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# Chemical and Technological Properties of European Cranberrybush (*Viburnum opulus* L.) Fruits

MEHMET AKBULUT*, SEDAT CALISIR†, TAMER MARAKOGLU† and HACER COKLAR
*Department of Food Engineering, Faculty of Agriculture*
*University of Selcuk, Konya 42031, Turkey*
*Fax: (90)(332)2410108; Tel: (90)(332)2232915*
*E-mail: makbulut@selcuk.edu.tr; makbulut44@hotmail.com*

The European cranberrybush (*Viburnum opulus* L.) fruits were analyzed for selected technological properties (dimensions, geometric mean diameter, sphericity, bulk density, fruit density, volume, terminal velocity, rupture strength, porosity) and proximate composition (moisture, reducing sugar, ascorbic acid, total anthocyanin and phenolics, crude protein, crude oil, crude energy, crude fiber, ash, pH, acidity, alcohol soluble extract and colour) properties. Mineral content of *Viburnum opulus* growing in Turkey were determined by inductively coupled plasma atomic emission spectrometer (ICP-AES). All materials contained high amounts of Ca, K, Mg, Na, P and S. The average pulp mass ratio, thickness, width, length, mass, volume, geometric mean diameter, sphericity and projected area were measured as 653.0 g/kg, 9.59 mm, 9.71 mm, 10.18 mm, 0.65 g, 638 $mm^3$, 9.82 mm, 0.96 and 0.9988 $cm^2$, respectively. The energy, reducing sugar, protein, cellulose, oil, ash, acidity, ascorbic acid, total phenolics, total anthocyanin and soluble solid matter values of European cranberrybush fruits were established as 256.56 kJ/g, 63.46 g/kg, 64.85 mg/kg, 180.71 g/kg, 6.70 g/kg, 12.83 g/kg, 17.92 g/kg, 595.24 mg/kg, 3253.87 mg/kg, 654.23 mg/kg and 104.31 g/kg, respectively. It is very important to evaluate the technological properties of equipment used harvesting, transportation, storage and processing of fresh fruits. Also, the information supplied on the chemical properties of the European cranberrybush fruit serves as food in human nutrition.

**Key Words: European cranberrybush, *Viburnum opulus* L., *Caprifoliaceae*, Proximate composition, Technological properties.**

## INTRODUCTION

European cranberrybush is an important plant in the middle Anatolia region of Turkey. It grows in Kayseri, Bursa, Sakarya, Ankara, Tokat, Trabzon, Çorum, K.Maras, Kirsehir, Istanbul, Izmit, Erzurum and Samsun regions of Turkey[1-3]. European cranberrybush (*Viburnum opulus* L.), belonging to the *Caprifoliaceae* family, is consisting of middle trees and

†Department of Agricultural Machinery, Faculty of Agriculture, University of Selcuk, Konya 42049, Turkey.

shrubs. Common names for European cranberrybush, which are members include may, gilabou, gilaburu, European cranberrybush, American cranberrybush, cranberry tree, crambark tree, guelder-rose, gueldres rose, wild guelder-rose, cherry-wood, rose elder, red elder, marsh elder, water elder, white elder, gadrise, gaiter tree, gatten, love rose, may rose, pincushion tree, dog rowan tree, whitten tree, squash bush, witch-hobble and witchhopple. European cranberrybush is an erect native shrub, averaging in height from 2 to 3 m, occasionally taller on good sites. The plants are multi-stemmed but do not form thickets by spreading. They are dense shrubs because of close branching. The leaves are opposite, 3-lobed maple-like leaves and from 5 to 12.5 cm long. In the fall the leaves become scarlet. The creamy-white flowers, which appear in late May and June, measure 7 to 10 cm across. Each bloom is composed of an outer ring of large sterile flowers and an inner ring of tiny fertile ones. The fruit, which ripens in September and October, resembles the true cranberry in size and colour but is more translucent when ripe. Fruit hangs on the branches all winter and used in sauces, jellies and juices. If picked after a heavy frost the fruit are softer and more palatable but they develop a musty, somewhat objectionable odour during cooking. The species has never developed into a commercial fruit crop[2,4]. The bright red fruits often persist on the plants throughout the winter, good for ornamental value but suggesting that they may not be especially palatable for wildlife. Still, they are known to be eaten by deer, moose, foxes, raccoons, chipmunks, squirrels, skuns, mice, rabbits, grouse, pheasants, robins, cedar waxwings and other songbirds. They are not normally eaten by birds until after they have frozen and thawed several times[2]. However, European cranberrybush fruits have been used for manufacturing fruit juice for a long time. The fruit juice of European cranberrybush is a traditional drink for people living in Kayseri city and middle Anatolian region. It has a nice taste. People living in the middle Anatolian region of Turkey drink it to prevent some stomach and kidney problems[5]. European cranberrybush commonly used in herbal medicine as a nerve sedative and antispasmodic in asthma and hysteria. It is also used to relieve muscle tension in the intestines, airways, uterus and striated muscles in the limbs or back. It can be taken internally or applied externally for those conditions. It has also been used in treating high blood pressure and other circulatory conditions[2]. Studies have confirmed the potential of European cranberrybush fruits as a good source of antioxidants constituents[6-8]. *Viburnum opulus* (*Caprifoliaceae*) contains arbutin and four novel iridoid glycoside esters, named[9] opulus iridoids I-IV. No work was made on the chemical and the physical properties of European cranberrybush fruits hitherto. Therefore, attempts were made in this study to determine the chemical composition and the physical properties of equipment used in plantation, harvesting, transportation, storage and processing of matured wild European cranberrybush fruits.

