Post-harvest engineering properties of Japan flowering crabapple (Malus floribunda) fruits

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Abstract: The aim of this research is to investigate the post-harvest engineering (physical, mechanical and chemical) properties of Japan flowering crabapplefruits.The known post-harvest engineering properties of Japan flowering crabapple fruits are the main determining factor to design and improve of appropriate machines and equipment for harvesting, sizing, grading, separating, cleansing, handling, storing, processing, and packing. The physical properties such as geometric mean diameter, sphericity, surface and projected areas, bulk and fruit densities, porosity, andcolour characteristics were measured of Japan flowering crabapple. Mechanical properties (skin and flesh firmness, rupture force and cutting force) and chemical properties (totalsoluble solids content, titratable acidity and pH) of Japan flowering crabapplefruit were determined. The geometric mean diameter, sphericity and surface area of Japan flowering crabapplewere found as 33.96 mm, 97.69% and 36.45 mm2, respectively. The bulk and fruit densities of Japan flowering crabapplewere observed as 658.5 kg/m3 and 1031.07 kg/m3, respectively. The static coefficient of friction of Japan flowering crabapplefruitwaslower for laminate than the other surfaces.The total soluble solids content and titratable acidity of Japan flowering crabapplefruit were found as 7.57% and 0.311 g/(100 g), respectively. The post-harvest engineering properties are important to identify the relevant machines and systems operation efficiencies and to determine the crop quality of Japan flowering crabapple fruits.Consequently, the informations on these properties are directly useful and should be considered in designing or adopting any processing and handling equipment for post harvest applications.

Keywords: Small crabapple, physical, mechanical and chemical properties

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1 Introduction

Japan flowering crabapple is the fruit of *Malusfloribunda*in the family of Rosaceae.Japan flowering crabapple(*Malus floribunda*) is a small crab apple with a diameter of 3-5 cm, of whichtaste is sourish, and this apple has a hard skin. Japan flowering crabapplehas a dominant resistance gene to apple scab *Ventureuinequalis*. The tree is used for ornamentation and for pollination in big plantations of common apple. The fruit can be used for juice or making jelly. The Japan flowering crabapplefruit production can be converted to juice or employed to make jelly (Vaughan and Geissler, 1997). The concentrated juice is obtained from Japan flowering crabapplefruit in a three process consisting: fruits are washed, mashed and pressed and a juice with 11–12 °Brix is obtained, thenfruit juice is clarified and depectinised, and fruit juice is vacuum concentrated with aroma recovery at the beginning, until a soluble solids of 70 °Brix is obtained (Cepeda and Villaran, 1999).

Japan flowering crabapple fruit juices are complex systems exhibiting flow properties that depend on mechanical properties such as shear time as well as on shear rate (Jimenez and Durh 1979). Nagel (1992) described a Japan flowering crabapplejuice has a light, whitish-yellow, definite cloudiness, shows no sedimentation, but has no astringent or bitter taste(Cepedaet al., 1999).

In addition to, the factors that define Japan flowering crabapple fruit quality, such as colour, firmness, and flavour, size are also an economically important

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characteristic. The effect of environmental factors on size of crab apple by some reports has explained (Atkinson et al., 2001; Stanley et al., 2001). There is a great difference in fruit size among *Malus* species. For example, crabapples are seldom larger than 5 cm in diameter, whereas some cultivated apples are often larger than 10 cm. Recent DNA analyses have suggested that the domesticated appleorigined from *M. sieversii*, a 'wild apple' of Central Asia, whose fruit is only about 4 cm indiameter (Harris et al., 2002).However, when grown under the same conditions, some cultivars have large fruit, while others have small fruit, so that conspicuous differences in fruit size among cultivars appear to be of genetic origin (Harada et al., 2005).

