Chemical Study of the Fruits of Some Prunuscerasia Blanche Phenotypes Prevailing in the Syrian coast

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Plums constitute a large and diverse plant population, including many selected species of more than 12 species of *Prunus*[2]. Plum trees can grow in the five continents and their cultivation is concentrated in the temperate regions of the northern hemisphere. World production is over 11 million tonnes, about half of which is consumed as fresh fruit ([3]; [4];[5]; [6]). European plum*Prunusdomestica* L. is one the most important internationally-cultivated species[7], of which most internationallyprevailing plum cultivars come from [8]. It is characterized by a variety of fruits in colour and taste, and is one of the best species of plums in terms of fruit quality [2].

Prunuscerasia Blanche (*P. cerasia*) is a species of *prunus L* and sub-family *Prunoideae*of the family*Rosaceae*[1]. It is an important wild species in Syria due to its widespread, especially in the northwestern region and its natural adaptation to different environmental conditions, including drought and soil erosion [9], as well as its pest and disease resistance [10] and its potential for use a rootstock for some almond species. Its fruits are eaten fresh, dried or used in jamindustry [11].

Plum fruits are used for several purposes (food, medical and industrial). The main processed products of plums are (compote, dried fruits, frozen fruits, jams and alcoholic beverages). Due to their taste and nutritional value, plum fruits are widely consumed by children and adults of all ages. Plumsare an important exporting fruit; both fresh and frozen [12].

Plums significantly contribute to human nutrition and are an important component of the diet in terms of nutritional value due to the abundance of active biochemical compounds such as anthocyanins, bactines and carotenoids ([13]; [14]). Plums are essential for human health and protection from various diseases ([15]; [16]),and a source of fiber and mineral elements

Abstract

The research was conducted in 2017 to identify the most important chemical components (total sugars, total acidity, dry matter and soluble solids) for ripe fruits of 42 shrubs of Prunuscerasia Blanche on 12 sites in the Syrian coast, with the objective of making comparison of the studied shrubs to determine variation between them and know the best for breeding and genetic improvement programmes of almonds. The results showed variation in the chemical content of studied traits of wild plum fruits, so the fruit content of soluble soilds had the highest value 23% for the shrub (LK3) in Kassab site (Lattakia province) and the lowest value 10.2% for the shrub (TR1) in Rjam site (Tartous province). The highest total acidity was 3.06% for the shrub (TM1) in Matn al-Sahel town and the lowest was 0.64% for the shrub (TS1) in al-Souda town, and both sites are in Tartous province.As for fruit content of sugars, the two shrubs (LD1 and LD2) in Al-Daliya site had good content of sugars (8.83 and 8.9%) respectively, and they were significantly higher than other studied shrubs in this trait. In addition, significant variation between plum shrubs in terms of fruit content of dry matter was found, ranging between (12.07-25.18%).

Keywords: wild plum, chemical composition, sugars, TA, TSS

I. INTRODUCTION

Syrian Arab Republic is rich in biodiversity in all its forms and is a stock for many wild plant genetic resources in addition to the cultivated and domesticated plants that have been introduced to it over different periods and have adapted to their environments well. According to Syrian flora, the number of wild species prevailing in Syria is estimated at 3650 species falling within 130 subfamilies and 910 genera [1]. have been no chemical studies compared to wild plums [33].

Plum cultivars and its wild genotypes have diverse physical, chemical and sensory characteristics ([6]; [33];[34]; [35];[36]; [37];[38]; [39]; [40]).This diversity is due to the specifications of cultivars and environmental conditions [41].

Due to the importance of wild rootstocks naturally prevailing in the Syrian coast including Prunuscerasia: their adaptation to local environmental conditions; tolerance to environmental stresses, different diseases and pests; and lack of chemical research on wild plum species, this research aims to evaluate some shrubs of P. cerasia prevailing in different areas of the Syrian coast in terms of their chemical content of (total sugars, total acidity, TSS and DM) to identify the best for breeding and genetic improvement programme of plums.

II. MATERIALS ANDMETHODS A. Study sites and plant material

The research was carried out at the Centre of Agricultural Scientific Research in Lattakia in collaboration with Tishreen University, Faculty of Agriculture, Department of Horticulture during 2017. Some sites in both Lattakia and Tartous provinces were selected, where the wild plum shrubs *P. cerasia* is natively found. Forty-twoshrubs were identified within the current study sites (Table 1).