## EXPERIMENTAL

Fresh wild European cranberrybush fruits were collected from European cranberrybush trees growing from Kayseri (Gömeç) in Turkey in September 2005. The fruits were transported in polypropylene bags and held at room temperature. Fruits were cleaned by a combination of manual and mechanical means to get rid of all foreign matter and crushed and imature fruits. Moisture content was immediately measured on arrival soon.

All physical properties of fruits were determined using 10 repetitions at the natural moisture content of 88.32 % w.b.

To determine the size of fruits, ten groups of samples consisting of 100 fruits have been selected randomly. 10 Fruits have been taken from each group and their linear dimensions- thickness, width and length have been measured. Linear dimensions were measured by a micrometer to an accuracy of 0.01 mm.

Projected area of fruits was determined by using a digital camera (Canon A 200) and Sigma Scan Pro 5 program[10].

The mass (M) of fruits were measured by an electronic balance to an accuracy of ± 0.001 g.

The bulk density ($\rho_b$) was determined with a hectoliter tester which was calibrated in kg per hectoliter[11]. The fruits were filled the calibrated bucket from a height of about 15 cm and the excess buds were removed by a strike off stick. The fruits were not compacted in any way.

The fruits volume and its fruit density ($\rho_f$), as a function of moisture content, were determined by using the liquid displacement method. Toluene ($C_7H_8$) was used instead of water because it is absorbed by fruits to a lesser extent. Also, its surface tension is low, so that it fills even shallow dips in a fruit and its dissolution power is low[12,13].

The porosity ($\varepsilon$) was determined by the following equation:

$$\varepsilon = 1-\rho_b/\rho_f$$

In which $\rho_b$ and $\rho_f$ are the bulk density and the fruit density, respectively[13,14].

Rupture strength radial and axial values of fruits were measured by forces applied. Rupture strength of fruits, were determined with Test Instrument of Biological Materials using the procedure described by Aydin and Ogut[15] (Fig. 1). The device, has three main components which are stable up and motion bottom of platform, a driving unit (AC electric motor and electronic variator) and the data acquisition (dynamometer, amplifier and XY recorder) system. Rupture strength of fruit was measured by the data acquisition system. The fruit was placed on the moving bottom platform and was pressed with stationary platform. Probe used in experiment with 2 mm diameter was connected to dynamometer. Experiment was conducted at a loading velocity at 50 mm/min.

