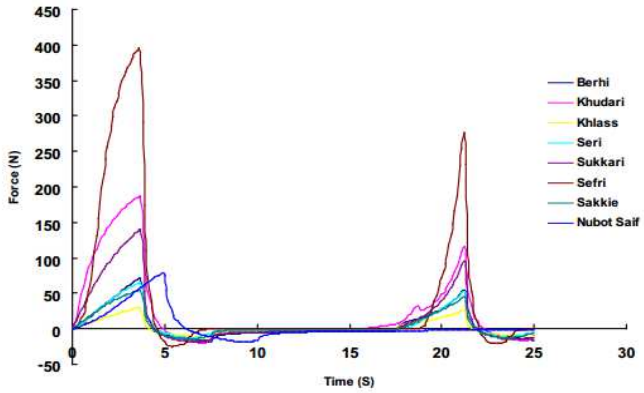
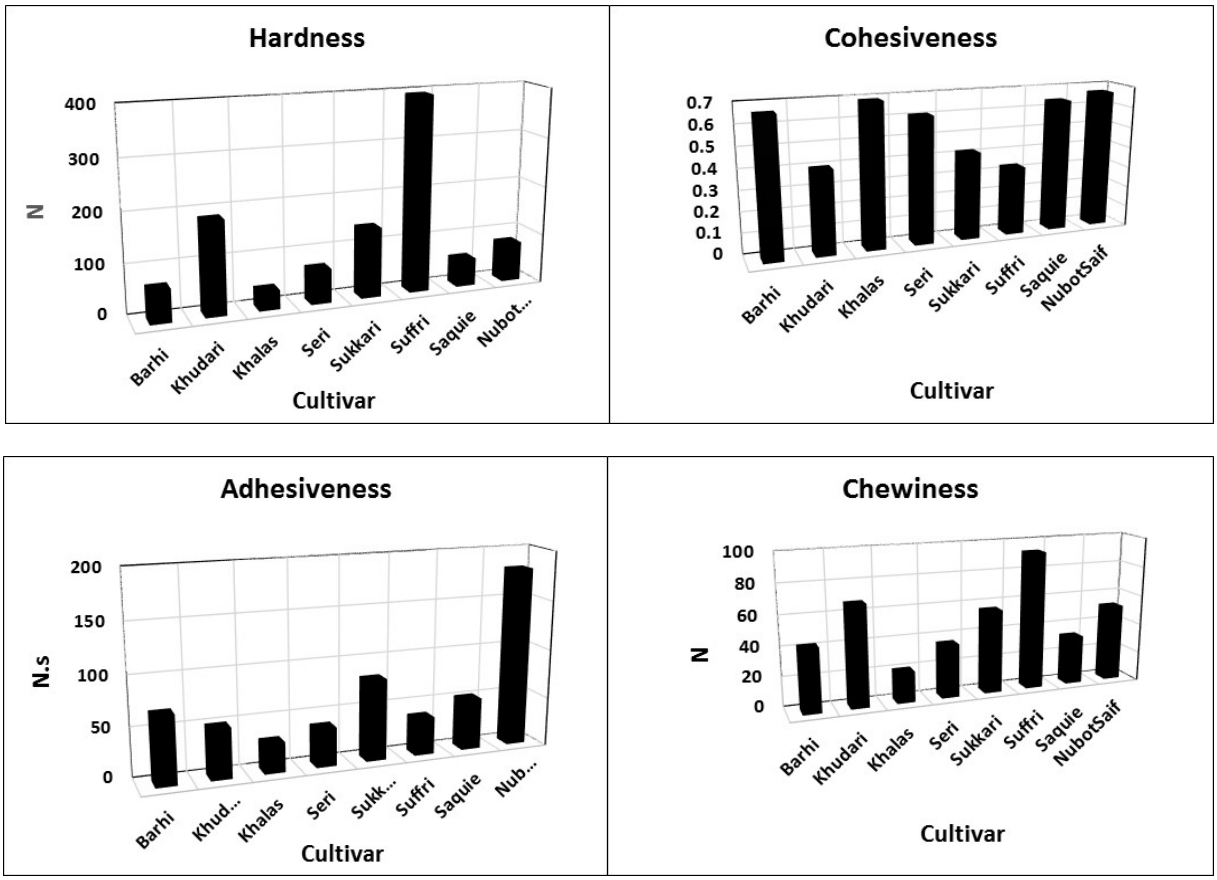