(Ca, K, P, Mg)([17]; [18];[19]). They contain a relatively large amount of carbohydrates as a source of energy [20] and little amount of vitamin C([18]; [19];[21]). They are also an important source of boron [22]. Plum fruits have low calorie content and a relatively high nutritional value as they contain carbohydrates, organic acids such as citric, malic, bactinicfibre, tannins, aromatic substances and enzymes. These substances determine nutritional value and taste [23]. Plum fruits lower total cholesterol and triglyceride levels in blood. Due to the high sodium content and beneficial sodium to potassium ratio, plumsare recommended for the patients with high arterial tension ([24]; [25];[26]).

Consumer acceptance of plums is highly correlated with harvest date and fruit ripening ([27]; [28]). When making a purchase decision, consumer evaluates the fruit appearance and then taste which is associated with the content of total soluble solids and acidity [28]. The content of dry matter (DM) and total soluble solids (TSS) is very important for fruit quality because they determine fruit taste andstorability. DM content greatly varies depending on environmental conditions and a particular growing season [29].

Wild plumshad been used as a nutritional and medical source for thousands of years([30]; [31]). There are numerous studies on the chemical composition of cultivated plums [32], but there

| Province | Site | Shrubs | Altitude (m) | Latitude E | Longitude N |
|----------|---------------|---------------------------------|-----------------|------------|----------------|
| Lattakia | Mashqita | LM1, LM2, LM3, LM4, LM5 | 232 | 35°54.915 | 35°40.918 |
| | Qsmeen | LQ1, LQ2, LQ3, LQ4, LQ5 | 277 | 35°54.244 | 35°38.142 |
| | Al-Draoukiyat | LDr1, LDr2, LDr3, LDr4, LDr5 | 158 | 35°52.44 | 35°41.947 |
| | KhirbtSolass | LS1, LS2, LS3, LS4, LS5 | 402 | 35°58.51 | 35°41.410 |
| | Kassab | LK1, LK2, LK3, LK4, LK5 | 711 | 36°00.339 | 35°56.433 |
| | Ras al-Shimra | LRsh1, LRsh2 | 27 | 35°47.237 | 35°35.048 |
| | Ras al-Ein | LR1, LR2 | 117 | 35°59.339 | 35°20.193 |
| | Al-Daliya | LD1, LD2 | 986 | 36°09.455 | 35°14.012 |
| | Hibeit | LH1, LH2 | 379 | 36°02.13 | 35°33.439 |
| Toutour | Rjam | TR1, TR2, TR3, TR4, TR5 | 247 | 36°04.39 | 34°50.073 |
| Tartous | Mitn al-Sahel | TM1, TM2 | 275 | 35°56.371 | 34°58.565 |
| | Al-Souda | TS1, TS2 | 289 | 35°55.79 | 34°58.958 |

Table (1) Sites of current study in terms of altitude, geographical coordinates and studied shrubs

phenol hair follicle until the appearance of the pink colour[43]. Based on the resulting values, the studied shrubs were divided into groups as shown in Table (2).

3. Determination of total sugars (TS%)

The percentage of total sugars wasestimated by calibration method [44]. Based on the resulting values, the studied shrubs were divided into groups as shown in Table (2).

4.Determination of dry matter (DM%)

The percentage of the dry matter was estimated by drying in the oven at 2 g of the sample (fruit fat), where the sample is placed in the oven at 105 $^{\circ}$ C and left until weight stability. The dry matter is then calculated as a percentage by calculating weight difference before and after drying as in the following relation:

Dry matter = dry sample weight/wet sample weight * 100 [43].

Based on the resulting values, the studied shrubs were divided into groups as shown in Table (2).

B. Research methodology

Fully-ripened and coloured fruits were randomly gathered from each shrub. Fruit ripening dates varied by site (July and August). Fruits were transferred to the laboratory and analyzed in terms of chemical composition. The shrubs were then divided into groups according to each analysis based on categorical grouping law[42].

1. Determination of total soluble solids (TSS%)

Percent TSS was estimated by a refractometer at 25 $^{\circ}$ C by taking a drop of juice and placing it in the designated place of the machine and taking the electronically corrected reading [43]. Based on the resulting values, the studied shrubs were divided into groups as shown in Table (2).