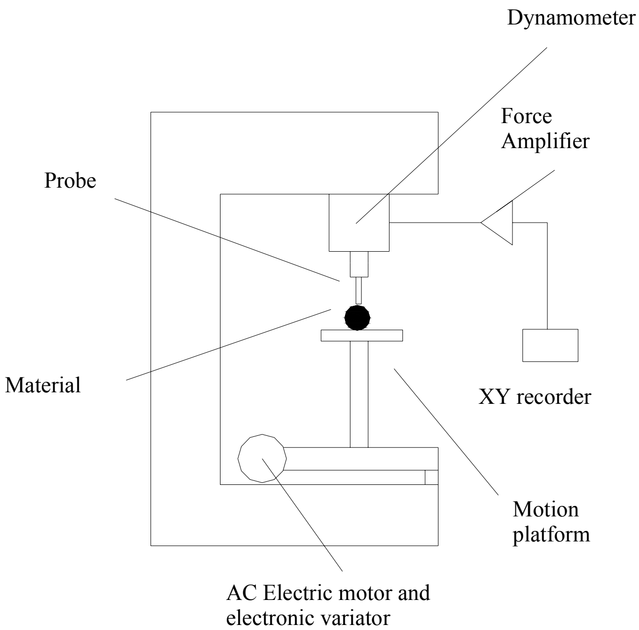


Fig. 1. Biological material test unit (B.M.T.U.)

The terminal velocities of fruits were measured using an air column. For each test, a sample was filled into the air stream from the top of the air column, up which air was blown to suspend the material in the air stream (Fig. 2). The air velocity near the location of the fruits suspension was measured[16] by electronic anemometer having a least count of 0.1 m/s.

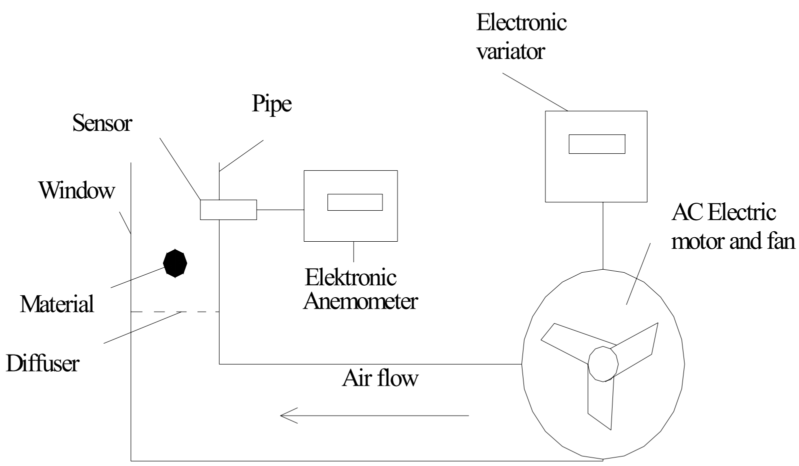


Fig. 2. Unit for measuring terminal velocity

Geometric mean diameter ($D_g$) and sphericity (Ø) values were found using the following formula[13]:

$$Dg = (A.B.C)^{0.333}$$

$$Ø = D_g/C$$

[where A = width of the fruit, B = thickness of fruit, C = length of fruit, Ø = sphericity of fruit].

The coefficient of friction of fruit was measured using a friction device modified by Tsang-Mui Chung *et al.*[17] and improved by Chung and Verma[18]. Also, both the static and dynamic coefficient of friction with an applied torque was measured and calculated using the equation[18]:

$$\mu_s = Ta/W.q$$

$$\mu_d = Tm/W.q$$

where $\mu_s$ = static coefficient of friction, $T_a$ = beginning value of torque, $\mu_d$ = dynamic coefficient of friction, $T_m$ = average value of the torque, q the length of torque arm and W is the weight of fruits to calculate the dynamic and static coefficients of friction, the average value of the torque during the rotation of the disk and the maximum value of torque obtained as the disk started to rotate were used the rotating surface.

**Proximate composition:** Moisture, reducing sugar, crude oil, crude protein, crude energy, ash, crude fiber, water-soluble extract, alcohol-soluble extract, pH, acidity and non soluble extract were determined according to Cemeroglu[19] and AOAC[20]. Total anthocyanin and phenolic compounds analysis were determined according to Fuleki and Francis[21] and Spanos *et al.*[22].

Colour of European cranberrybush was analysed by measuring Hunter L (Brightness; 100: white, 0: black), a (+: red; -: green) and b (+: yellow; -: blue) parameters with a colourimeter (Model CR 400, Chromometer, Minolta, Japan)[23].

