Archive of SID

Iranian Food Science and Technology Research Journal
Vol. 12, No. 1, Apr. May. 2016, p. 152- 162

نشریه پژوهشهای علوم و صنایع غذایی ایران
جلد ۱۲، شماره ۱، فروردین-اردیبهشت ۱۳۹۵ ص.۱۶۲-۱۵۲

# Detection of pomegranate arils and determination of their freshness using thermography

**M. R. Golzarian[1*], A. Mohammadzadeh[2], M.H. Abbaspour-Fard[3]**

Recfeived: 2014.07.26
Accepted: 2015.01.22

**Introduction:** Every year about 600 million tons of fruits and vegetables are produced in Asia and around 35% out of it is wasted during production, postharvest, processing, distribution and consumption (FAO, 2011). In most cases, the sale rate of agricultural products is affected by their internal quality. Although consumers are unable to detect product's internal quality and freshness while buying, their negative perceptioncan be formed against their next buy if the internal quality of what they bought does not meet their satisfaction (Leemans et al., 2002). For assessing fruits quality factors some destructive and non-destructive tests are performed. The qualityfactors are categorized into external quality and internal quality factors. With the visual inspection methods, the external features of Bio-materials (e.g. shape, color and texture) can be evaluated (Shiranita et al., 1998) while the internal quality factors, including freshness, cannot be determined from these apparent visual characteristics (Jha et al., 2002). Therefore, the shelf life of agricultural products that are internally defective is less as they perish sooner and the infection expands quicker (Ohali, 2011). Among the common nondestructive methods for assessing internal quality parameters, MRI, X-RAY, Ultrasonic and NMR can be named (Du et al., 2004; Mery et al., 2011). In fruits, vegetables and fruits, the status of freshness is affected by the changes occurred in their physical, chemical and biological structures. These changes and, therefore, freshness, conventionally, is quantified by parameters such as product's mechanical stress, moisture content, temperature and pH.Recently, some advanced technologies such as thermography have been used in quality assessment of agricultural products. Thermography is performed in two types: active and passive. In passive thermography, the heat emitted from the objects is recorded by the camera while in active thermography, which is more common in post-harvest applications, there is an external energy source to produce a thermal contrast between the sample product and the background. The objectives of this research areto use thermography in order to study the effects of time after harvest on the distribution of arils surface temperature and to relate the thermal properties to the freshness of arils.

**Materials and methods:** Freshly harvested pomegranate fruits of Khazar variety were provided from Kashmar gardens. The arils were extracted from 35 randomly selected fruits. The arils of each fruit were kept for 15 days at 5°C. The arils were thermally and visibly imaged and their physical and mechanical properties were measured every 5 days: first day, fifth day, tenth day and fifteenth day after openingthe fruit to have variations in freshness. The size of thermals images was 320×240 pixels with the temperature resolution of 0.08°C. The images were taken with the emissivity set at 0.95, which was obtained from masking method (using a high-emissivitypatch). This emissivity value was within the range documented for biological products, i.e. 0.93-0.99 (Hellebrand et al., 2006). The thermal images were taken from the arils every 10 seconds for 180 seconds after imposing thermal shock by placing the arils in a freezer compartment at -2°C for 60 seconds. The distance from the thermal camera to the arils was 30cm and the room temperature was 22.5°C. The images were processed and analyzed in Matlab (MathworksInc, US) and the thermal features were extracted from the histogram of each thermal images, which included: mean temperature, variance, third moment, smoothness, homogeneity and entropy.Linear Discriminant Analysis (LAD) was employed for classification based on the mentioned features. The validity of input data was examined using Leave-one-out method. Statistical analysis was carried out using stepwise regression method in SPSS ver. 16.

**Results and discussion:** The temperature extraction from the aril regions was done using the fusion of the segmented red/green ratio and the thermal image. The results showed that the temperature gradient with respect to time for one-day was the same as that for the five-day arils. This behavior was probably because the sound and fresh part of these arils was still large enough so that it causes less sensitivity with respect to the temperature

1, 2 and 3- Asistant Professor, MSc Student and Associate Professor, Department of Biosystems Engineering, Ferdowsi University of Mashhad Respectly
(* Corresponding author email: m.golzarian@um.ac.ir)

www.SID.ir

Archive of SID



change. However, the temperature gradient for ten-day and fifteen-day arils was relatively large. The analysis of temperature variations on arils surface showed that the less fresh the arils were,the more thermally sensitive they were with respect to their surroundings. The less fresh arils were cooler than the one-day and five-day arils. This might be due to the extended evaporation from the surface and the larger emissivity of older arils than fresher ones. The larger emissivity in less fresh tissues cause quicker heat penetration inwards or quicker heat loss from inside out, thus, the tissue become cool or hot quicker. Conversely, the fresh tissues have reduced heat transfer.They release heat in a cold environment or becomes warm it a warmer environment at a slow pace rate.The extracted temperature features were used in a Linear Discriminant Analysis (LDA) model for quality assessment and classification of pomegranate arils stored for three 60-second periods. The mean accuracy of classification of arils for three 60-second periods of imaging were obtained to be 62.1%, 72% and 79.8%. The optimum classification results were obtained from the third 60s. In this range, the accuracy of classification ofone-day, five-day, ten-day and fifteen-day arils were 98.7%, 69.23%, 65.4% and 89.8%, respectively.

**Conclusion:** Twelve thermal features were extracted from thermal images of arils for classification in terms of freshness. The results confirm that thermography can be used as a non-destructive method for determining the freshness status of pomegranate arils during storage periods.

**Keywords:** Pomegranate aril, Thermal imaging, Freshness level, Shelf-life

www.SID.ir