There is a need to know the post-harvest engineering properties (such asphysical, mechanical and chemical ones) to design and improve of relevant machines and equipment used in harvesting, transportation, handling, processing, storingand packaging of Japan flowering crabapplefruits.The size, shape, mechanical behaviors and chemical properties of Japan flowering crabapple fruits are important to designing of harvesting, separating, sizing, storage and packaged machines.Bulk density and porosity of Japan flowering crabapple fruits has an important effect to the designing of storage and transporting structures.Itis also necessary, the coefficient t of friction of the Japan flowering crabapplefruits against the various surfaces for the designing of conveying, transporting and storing structures. The maturity level, sugar, colour, size, soluble solids, mechanical defect and firmness are considered inJapan flowering crabapplepost-harvesttechnologies.

No detailed study concerning the post-harvest engineering properties of Japan flowering crabapplewas not studied.Therefore, beside the determination of physical properties, mechanical properties and chemical properties of Japan flowering crabapplefruithave been investigated in this study.

2Materials and methods

The Japan flowering crabapplefruits were harvested manually from Tokat city (40°20'.02.19'' N latitude, 36°28'.30.11E longitude)inMid-Black Sea Transition Climate Belt region during the harvest season on 1 November 2013. Fruits were randomlycollected from nine trees and they were cultivated at 623m above sea levelfromGaziosmanpasa University, Faculty of Agriculture plantation landscape.Harvested Japan flowering crabapplefruits were transferred to the laboratory in polyethylene bags to reduce water loss during transport. To determine the Japan flowering crabapplesize, one hundred Japan flowering crabapplefruits were randomly selected and the fruits were cleaned to remove all foreignmattersand immature anddamaged fruits.

The length anddiameter of Japan flowering crabapplefruits were measured using a digital-micrometer(0.01 mm accuracy), and the Japan flowering crabapplefruit mass was measured using a digital electronic balance (0.001 gresolution). The geometric mean diameter (D_g), sphericity (Φ), volume, fruit and bulk densities and porosity of a fruit of Japan flowering crabapplewere determined methods presented by Mohsenin (1970).The projected area was measured by a digital planimeter (Placom Roller-Type, KP90N). The projected area measurements, along X-, and Y- axes, were determined according to the method of Razavi and Parvar (2007).

$$D_g = (LWT)^{1/3} \quad (1)$$

$$\Phi = \left[\frac{(LWT)^{1/3}}{L} \right] \times 100 \quad (2)$$

$$V = \left(\frac{\pi}{6} \right) \times LWT \quad (3)$$

$$S = \pi D_g^{\ 2} \quad (4)$$

Where *L* is the length, *W* is the width and *T* is the thickness in mm.

The colour of Japan flowering crabapple fruits in terms of *L**, *a**, *b** values was determined using a Minolta colourimeter (CR-300 Model, Minolta Corp., Japan), Ramsay, NJ).Colourimeter was calibrated to a standard white reflective plate and used Commission Internationale de l'Eclairage (CIE) illuminant C. *L** denotes the lightness or darkness of fruit; *a** is green or red colour of fruit; and *b** is blue or yellow colour of the Japan flowering crabapple fruit samples(Avila and Silva, 1999). The *a** and *b** values were used to compute values for hue angle and chroma (colour intensity). Hue angle and chroma are effective parameters for describing the visual colour appearance. Chroma (C^*) and hue angle (h°) values were calculated using the following equation (Bernalte et al., 2003):

$$C = \left(a*^2 + b*^2\right)^{\frac{1}{2}} \quad (5)$$

$$h^\circ = \left[\tan^{-1}\frac{b*}{a*}\right] \quad (6)$$

The colours were measured at three points of each Japan flowering crabapple fruit sample and measurements were computed as the means of three replication values. Colour measurements were conducted on skin and flesh surface along longitudinal axis (Jha et al., 2005).The coefficient of friction of Japan flowering crabapple fruit is defined as tangent value of the angle of slope between sliding surface and vertical and horizontal planes (Celik et al., 2007). The measurement was conducted by using laminate, plywood, chipboard and rubber friction surfaces.

