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Development and evaluation of a vibratory-pneumatic pomegranate arils extractor

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Introduction

Iran is a frontier of pomegranate fruit production in the world (with almost 40 % of the world`s production). However due to traditional processing operations is not ranked as the largest pomegranate exporter. Saveh, Neyriz and Ferdows are the top pomegranate producing cities in Iran. Pomegranate is consumed as a fresh fruit as well as processed product as food additive, paste, syrup, jelly, pectin, jam, beverage, essence, vinegar and concentrate. Aril extraction is the first and essential postharvest operation for pomegranate processing. Arils are mostly extracted manually even in large scales for fresh and processed consumption. This labor intensive operation is rational when aril quality is an important index for consumer. But whenever pomegranate juice is desired, the aril quality has no priority for consumer, and therefore arils can be extracted with less care. Sarig (1985) was the first inventor of a pomegranate aril extractor who employed air jet force to extract the arils. Later, other researchers employed the same method as well as water jet to extract fruit juice and sac. In the present study, fabrication and evaluation of vibratory aril extractor augmented with air system was conducted.

Materials and Methods

The study was conducted using Rabab cultivar samples which were manually harvested from an orchard in Neyriz town, Fars province. Samples were kept in refrigerator at 5 ^{0}C till experimental trials. Initial moisture content of fruit skin, arils and internal fleshes were measured by gravimetric method as 31.7±2.6 %, 61.5±1.8 % and 42.8±1.4 %, respectively and for a whole fruit was measured 45.3±11.5 % (w.b.). For conducting laboratory tests, an aril extraction unit was designed and fabricated. It comprised a steel main frame, a 746 W electric motor, drive mechanism (eccentric and shaft), sample retentive unit, air jet unit, aril tank, and an air compressor-tank assembly. Sample retentive unit was designed in such a manner to hold a halved fruit. This unit was made from four elements, a hemisphere bowel, four pressure (spring) arms to apply force on skin of the sample, and four tension (spring) arms for fixing the sample in the bowel by applying pressure on the edges of the halved sample. Such configuration helped sample to open more and more while extracting the arils to expose trapped aril for easier extraction. Sample retentive assembly was vibrated by the electric motor and drive mechanism. Electric motor was equipped with an electric convertor to create different levels of vibration frequency. Also, the drive mechanism was designed in such a manner to create different levels of vibration amplitudes. According to the previous studies, 2 nozzles with 3.5 mm diameter were selected for air jet unit. Nozzles were spaced at 8 cm apart according to the measured mean diameter of samples. Outlet air jet from nozzles covered the cross sectional area of the halved fruit. Nozzles assembly was rotated 180 degrees clockwise and counterclockwise with an electronically controlled stepper motor. Pressurized air (from air tank) was transferred to nozzles assembly by flexible pipes. Air pressure was controlled at 500 kPa level by air regulator. To conduct experimental trials, samples halved at three different cutting directions (horizontal (equatorial), vertical and oblique) by a sharp cutter and halved samples were used for tests. Halved sample was fixed in bowel and then the unit was excited by the electric motor. The assembly was vibrated for 60 seconds before blowing the air jet for extra 30 seconds. Tests for air jet alone were conducted for 90 seconds and percentage of detached and damaged arils were calculated. Damaged aril during cutting process was subtracted from total damaged arils for each trial. Collected data were analyzed according to factorial experiments based on completely randomized design, and means were compared by Duncan post-hoc test. Data of combined and air jet alone systems were analyzed by two independent sample t tests.

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Results and Discussion

ANOVA results revealed that cutting type, frequency and amplitude, significantly influenced the percentage of aril extraction at 5 % level of significance. The highest amount of extraction was obtained at 30 Hz frequency and 4 mm amplitude for diagonal cutting by 87 %. At this condition, 13.9 % of arils were damaged by air jet pressure. A significant difference in percentage of extracted and damaged arils was observed between vibratory-air and air systems at 5 % level of significance. The highest amount of aril extraction as well as damage was observed for vibratory-air system with the means of 80.1 % and 9.9 %, respectively.

Conclusions

Maximum percentages of extraction and aril damage were achieved by applying the combined system with as compared to air jet system alone, so that combined system increased aril extraction by 7.1 % with 2.2 % extra damages.

Keywords: Air jet, Aril extractor, Pomegranate, Vibration

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