About 0.5 g dried and ground fruit was put into burning cup and 15 mL of pure $HNO_3$ was added. The sample was incinerated in MARS 5 Microwave oven at 200 °C and the solution diluted to the certain volume with water. Concentrations were determined[24] with an ICP-AES.

## RESULTS AND DISCUSSION

The physical properties such as size distribution of European cranberrybush fruits are given in Table-1. The following general expression can be used to describe the relationship among the average dimensions of fruits at 88.32 % (w.b.) moisture content.

Physical properties such as pulp mass ratio, thickness, width and length of fruit, mass, volume of fruit, geometric mean diameter, sphericity, bulk and fruit density, porosity, projected area, terminal velocity, rupture strength at radial and axial direction, static and dynamic coefficient of friction were established at 88.32 % moisture content level. The average pulp mass ratio,

TABLE-1
TECHNOLOGICAL PROPERTIES OF EUROPEAN CRANBERRYBUSH FRUITS

| Properties | Values |
|---|---|
| Thickness (mm) | 9.59 ± 0.101 |
| Width (mm) | 9.71 ± 0.097 |
| Length (mm) | 10.18 ± 0.080 |
| Pulp mass ratio (%) | 65.33 ± 2.660 |
| Mass (g) | 0.65 ± 0.013 |
| Geometric mean diameter (mm) | 9.82 ± 0.082 |
| Sphericity | 0.96 ± 0.005 |
| Projected area ($cm^2$) | 0.9988 ± 0.022 |
| Fruit density ($kg/m^3$) | 1087 ± 22.000 |
| Bulk density ($kg/m^3$) | 608.8 ± 3.640 |
| Volume ($mm^3$) | 638 ± 57.000 |
| Terminal velocity (m/s) | 7.06 ± 0.140 |
| Rupture strength at radial direction (N) | 1.61 ± 0.107 |
| Rupture strength at axial direction (N) | 1.32 ± 0.042 |
| Porosity (%) | 44.34 ± 0.680 |

thickness, width, length, mass, volume, geometric mean diameter, sphericity and projected area were measured as 65.3 %, 9.59 mm, 9.71 mm, 10.18 mm, 0.65 g, 638 $mm^3$, 9.82 mm, 0.96 and 0.9988 $cm^2$, respectively. The moisture content is very important because of the physical properties such as bulk density, fruit density, porosity and pulp mass ratio, static and dynamic coefficient of friction of European cranberrybush fruit[25].

The frequency distributions of the dimensional properties are given Figs. 3 and 4. 88 % of fruits are between 0.52 and 0.8 g in terms of moisture content of 88.32 % in mass, 80 % of them is between 8.08 and 10.33 mm in thickness, 92 % of them is between 8.38 and 10.71 mm in width and 86 % of them is between 9.29 and 11.01 mm length.

The following general expression can be used to describe the relationship among the average dimensions of the fruits at 88.32 % (w.b.) moisture content:

$$A = 1.013 \times B = 0.953 \times C = 0.988 \times D_g = 10.11 \times Ø = 14.93 \times M$$

The coefficients of correlation (Table-2) show that the A/B, A/C, A/$D_g$, A/M and A/Ø rations were found highly significant. Similar results were found by Demir *et al.*[26] for hackberry. This indicates that the length, mass, the geometric mean diameter and sphericity are closely related to the diameter of fruit.

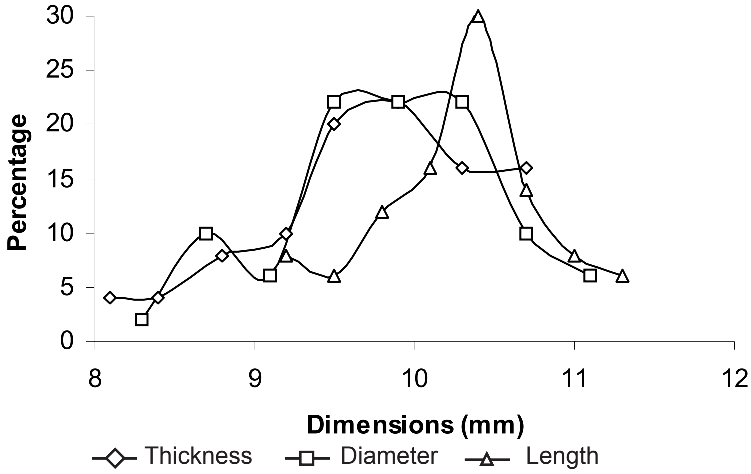


Fig. 3. Frequency distribution curves of thickness, width and length measuring of European cranberrybush fruits at the moisture content of 88.32 % w.b.