To determine the mechanical behavior of the Japan flowering crabapplefruits, a biological materials test device (Sundoo, SH–2, 500 N, China) was used. This device has three main components: a moving platform, a driving unit and a data acquisition (load cell, PC card and software) system. The fruit sample was placed on the moving platform and loaded and pressed with a plate fixed until the Japan flowering crabapple fruit ruptured by compressed and punctured or cutted. The *X*- axis (force F_x) is the longitudinal axis (length), the *Y*- axis (force F_y) is the transverse axis (width) at right angles to the *X*- axis in the plane of the suture, and the *Z*- axis (force F_z) is the transverse axis (thickness) at right angles to the plane of the suture (Figure 1). The firmness of Japan flowering crabapplefruits was measured using by an 1.2 mm diameters stainless steel needle probes by using biological test machine and hand penetrometer using by 11.1 mm. In the compression test, ruptures forces of Japan flowering crabapple fruit were directly measured at three axes (*X*-, *Y*- and *Z*- axes).

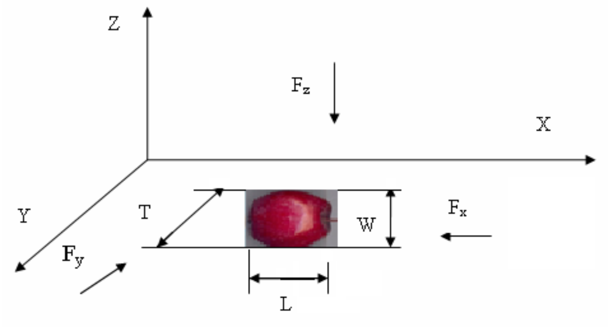

Figure1Representation of the three axial forces (F_x,F_y, and F_z)and three perpendicular dimensions of Japan flowering crabapple fruit

The Japan flowering crabapplefruit was placed on the moving platform considering along three axes (*X*-, *Y*- and *Z*- axes) and punctured with a cylindrical probes, and compressed with a cylindrical tables, and cutted with a stationery knife fixed on the load cell until the Japan flowering crabapple fruit ruptured and cutted (Figure 1). Three replications were made each test and 15 samples in each test were used (Braga et al., 1999).

According to the methods presented by the Association of Official Analytical Chemists (1984), pH of Japan flowering crabapple fruit was determined. The total soluble solids content (TSSC) of Japan flowering crabapple fruit was determined by a digital refractometer (PAL-1, McCormick Fruit Tech., Yakima, Wash.).Titratable acidity (TA) of Japan flowering crabapple fruits was measured by titration with 0.1 mol/L NaOH.

3 Results and discussion

The physical properties of Japan flowering crabapple fruits are given in Table 1.The geometric mean diameter and fruit mass of Japan flowering crabapplerangedbetween 28.85 to 40.53 mm and 13.83 to 34.18 g, respectively.

Table 1 Some physical properties of Japan flowering crabapple fruits

Physical properties	Mean ±SEM*
Length (L), mm	34.81 ±0.46
Width (W), mm	34.65 ±0.48
Thickness (T) , mm	32.88 ±0.45
Geometric mean diameter (D_g), mm	33.96 ±0.42
Sphericity (Φ),%	97.69 ±0.69
Fruit mass (M), g	22.36 ±0.78
Bulk density (ρ_b), kg/m^3	658.53 ±3.21
Fruit density (ρ_f), kg/m^3	1031.07 ±30.05
Porosity (ε), %	35.87 ±1.81
Surface area (S), mm^2	36.45 ±9.18
Volume, mm^3	21.12 ±0.81
Projected area	
X (length), cm^2	13.69 ±1,01
Y (width) , cm^2	14.85 ±1.28

