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TECHNICAL NOTES

Correlation between Sensory and Instrumental Textural Attributes of Date Palm *(Phoenix dactylifera L.)* fruits: Technical Note

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الارتباط بين السمات المقيمة حسيا و بالأجهزة لفاكهة شجرة النخيل (التمر) *(Phoenix dactylifera L.)*: ملاحظة فنية

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ABSTRACT. Food industries are constantly looking for optimum instrumental methods that can consistently estimate sensory textural qualities of food products. Monitoring texture using instrumental methods is cheaper over time than maintaining a sensory quality panel. However, a good correlation between sensory and instrumental textural attributes is highly needed. In the present research, we aimed to report the correlation between instrumental and sensory textural attributes of date fruit varieties. Specifically, Instrumental Texture Profile Analysis(TPA) and sensory textural attributes were correlated. We found significant correlations between sensory and instrumental TPA attributes of date fruit varieties and this suggests a great promise for developing quality control.

KEYWORDS: Date fruits, Sensory analysis, Instrumental texture, *Phoenix dactylifera, Correlation*

المستخلص:تبحث الصناعات الغذائية باستمرار عن الأساليب الآلية المثلى اللتي تمكنها من تقدير جودة صفات التركيب النسيجي الحسي للمنتجات الغذائية. تعد متابعة النسيج باستخدام الأجهزة أرخص مع مرور الوقت من الحفاظ على لوحة لمقيمي الجودة الحسية. ومع ذلك، من الضرورة أن يوجد ارتباط وعلاقة جيدة بين السمات المحددة حسيا و تلك المحددة بالأجهزة. هدفنا في البحث الحالي هو تحديد الارتباط بين السمات المقيمة حسيا و بالأجهزة لنسيج أصناف من فاكهة التمر. و بالتحديد، كان هناك ارتباط بين السمات المحددة حسيا و باستخدام الجهاز المخصص لتحليل النسيج (TPA) لفاكهة التمر و قد كان هذا الارتباط ذو أهمية إحصائية؛ مما يعني أن هناك إمكانية لتطوير مراقبة الجودة باستخدام الأجهزة.

الكلمات المفتاحية: ثمار التمر، التحليل الحسي، النسيج الآلي، فينيكس داكتيليفيرا *(Phoenix dactylifera)*، الارتباط

Introduction

Texture, defined as the sensory manifestation of food structure and the way this structure reacts to the forces applied and it represents the junction of all the mechanical, geometric, and superficial attributes of a product, sensed through mechanical, tactile, visual, and hearing receptors (Rahman, 2009; Rahman et al., 2020). Assessment of textural attributes by either instrumental method (i.e. Textural Profile Analysis, TPA) and or by sensory methods is of great interest in food technology (Rahman, 2019). The correlation obtained between sensory and instrumental texture measurements could be used to assess quality control parameters, consumers liking and their overall acceptability for product development or improvement, and it is also useful to improve the instrumental method for better pairing with sensory results (Aguirre et al., 2018; Kurotobi et al., 2018). Date Fruits (DFs) are popular staple food in the Middle East as well as, source of income for many families. The DFs are commercially important and sold as fresh (i.e. *Rutab*) and dried (i.e. Tamar) (Chandrasekaran and Bahkali, 2013). Hence, there is a great amount of research in the field of DF including their phytochemical contents (Al-Hinai et al., 2013; Essa et al., 2019; Hossain et al., 2014; Singh et al., 2013; Singh et al., 2012). The growing food industry is also utilizing the DFs to produce variety of products (e.g. biscuits, flavored dairy products, and chocolate). Texture is a critical property of the fruit that can dominate quality of the product. In the past decade few studies have focused on the instrumental texture of the DF (Al-Hinai et al. 2013). The growing date industries demands for assessing the sensory analysis of date fruits.

The fruits quality is assessed based on texture, flavor, color, and nutritional properties (Ismail et al., 2008).The sensory textural characteristics are recognized as critically important factors of food choice (Grunert, 2015;

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Rahman, 2019). Generally, sensory methods are more useful in developing new products and defining product standards in comparison with instrumental method (i.e. TPA). Although sensory analysis (i.e. descriptive method) require a panel training and maintenance, however, it is not only time-consuming and expensive, but also demands proper reference standards for calibration (Joyner, 2018). Hence, attempt have been made to establish the relationship or predictive model between sensory attributes and instrumental parameters (Li et al., 2020; Taniwaki et al., 2010).