Figure 1: TPA Curves for Cylindrical Samples of Date Pastes from Eight Saudi date Cultivars



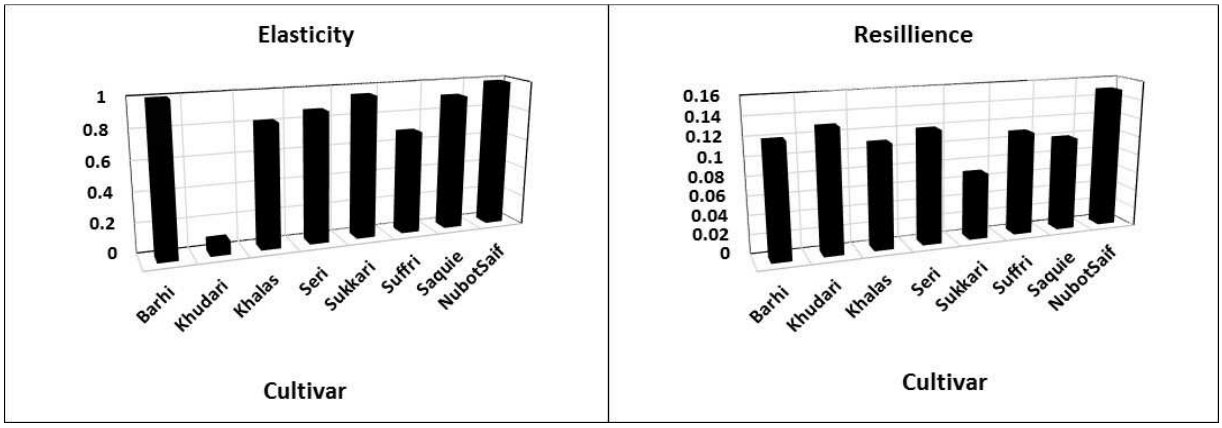


Figure 2: Mean Values of the Textural Properties of the Date Pastes of Eight Saudi Date Cultivars

Table 1: Mean Values of Moisture Content and Water Activity for the Eight Date Cultivars at Tamer Stage of Maturity

Cultivar	Moisture Content (w.b) %	Water Activity (a_w)
Barhi	06.92	0.385
Khudari	11.24	0.442
Khalas	08.96	0.420
Seri	07.75	0.388
Sukkari	12.56	0.636
Suffri	07.93	0.414
Saquie	11.71	0.453
NubotSaif	11.32	0.443

Table 2: Comparison of the Mean Values of TPA Properties of the Eight Date Cultivars of Date Pastes from Eight Saudi Date Cultivars

Cultivar	Hardness N	Cohesiveness	Adhesiveness N.s	Chewiness N	Elasticity	Resilience
Barhi	65.60^{ef}	0.66^{ab}	68.67^{ab}	42.45^{cd}	1.00^{a}	0.12^{bc}
Khudari	186.59^{b}	0.40^{c}	50.30^{ab}	67.42^{b}	0.91^{abc}	0.13^{b}
Khalas	38.04^{g}	0.69^{a}	29.93^{a}	20.58^{h}	0.82^{c}	0.11^{c}
Seri	68.72^{e}	0.61^{b}	38.84^{ab}	35.79^{d}	0.87^{bc}	0.12^{b}
Sukkari	140.31^{c}	0.42^{c}	82.04^{b}	56.07^{b}	0.95^{ab}	0.07^{d}
Suffri	394.65^{a}	0.33^{d}	37.96^{a}	92.82^{a}	0.69^{d}	0.11^{bc}
Saquie	55.97^{f}	0.64^{ab}	52.24^{ab}	32.88^{de}	0.91^{abc}	0.10^{c}
NubotSaif	79.45^{d}	0.67^{ab}	181.48^{c}	51.99^{c}	0.99^{ab}	0.15^{a}
*The same letter in the same column (a, b, c etc.) indicates that the values are not significantly different at the 0.05 level.						