Note: SEM*: Standard error of the mean

The sphericity, surface area and volume ranged between 90.09%to 99.91%; 26.15 to 51.60 mm^2 and 12.70 to 35.24mm^3, respectively.Tabatabaeefar and Rajabipour (2005) reported that the average fruit length, width and thickness were 73.0, 70.0 and 67.0 mm for Red Delicious and Golden Delicious, respectively. These researchers reported that the geometric mean diameter, length, width and thickness of Redspar and Delbarstival apples were 79.54, 74.78, 83.80 and 80.37 mm for Redspar and 63.38, 58.31, 67.00 and 65.04 mm for Delbarstival, respectively.The geometric mean diameter, fruit mass, volume and sphericity of wild medlar was reported as 28.9 mm, 12.0 g, 13.7 cm^3 and 0.90 at 72.2% (d.b.) by Haciseferogullari et al. (2005) for ripening period. Altuntas et al. (2013a) reported that the sphericity, surface area and volume ranged between 0.97 to 0.95; 29.69 to 22.62 mm^2 and 15.3 to 10.3 cm^3 from physiological maturity to ripening period of medlar fruits, respectively. Owolarafe et al. (2007) reported that the size of fresh palm (cv. Dura) such as fruit length and width were found to be 30.25 and 19.94 and 15.66 mm, respectively. Ozturk et al. (2012a) reported that the average length (L), width (W), thickness (T), geometric mean diameter (D_g) and fruit mass (M) of apple were 63.60, 73.61, 71.24, 69.03 mm and 186.8 g. Ozkan et al. (2012) reported that the length, width, thickness, geometric mean diameter were obtained as 63.60, 73.61, 71.24 and 69.03 mm for Braeburn apple, respectively.

The fruit density of Japan flowering crabapple ranged from 956.02 to 1161.17 kg/m^3 (21.45% increase), while bulk density between 648.99 to 667.35 kg/m^3 (2.83% increase) for Japan flowering crabapple fruit, respectively (Table 1).The projected area of Japan flowering crabapple fruits ranged from 11.70 to 15.97 cm^2 and 12.80 to 15.50 cm^2 for along X- and Y-axes, respectively. The porosity of Japan flowering crabapple fruits ranged from 31.81% to 44.11% (38.67% increase). Haciseferogullari et al. (2005) reported as the fruit density of 1031.1 kg/m^3, bulk density of 379.9 kg/m^3, porosity of 63.1% and projected area of9.3 cm^2 for ripening period of wild medlar fruits. Altuntas et al. (2013a) reported as the fruit density of 1048.46 kg/m^3, bulk density of 256.89 kg/m^3, porosity of 75.41% and projected area of 7.15 cm^2 (X-axis) and 6.87 cm^2 (Y-axis) for medlar fruits. The projected area along X- and Y- axes of the kiwifruit has been reported as 4.11 and 3.24 mm^2, respectively (Celik et al., 2007). The projected area and spread area of Braeburn apple changed as37.33 cm^2 and 0.301 m^2/kg^1 were reported by Ozturk et al. (2012a), while,Kheiralipour et al. (2008) reported that the average projected area of Redspar and Delbarstival apple cultivars were 59.73 and 38.95 cm^2, respectively.

Razavi and Parvar (2007) reported that the average the geometric mean diameter, sphericity, the surface area, bulk and fruit densities and porosity of 54.1 mm, 79.8%, 91.97 cm^2, 563.2 kg/m^3, 996 kg/m^3 and 43.4%, respectively. The bulk density values of Japan flowering crabapple fruits were found higher than that of Haciseferogulları et al. (2005); Altuntas et al. (2013a);

while the fruit density of Japan flowering crabapple fruits was similar to the findings of previous reports (Haciseferogulları et al., 2005).