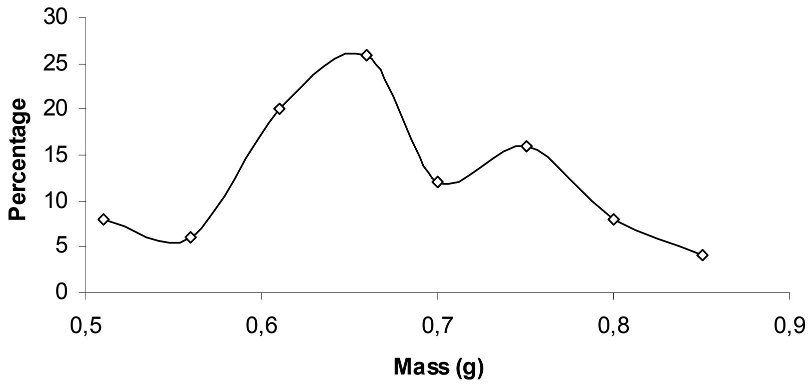


Fig. 4. Frequency distribution curves of mass measuring of European cranberrybush fruits at the moisture content of 88.32 % w.b.

TABLE-2
CORRELATION COEFFICIENT OF EUROPEAN CRANBERRYBUSH FRUITS

| Particulars | Ratio | Degrees of freedom | Correlation coefficient |
|---|---|---|---|
| A/B | 1.013 | 98 | 0.818* |
| A/C | 0.953 | 98 | 0.579* |
| A/$D_g$ | 0.988 | 98 | 0.927* |
| A/ Ø | 10.11 | 98 | 0.587* |
| A/M | 14.93 | 98 | 0.847* |

*Significant at 1 % level.

The static and dynamic coefficients of friction for European cranberry-bush fruit examined with galvanized steel sheet and plywood sheet surfaces are given in Table-3. At the same moisture contents, both the static and dynamic coefficients of friction were greatest for European cranberrybush fruits on iron sheet.

TABLE-3
RELATIONSHIPS BETWEEN FRICTION COEFFICIENTS AND MOISTURE CONTENT OF EUROPEAN CRANBERRYBUSH FRUITS FOR VARIOUS MATERIAL SURFACES

| Properties | Galvanized steel sheet | Plywood sheet |
|---|---|---|
| Dynamic | 0.145 ± 0.021 | 0.218 ± 0.015 |
| Static | 0.168 ± 0.025 | 0.255 ± 0.017 |

**Proximate compositions:** The chemical properties of European cranberry bush fruits are given Table-4. The moisture, reducing sugar, ascorbic acid, total anthocyanin and phenolic compounds, crude protein, crude oil, crude cellulose, crude energy, ash, non-soluble HCl acid ash, pH, acidity

TABLE-4
CHEMICAL PROPERTIES OF EUROPEAN CRANBERRYBUSH FRUITS

| Properties | Values |
|---|---|
| Moisture (%) | 88.32 ± 0.96 |
| Soluble dry matter (%) | 10.43 ± 0.26 |
| Reducing sugar (%) | 6.34 ± 0.36 |
| Ascorbic acid (mg/kg) | 595.24 ± 39.28 |
| Total phenolics (mg/kg) | 3253.87 ± 234.97 |
| Total anthocyanin (mg/kg) | 654.23 ± 42.04 |
| Crude protein* (%) | 6.48 ± 0.58 |
| Crude oil (%) | 0.67 ± 0.03 |
| Crude cellulose (%) | 18.07 ± 0.68 |
| Crude energy (kJ/g) | 256.56 ± 12.61 |
| Ash (%) | 1.28 ± 0.01 |
| Non-soluble HCl ash (%) | 0.0016 ± 0.00 |
| pH | 3.04 ± 0.01 |
| Acidity (%) | 1.79 ± 0.12 |
| Alcohol-soluble extract (%) | 18.42 ± 0.78 |
| Colour indicators | L: 24.33 ± 2.57 |
| | a: +16.09 ± 1.73 |
| | b: + 2.08 ± 1.23 |