There is continuous industrial search for certain instrumental techniques for forecasting the sensory textural attributes of final processed products and/or even raw materials (Barbieri et al., 2018; Li et al., 2020; Rahman et al., 2020; Taniwaki et al. 2010). Instrumental methods have advantage, as they tend to offer precise results (Rahman et al., 2020). Generally, instrumental results can be directly linked to chemical and physical properties permitting the investigator to achieve a mechanistic understanding of experimental differences. Instruments are more sensitive to small alterations between samples and capable to detect trends in quality loss before it can be detected by humans (Mestres et al., 2019; Rahman et al., 2020; Yu et al., 2017). Instruments can be used to yield large amounts of data without objection, making them excellent screens in quality control operations (Yu et al., 2017). The data on the instrumental and sensory textural attributes of 9 date fruit varieties as a function of their physicochemical characteristics were published earlier (Singh et al., 2013; Singh et al., 2015). Hence, we aimed in this paper to report the correlation between the instrumental and sensory textural attributes of date fruit varieties.

Materials and methods

Nine batches of DFs at *Tamar* stage (Figure 1) with different quality levels were obtained from the local market at Muscat. All the samples were stored at -20˚C until used for the analysis (Singh et al., 2013).

Instrumental Texture Profile Analysis (TPA)

Different instrumental textural attributes (i.e. hardness; adhesiveness; springiness; cohesiveness; resilience; gumminess; chewiness; elasticity) of date fruits samples were measured earlier (Singh et al., 2013). Briefly, all experiments were conducted at room temperature (25 ± 2°C). One pitted date was divided into two halves and one side was placed over another. It was then pressed to prepare a flat slab. A typical force-time graph of two-cycle instrumental TPA for different date samples was analyzed (Singh et al., 2013).

Textural Sensory Analysis

The textural sensory attributes (i.e. hardness; adhesiveness; springiness; cohesiveness; resilience; gumminess; chewiness; elasticity) of date fruits were assessed by 20 trained-panels (SQU students) using descriptive test. The panelists were trained on how to assess the defined attributes with respect to the provided references. The training proceeds with the actual samples. More details were presented in the earlier published work (Singh et al. 2015).

Statistical Analysis

Experimental data were analyzed using PAST Software. Multivariate Analysis (MVA) was performed to determine the correlations between sensory and instrumental textural characteristics of DFs (Hammer et al., 2001). MVA including Pearson's (i.e. linear) and Spearman's correlation matrix were run using all sensory and instrumental textural attributes. Linear and Spearman's correlations were used to determine the relationships between each variable for the P values ≤ 0.05 and P≤ 0.10.

Results and Discussion

The instrumental forces for texture analysis were correlated with sensory attributes. Correlation results showed that instrumental hardness were significantly correlated with sensory hardness, along with adhesive-

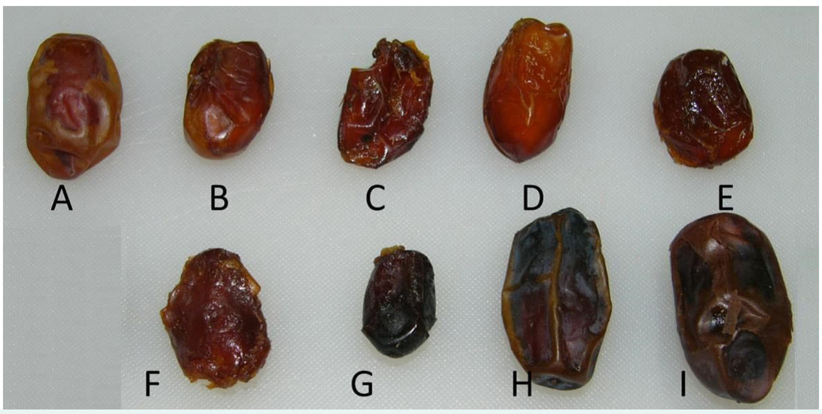

Figure 1. Photos of date samples used for the textural studies

ness, springiness, cohesiveness, chewiness and elasticity (P<0.05) in both linear and spearman's correlation, and with sensory resilience (P<0.1) linearly (Table 1). In the literature, often instrumental hardness are significantly correlated with the sensory hardness (Prakash et al., 2005; Tao et al. 2020). Similar correlation was reported for Instrumental hardness with sensory hardness in cooked rice (P<0.05) (Prakash et al., 2005). Significant correlations were also observed in the cases of instrumental hardness and springiness with sensory hardness and springiness (P<0.001) when 21 different foods samples, for examples caramel, egg white, cream cheese, corn muffin were considered (Meullenet et al. 1998). In the case of baked product, Young's modulus correlated with sensory elasticity. Conversely, instrumental cohesiveness and chewiness did not show correlations with sensory cohesiveness and chewiness (P>0.05). However, correlations of these two attributes were significantly improved when the variables were transformed with logarithmic function (i.e. non-linearity) (P<0.05) (Meullenet et al., 1998). We observed similar results for our instrumental cohesiveness, which did not show any linear correlation however, correlation was improved in spearman's correlation with sensory cohesiveness (P<0.1), chewiness and resilience (P<0.05).