Colour characterisitcs of Japan flowering crabapple for skin and flesh fruits are given inTable 2.The *L**, *a** and *b** values of Japan flowering crabapple were between 36.19 to 39.42; 22.67 to26.30 and 20.02 to 23.92 for skin fruits, while, *L**, *a** and *b** values of flesh of Japanfloweringcrabapplewere between 47.96 to 58.92; 17.67 to 34.43 and 30.15 to 34.41, respectively (Table 2). Chroma and hue angle of skin of Japan flowering crabapple ranged from 30.68 to 34.22 and 37.23 to 44.42; while chroma and hue angle offleshof Japan flowering crabapple ranged from 35.59 to 48.36 and 37.95 to 47.67, respectively (Table 2). The skin colour of kiwifruit was found as*L**, *a** and *b** values of43.94, 5.51 and 24.04 by Celik et al. (2007), while theflesh colour of kiwifruit as *L** of 56.41, *a** of -17.47 and *b** of 32.35 reported by Costa et al. (2006). Ozturk et al. (2012a) reported that the skin colour characteristics (*L**, *a**,*b**, *C** and *h*°) of Braeburnapple were as 43.75, 30.72, 25.21, 40.07 and 39.56, respectively. Ozkan et al. (2012) reported that the skin colour characteristics (*L**, *a**,*b**, *C** and *h*°) of Braeburnapple were as 44.21, 30.47, 25.93, 40.07 and 40.72,while the colour characteristics (*L**, *a**,*b**, *C** and *h*°) of flesh of Braeburnapple were as 81.05, -3.47, 37.40, 37.57 and 95.33, respectively. Altuntas et al. (2012) reported that the colour characteristics (*L**, *a**,*b**, *C** and *h*°) of skin of Fuji apple were as 53.50, 24.61, 26.05, 47.86 and 35.97, respectively. The skin colour of kiwifruit (cv. Hayward) was determined as *L** value of 43.94 and *b** value of 24.04 by Celik et al. (2007). According to these results, our results related *a** and *b** were similar to that reported for Fuji apple by Altuntas et al. (2012); for kiwifruit by Celik et al. (2007); and *h*°value was found to be similar to that reported for Braeburn apple by Ozturk et al. (2012a).

Table 2 Colour characterisitcs of Japan flowering crabapple fruits

Colour properties	Mean ±SEM*
Skin	
*L**	37.69±0.52
*a**	24.57±0.63
*b**	21.48±0.56
*C**	32.67±0.52
h°	41.35±0.36
Flesh	
*L**	54.62±1.85
*a**	25.71±1.63
*b**	32.53±0.79
*C**	41.70±1.91
h°	42.30±0.48

Note:SEM*: Standard error of the mean

The mechanical characteristics (firmness, rupture force and cutting force) of Japan flowering crabapple fruits are presented in Table 3.Skin firmness of Japan flowering crabapple fruits punctured using with 1.2 mm needle probe along *X*- axis and *Y*-axis ranged from 6.5 to 11.1 N (70.8%increase) and 6.5 to 12.9 N mm(98.5%increase), respectively.

Table 3 Some mechanical characteristics of Japan flowering crabapple fruits

Mechanical properties	Values
Puncture test (by 1.2 mm needle probe)	
Skin firmness (*X*- axis, N)	8.286±0.621
Skin firmness (Y- axis, N)	9.550±1.120
Flesh firmness (*Y*- axis, N)	8.820±1.149
Hand penetrometer	
Skin firmness, *Y*- axis (N) (11.1 mm probe)	88.8±6.40
Skin firmness, *Y*- axis (N) (7.9 mm probe)	73.2±14.46
Compression test (by 79 mm circular table)	
Rupture force	
X- axis (N)	256.04±10.74
Y- axis (N)	263.08±5.231
Z- axis (N)	261.82±10.74
Cutting test (by stationary knife)	
Cutting force	
X- axis (N)	17.04±1.111
Y- axis (N)	25.78±1.229
Z- axis (N)	50.43±0.450
Coefficient of friction	
Laminate	0.397±0.006
Plywood	0.456±0.009
Chipboard	0.461±0.013
Rubber	0.459±0.011

Note:SEM*: Standard error of the mean

Flesh firmness of Japan flowering crabapple fruits punctured using with 1.2 mm needle probe along *Y*-axis ranged from 4.6 to 13.0 N. The mean flesh firmness of Japan flowering crabapple fruits (8.82 N) was lower than skin firmness (9.55 N) along *Y*- axis. Firmness measured using by 11.1 and 7.9 mm cylindirical probes along Y axis with hand penetrometer were as 88.8 and 73.2 N, respectively.