2. Determination oftotalacidity(TA%)

Percentage of total acidity in the studied fruits was estimated on the basis of malic acid by calibrating the organic acids found in them with a normal sodium soluble solution (0.1) and with

 Table (2) Index of the percentages of studied chemical properties of fruitsP. cerasia
 cerasia
 different sites

 of the Syrian coast
 Index of the studied chemical properties of fruitsP. cerasia
 Index of the studied chemical properties of fruitsP. cerasia

| Studied trait Percentage within the fruit | | | | | |
|---|--------|---------------|--------|--|--|
| TSS% | <14.47 | 14.74 - 18.74 | >18.78 | | |
| TSS | low | medium | high | | |
| TA% | <1.45 | 1.45 - 2.26 | >2.26 | | |
| ТА | low | medium | high | | |
| TS% | <4.54 | 4.54 - 6.72 | >6.72 | | |
| TS | low | medium | high | | |
| DM% | <16.44 | 16.44 -20.81 | >20.81 | | |
| DM | Low | medium | high | | |

terms of TSS percentage in their fruit juice. The lowest TSS was for shrubs (TR1, TR2, TR3, TR4, TR5) prevailing in Rjam site inTartous province. This agrees with the results of [22] where the studied plum cultivars varied in terms of their fruit content from TSS, so that TSS values ranged from 12.40% for Oltenalto 20.43% for Tuuleu de Sinesti.

In a study conducted in Turkey on genotypes of *Prunusspinosa*, the TSS was 11.98% for genotypes having dark purple fruits, 14.98% for genotypes having red fruits [33]. TSS in the fruits of 16 genotypes of plum shrubs prevailing in four different sites in Pakistan ranged (8.17 - 16.23%) [6]. In another study the TSS of some plum species ranged (16.80 - 19.20%)[17].

B. Total acidity (TA%)

The highest TA was 3.06% in the fruits of (TM1) and the lowest was (0.64%) in the fruits of (TS2). (Table 3)

5. Statistical analysis

The experiment was a completely randomized design. The results were analyzed using the statistical software GenStat (release 12.1), dependingon one-way analysis of variance (ANOVA) and comparing the differences between the averages by the least significant difference (LSD) at 5% significance level.

III. RESULTS AND DISCUSSION

A. Total soluble solids (TSS%)

Studied wild plum shrubs varied in terms of TSS in the fruit juice (Table 3). The highest value (23%) was found in the fruits of shrub (LK3), while the lowest value (10.2%) was in shrub (TR1). The results of statistical analysis at (LSD 5% = 0.1972) showed significance of shrubs (LK1, LK2, LK2, LK3, LK4, LK5, LR2, LD1, LD2, TS2, TS2) prevailing in Kassab, Ras al-Ein and Al-Daliyain Lattakia province and al-Souda in Tartous province over other studied shrubs in

(smell, taste, texture). In a study to determine TS% for plum genotypes in Pakistan, the results showed TS% of (6.71-10.5%) [6]. Inanother study conducted to determine the physical and chemical properties of plum cultivars grown in Serbia, the percentage of total sugars ranged (10.31-11.78%) [17] and was higher than that of the European plum cultivars grown in Turkey at (9.6%) [46].

D. Dry matter(DM%)

The highest dry mater value was (25.18%) for fruits of (LK5) and the lowest value was (12.07%) for fruits of (TR3) (Table 3).

The results of the statistical analysis at (LSD 5% = 1.3608) showed that the shrubs (LK1, LK2, LK3, LK4, LK5) prevailing in Kassab site inLattakia were more significant in terms of dry matter than other studied shrubs. This is consistent with the results of [22]. The dry matter for the studied plum cultivars ranged from 13.76% for Flora to 25.20% for Tuleu de Sinesti.

In a study conducted on plum cultivars, the results showed a significant variation in the dry matter of tested cultivars. This variation is due to the changing environmental and growing conditions. The dry matter was (19%) in fruits of Elena andWegierkaZwykla and (12%) in Bluefre[29]. In another study, the dry matter of the studied plum genotypes ranged (10.83-29.60%) [6].

The statistical results at (LSD 5% = 0.1067) demonstrated that the two shrubs (TM1, TM2) prevailing in Matn al-Sahel inTartous province were more significant in terms of TA than other studied shrubs. This is in line with the results of [6]where the TA of the studied plum genotypes ranged (1.49-2.34%). TA of the current study was less than that of the study [33] on *Prunusspinosa* genotypes. TA was 4.99% for genotypes having red fruits and 3.87% for genotypes having dark purple fruits.

In a study on plumcultivars in Romania, acidity values ranged from 0.34% for RencoldAlthan to 0.83% for Tuleu Gras cl.14 [22].In another study, the TA of studied plum cultivars ranged (0.88-1.37%) [17].