relations. Similar results were reported in the case of cooked rice, where instrumental adhesiveness did not show any correlation with sensory stickiness (P>0.05) (Prakash et al., 2005). The poor correlation between sensory and TPA springiness was not surprising since similar results were reported recently (Nishinari et al., 2019).

Moreover, instrumental gumminess showed linear correlation with sensory hardness and elasticity (P<0.05) and with sensory adhesiveness, springiness, cohesiveness and chewiness (P<0.10). Instrumental chewiness was significantly correlated with sensory chewiness (P<0.05) and with all others sensory attributes except gumminess. In the case of cereal snack bars, sensory attributes of chewiness, firmness, and crumbliness showed very high degrees of correlations (P<0.001) with the instrumental TPA (Kim et al., 2009). Similarly, Chinese moon cake showed instrumental hardness, chewiness, and stickiness highly correlated with the sensory data (Jia et al., 2008).

Instrumental Elasticity 1 was correlated with sensory elasticity in both linear and spearman's correlation. It was linearly correlated with sensory cohesiveness chewiness (P<0.05), hardness, adhesiveness (P<0.1). Further, correlation with sensory hardness (P<0.05), springiness (P<0.1) was improved in Spearman's. Instrumen-

Table 1. Coefficients of Linear and Spearman correlation between sensory and instrumental texture measurements for nine varieties of Date fruits

Instrumental attributes	**Sensory attributes**															
	Linear correlation								**Spearman's correlation**							
	HA	AD	SP	CO	RE	GU	CH	ES	HA	AD	SP	CO	RE	GU	CH	ES
HA	*	*	*	*	**	NS	*	*	*	*	*	*	NS	NS	*	*
AD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CO1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**	*	NS	*	NS
RE	*	*	*	*	**	NS	*	*	*	*	*	*	**	NS	*	*
GU1	*	**	**	**	NS	NS	**	*	**	NS	*	NS	NS	NS	NS	**
CH1	*	*	*	*	*	NS	*	*	*	*	*	*	*	NS	*	*
E1	**	**	NS	*	NS	NS	*	*	*	NS	**	NS	NS	NS	NS	*
E2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	NS	*	NS	NS

*** p<0.05; ** p<0.10; NS: No significant correlations**

Note: HA: hardness; AD: adhesiveness; SP: springiness; CO: cohesiveness; RE: resilience; GU: gumminess; CH: chewiness; E: elasticity

Further, our results showed that instrumental resilience was correlated with sensory resilience (P>0.10) and with other sensory attributes, such as hardness, adhesiveness, springiness, cohesiveness, chewiness and elasticity in both Pearson's and Spearman's correlations. Instrumental adhesiveness and springiness did not show significant correlations (P>0.10) with the any of the sensory attributes in both Pearson's and Spearman's cor-

tal Elasticity 2 did not show any linear correlation with respective sensory attributes however, in spearman correlation, it was related to sensory gumminess (P<0.05), springiness (P<0.1). Out of eight sensory attributes studied, four were well predicted with their respective instrumental measurements, while others i.e. adhesiveness, cohesiveness, springiness and gumminess were not correlated with their respective instrumental attributes.

This may be due to the difference in compression plate size and test sample in TPA, which may lead to variance in major cutting or shearing of the sample (Kim et al., 2009). The lack of cutting or shearing may lower the correlation values between instrumental and sensory attributes (Battaglia et al., 2020; Paula and Conti-Silva, 2014).

Conclusion

In the current study, sensory and instrumental textural attributes were correlated. The evaluation of texture obtained by instrumental measurements of dates had a significant correlation with the sensory evaluation of textural parameters. Among the eight sensory attributes studied, four were well predicted with their respective instrumental measurements. These attributes were hardness, resilience, chewiness, and elasticity. The significant correlations between the sensory attributes and the instrumental measurements showed great promise for developing quality control during the selection of dates for commercial processing.

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