Rupture force of Japan flowering crabapple fruits compressed using with cylindirical plate along *X*-, *Y*-, and *Z*- axes ranged from 221.4 to 298.4 N, 242.2 to 280.2 N, and 252.8 to 263.0 N, respectively. The mean rupture force Japan flowering crabapple fruits for *Y*-axis (263.08 N) was higher than *X*- and *Z*-axes. Cutting force of Japan flowering crabapple fruits cutted using with stationary knife ranged from 12.9 to 21.2 N, 22.9 to 31.9 N, and 49.4 to 52.1 N along *X*- axis, *Y*-axis and *Z*- axis, respectively. The mean cutting force Japan flowering crabapple fruits for *Z*-axis was higher than *X*- and *Y*-axes.

Celik et al., (2007) reported that the skin and flesh firmness of kiwifruit were 95.05 and 78.28 N at physiological maturity of fruit, respectively. Altuntas et al. (2013a) reported that the rupture force of medlar punctured using with cylindirical probe along *X*- axis ranged from 77.9 to 7.50 N (90.4% decrease) from physciological maturity to ripening period, respectively. Ozturk et al. (2012a) reported that the skin and flesh firmnesses were 106.1 and 84.8 N; Altuntas et al. (2012) reported that the skin and flesh firmnesses were 104.1 and 87.8 N for Braeburn apple, respectively. Altuntas et al. (2012) reported that the skin and flesh firmnesses were 100.4 and 71.0 N for Fuji apple, respectively. The highest rupture forces required when loading along the *Y*- axis were found to be 228.2–243.6 N for President plum variety by (Altuntas et al., 2013b).

The rupture forces required when loading along the *X*- axis, *Y*- axis and *Z*- axis were found to be 172.3, 235.9 and 189 N for President plum fruit by Altuntas et al. (2013b). According to these results, our results related skin and flesh firmnessesof Japan flowering crabapple fruits lower than the reported for previous studies (Celik et al., 2007; Ozturk et al., 2012a; Altuntas et al.,2012; Altuntas et al., 2013b).

The static coefficients of friction of Japan flowering crabapple fruits for all (laminate, plywood, chipboard and rubber) surfaces are represented in Table 3. The static coefficient of friction of Japan flowering crabapple fruits washigherforchipboard than the other friction surfaces. The static coefficient of friction was found as 0.397 (laminate); 0.456 (plywood); 0.461 (chipboard) and 0.459 (rubber), respectively. The static coefficient of friction was the lowest for laminate among the four surfaces, which may be due to the smoother surface of the laminate compared with plywood, chipboard and rubber (Table 3).

Demir and Kalyoncu(2003) reported that the static coefficient of friction were ranged from 0.79 to 0.85; 0.89 to 0.91;0.93 to 0.96 for steel, plywood and rubber friction surfaces for cornelian cherry, respectively. Topuz et al. (2005) reported that the static coefficients of friction for orange cultivars were 0.270, 0.258 and 0.247 for rubber, plywood and galvanized iron steel, respectively; whereas the static coefficient of friction for cactus pear were reported as 0.296, 0.261 and 0.243 for galvanized steel sheet, rubber and plywood, respectively by Kabas et al. (2006). Owolarafe et al. (2007) reported that the static coefficient of frictionsfresh palm fruit (cv. Dura) were as 0.58 (plywood), 0.53 (aluminium), 0.56 (mild steel sheet) and 0.56 (galvanized steel sheet), respectively.Ozturk et al. (2012a) reported that the static coefficients of friction were as 0.272 for rubber; 0.268 for galvanized metal and 0.319 for plywood, respectively. Ozkan et al. (2012) reported that the static coefficient of friction was found as 0.272 (rubber); 0.319 (plywood); 0.268 (galvanized metal) for Braeburn apple; while the static coefficient of friction as 0.329 (rubber); 0.272 (plywood); 0.276 (galvanized metal) for Fuji apple reported by Altuntas et al. (2012), respectively,

The static coefficient of friction of Japan flowering crabapple fruits was higher than the reported by Topuz et al. (2005); Kabas et al. (2006), Ozturk et al. (2012a), Altuntas et al. (2012); while the static coefficient of friction of Japan flowering crabapplefruitswas lower than the reported by Demir and Kalyoncu(2003), andOwolarafe et al. (2007).