*N × 6.25

(% citric), alcohol-soluble extract values, colour and mineral contents were determined. The energy, reducing sugar, ascorbic acid, total anthocyanin, total phenolics, protein, cellulose, oil, ash, acidity, soluble solid matter and alchol-soluble extract values of European cranberrybush fruits were established as 61.32 kcal/g, 6.34 %, 595.0 mg/kg, 654.23 mg/kg, 3253.87 mg/kg, 6.48, 18.07, 0.67, 1.28, 1.79, 10.4 and 18.07 %, respectively. The crude protein content of myrtle fruit is reported[27] as 3.16 %. However, higher values were observed in this work than in the previous studies which may be due to several differences and also to method of sample preparation suggesting the significant impact of variety on the protein, oil, fiber, energy and moisture contents of wild fruits. But generally the protein contents are always higher than the fat contents. The mineral contents of fruits are given in Table-5. All materials contained high amounts of Ca, K, Mg, Na, P and S. These values were found as 2441, 8420, 900, 345.3, 607.5 and 526.1 ppm, respectively. Ozcan *et al.*[28], established that K, Mg, P and Ca reported as major elements in hawthorn fruit samples.

Minerals contribute to biological process, but which have not been established as essential, are bromine and lithium[29]. Lithium is another element with beneficial pharmacological properties; it has been used effectively in the treatment of manic depressive disorders. There is evidence to suggest that lithium is also an essential element[30]. However, knowledge of their mineral contents of vegetable materials is very important for human nutrition.

Total anthocyanin, total phenolics and ascorbic acid contents of European cranberrybush fruits were established as 654.23, 3253.87 and 595 mg/kg, respectively. These values of European cranberrybush fruit were found higher than that of Ozcan and Akbulut[27].

TABLE-5
MINERAL CONTENTS OF EUROPEAN
CRANBERRYBUSH FRUITS (n=3)

| Minerals | ppm | Minerals | ppm |
|---|---|---|---|
| Al | 7.67 ± 0.865 | Li | 0.70 ± 0.014 |
| B | 40.47 ± 1.170 | Mg | 900.00 ± 98.790 |
| Ba | 6.45 ± 1.574 | Mn | 2.59 ± 0.198 |
| Ca | 2441.00 ± 369.500 | Na | 345.30 ± 23.120 |
| Co | 0.31 ± 0.021 | Ni | 1.43 ± 0.170 |
| Cr | 0.49 ± 0.035 | P | 607.50 ± 17.090 |
| Cu | 5.58 ± 0.091 | S | 526.10 ± 37.230 |
| Fe | 15.46 ± 0.695 | Sr | 8.63 ± 1.330 |
| K | 8420.00 ± 487.000 | Zn | 11.75 ± 1.780 |

Anthocyanin and phenolics are a good source of natural antioxidant, but they are quite unstable during the processing and storage. Temperature, pH, oxygen and water activity are considered to be important factors influencing its stability. During heating, degradation and polymerization usually lead to its discolouration[31,32].

## Conclusion

As a result, the chemical properties revealed nutritional values such as ascorbic acid, anthocyanin and phenolic compounds, reducing sugar, crude protein, crude fiber, crude oil, ash and mineral contents of European cranberrybush fruits. In addition, it is very important to establish the physical properties of equipment used harvesting, transportation, storage and processing of fresh fruits. However, further studies will need to physical properties to equipment design and to provide necessary information for the use of wild edible fruits.