The chemical characteristics of Japan flowering crabapplefruitsare presented in Table 4. The total soluble solidscontent, titratable acidity and pH of Japan flowering crabapple fruits rangedfrom 7.20% to 8.30% (15.28% increase); 0.224 to 0.405g/(100 g)(80.80% increase) and 3.91 to 3.98 (1.8% increase),respectively. Celik and Ercisli (2008) reported that the averagetotal soluble solids, pH, titratable acidity of Hachiyapersimmon variety were 17.1%, 5.40%, and 2.06%, respectively.Ozkan et al. (2012) reported that TSSC, TA and pH were 15.4 (^{o}Brix), 0.93 (g malic acid)/(100 g), and 2.80 for Braeburn apple, respectively.

Table 4 Some chemical properties of Japan flowering crabapplefruit

Chemical properties	Mean ±SEM*
pH	3.94 ±0.02
The total soluble solid content (TSSC), %	7.57 ±0.37
Titratable acidity (TA), g/(100 g)	0.311 ±0.052

Note: SEM*: Standard error of the mean

Ozturk et al. (2012b) reported that the total soluble solids content, pH and titratable acidity of Red Chief apple fruit ranged from 10.4% to 11.4%; 3.30 to 3.86 and 0.18 to 0.24 g/(100 g),respectively.Haciseferogullari et al. (2005) reported that pH and titratable acidity of wild medlarfruits were 4.3% and 0.3g/(100 g), respectivelyat ripening period.Ozturk et al. (2013a) reported that the total soluble solids content, pH and titratable acidity of Fuji apple fruit were 14.0%; 3.14 and 0.40 g/(100 g), respectively, while TSSC, pH and TA of Braeburn apple were 15.44%; 2.87 and 0.86 g/(100 g), respectively (Ozturk et al. 2013b).pH value of Japan flowering crabapple fruits is essentially consistent with results of previous studies (Ozturk et al., 2012b; Ozturk et al., 2013b).

4 Conclusions

In this study, the engineering properties of Japan flowering crabapplesuchasthe physical properties (geometric mean diameter, sphericity, surface and projected areas, bulk and fruit densities, porosity,andcolourcharacteristics), mechanical properties (skin and flesh firmness's, rupture force and cutting forces) and chemical properties (totalsoluble solids content, titratable acidity and pH) were determined. The static coefficient of friction of Japan flowering crabapplefruitwas lower for laminate than the other surfaces. The mean flesh firmness of Japan flowering crabapple fruits was lower than skin firmness along *Y*-axis. The mean rupture force Japan flowering crabapple fruits for *Y*-axis was higher than *X*- and *Z*-axes. The mean cutting force Japan flowering crabapple fruits for *Z*-axis was higher than *X*- and *Y*-axes.L^*, a^*,b^*, C^* and $h°$ values of skin colour of Japan flowering crabapple were lower than flesh colour of Japan flowering crabapple fruits. The engineering properties (physical, mechanical and chemical properties) of Japan flowering crabapple fruits are necessary considerations in the design and effective utilization of the equipment used in the harvesting, separating, sizing, transporting, processing, storing, and packaging treatments. The measured physical, mechanical and chemical properties will serve to design the equipment used in postharvest treatment and processing of Japan flowering crabapple fruit. The knowledge of engineering properties of Japan flowering crabapple enables the fundamental engineering data required to the design of post harvest machines, structures, processes and controls; to analyze and determine the efficiency of the machines and systems. And also, the informations on these properties should be considered in developing of a new product and evaluating and maintaining the quality of final product for consumer.

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