## REFERENCES


1. T. Baytop, Türkiye'nin Tibbi ve Zehirli Bitkileri. I.Ü. Yayinlari No: 1039, p. 400, Istanbul (1963).
2. T. Baytop, Treatment with Plants in Turkey, Istanbul Univ. Publ. No. 3255, Istanbul (1984).
3. P.H. Davis, Flora of Turkey and the East Aegan Island. Edinburgh University Press, Edinburg. Vol. 4, p. 544 (1972).
4. D. Brown, Encyclopedia of Herbs and Their Uses, Dorling Kindersley Pub. (1995).
5. M. Soylak, L. Elcit, S. Saraçoglu and U. Divrikli, *Asian J. Chem.*, **14**, 135 (2002).
6. V.G. Spriygin, N.F. Kushnerova and Y.A. Rakhmanin, *Gigiena i Sanitariya*, **3**, 57 (2003).
7. D.K. Shapiro, I.R. Kisilevsky, P.A. Moroz, T.I. Vasilevskaya and V.V. Verskovsky, *Farmatsevtichnii Zhurnal*, **44**, 55 (1989).
8. A.R. Karimova, S.G. Yunusova, S.I. Maslennikov, E.G. Galkin, T.S. Yunusov, V.V. Shereshovets and M.S. Yunusov, *Chem. Natural Comp.*, **36**, 560 (2001).
9. K. Bock, S.R. Jensen, B.J. Nielsen and J. Norn, *Phytochemistry*, **17**, 753 (1978).
10. T.P. Trooien and D.F. Heermann, *Transactions of the ASAE*, **35**, 1709 (1992).
11. S.D. Deshpande, S. Bal and T.P. Ojha, *J. Agric. Eng. Res.*, **56**, 89 (1993).
12. G. Sitkei, Mechanics of Agricultural Materials, Department of Woodworking Machines, University of Forestry and Wood Science, Sopron, Hungary (1976).
13. N.N. Mohsenin, Physical Properties of Plant and Animal Material, New York, Gordon and Breach (1970).
14. R.A. Thompson and G.W. Isaacs, *Transactions of the ASAE*, **10**, 693 (1967).
15. C. Aydin and H. Ögüt, *Selcuk University J. Agric. Fac.*, **1**, 45 (1991).
16. D.C. Joshi, S.K. Das and R.K. Mukherji, *J. Agric. Eng. Res.*, **54**, 219 (1993).
17. M. Tsang-Mui-Chung, L.R. Verma and M.E. Wright, *Transaction of the ASAE*, **27**, 1938 (1984).
18. J.H. Chung and L.R. Verma, *Transaction of the ASAE*, **32**, 745 (1989).
19. B. Cemeroglu, The Major Analyses Methods in Fruit and Vegetable Processing Industry (Meyve ve Sebze Isleme Endüstrisinde Temel Analiz Metotlari), p.381, Publ No. 02-2, Ankara (1992).

20. AOAC, Offical Methods of Analysis, Association of Official Analytical Chemists, Arlingon: VA, USA, edn. 14 (1984).
21. F. Fuleki and F.J. Francis, *J. Food Sci.*, **33**, 471 (1968).
22. G.A. Spanos, R.E. Wrolstad and D.A. Heathherball, *J. Agric. Food Chem.*, **38**, 1572 (1990).
23. A. Rommel, D.A. Heatherbell and R.E. Wrolstad, *J. Food Sci.*, **55**, 1011 (1990).
24. S. Skujins, Handbook for ICP-AES (Varian-Vista), A Short Guide to Vista Series ICP-AES Operation, Version 1.0, Varian Int. AG, Zug (1998).
25. E.S. Ajisegiri, Sorption Phenomena and Storage Stability of Some Tropical Agricultural Grains, Ph.D. Thesis, University of Ibadan, Nigeria (1987).
26. F. Demir, H. Dogan, M. Ozcan and H. Haciseferogullari, *J. Food Eng.*, **54**, 241 (2002).
27. M. Ozcan and M. Akbulut, *Gida*, **23**, 121 (1998).
28. M. Ozcan, H. Haciseferogullari, T. Marakoglu and D. Arslan, *J. Food Eng.*, **69**, 409 (2005).
29. R. Macrae, R.K. Robinson and M.J. Sadler, Encyclopaedia of Food Science, Food Technology and Nutrition, Academic Press INC., San Diego, CA, Vol. 7, pp. 4593-4600 (1993b).
30. R. Macrae, R.K. Robinson and M.J. Sadler, Encyclopaedia of Food Science, Food Technology and Nutrition, Academic Press INC., San Diego,CA, Vol. 5, pp. 3126-3131 (1993a).
31. P. Markakis, in ed.: P. Markakis, Stability of Anthocyanins in Foods, Anthocyanins as Food Colors, Academic Press, New York, pp. 163-180 (1982).
32. P.J. Tsai and H.P. Huang, *Food Res. Inter.*, **37**, 313 (2004).

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