C. Total sugars(TS%)

The highest total sugars value was (8.9%) for fruits of (LD1) and the lowest was (2.36%) for fruits of (TR2). (Table 3)

The results of the statistical analysis at (LSD 5% = 0.5172) showed the significance of (LD1, LD2) prevailing in Al-Daliya site inLattakia in terms of total acidity in their fruit juice over studied shrubs. This is consistent with [45]. The Total sugars ranged (7.5-8.6%) for the studied Japanese plum. Sugar is an important component of fruits and is directly related to their sweetness, which is an essential characteristic of fruit quality

| Shrub | TSS% | TA% | TS% | DM% | Shrub | TSS% | TA% | TS% | DM% |
|-------|--------|--------|--------|--------|-------|--------|--------|--------|--------|
| LM1 | 17.1 | 2.04 | 6.97 | 19.18 | LK2 | 21.2 | 0.85 | 6.6 | 24.21 |
| LM2 | 17 | 2.04 | 6.6 | 19.22 | LK3 | 23 | 1.02 | 7.38 | 23 |
| LM3 | 18 | 1.36 | 4.73 | 20.12 | LK4 | 21.5 | 0.98 | 8.65 | 24.2 |
| LM4 | 17.4 | 2.1 | 7.96 | 20.19 | LK5 | 19 | 0.84 | 5.12 | 25.18 |
| LM5 | 18 | 1.87 | 5.97 | 22.63 | LRsh1 | 14.2 | 2.21 | 3.58 | 16.2 |
| LQ1 | 17 | 1.29 | 6.97 | 20.17 | LRsh2 | 14.2 | 2.1 | 3.69 | 14.13 |
| LQ2 | 16 | 1.02 | 4.37 | 19.22 | LR1 | 18.6 | 1.02 | 3.69 | 22.15 |
| LQ3 | 18 | 1.19 | 5.34 | 18.17 | LR2 | 22 | 1.08 | 7.84 | 21.24 |
| LQ4 | 18 | 1.08 | 6.6 | 19.71 | LD1 | 21 | 0.68 | 8.9 | 22.08 |
| LQ5 | 18.1 | 1.19 | 4.64 | 17.42 | LD2 | 20 | 0.85 | 8.83 | 21.11 |
| LDr1 | 17.2 | 1.53 | 6.6 | 19 | LH1 | 18.2 | 1.29 | 7.38 | 21.18 |
| LDr2 | 17.4 | 2.04 | 7.29 | 19.1 | LH2 | 18 | 1.76 | 5.02 | 19.84 |
| LDr3 | 17.5 | 2.04 | 6.97 | 19.11 | TR1 | 10.2 | 0.68 | 3.06 | 13.71 |
| LDr4 | 18.5 | 1.7 | 6.97 | 21.34 | TR2 | 11 | 0.85 | 2.36 | 13.85 |
| LDr5 | 18.1 | 2.14 | 7.51 | 22.17 | TR3 | 11 | 1.32 | 5.7 | 12.07 |
| LS1 | 18 | 1.36 | 5.7 | 21.37 | TR4 | 10.5 | 1.29 | 5.45 | 12.41 |
| LS2 | 17.5 | 1.87 | 5.7 | 19.22 | TR5 | 10.7 | 1.29 | 6.38 | 12.12 |
| LS3 | 17.5 | 1.87 | 6.27 | 19.2 | TM1 | 15.9 | 3.06 | 3.92 | 17.82 |
| LS4 | 18 | 2.04 | 6.71 | 20.41 | TM2 | 16 | 2.89 | 4.64 | 17.64 |
| LS5 | 18.3 | 1.7 | 7.38 | 20.37 | TS1 | 21.1 | 0.68 | 5.02 | 24.17 |
| LK1 | 19.2 | 1.02 | 4.48 | 25.16 | TS2 | 21 | 0.64 | 4.78 | 24.09 |
| L.S.D | 0.1972 | 0.1067 | 0.5172 | 1.3608 | L.S.D | 0.1972 | 0.1067 | 0.5172 | 1.3608 |

Table (3) TSS, acidity, sugars, and dry matter within the fruits of *P. cerasia* with LSD values for studied straits at significance 5%

| | 5% | | | | 5% | | | | |
|--|----|--|--|--|----|--|--|--|--|
|--|----|--|--|--|----|--|--|--|--|

- [13] M.E. IONICA, V. NOUR, I. TRANDAFIR. "The influence of aero-ionized Stream on the storage capacity of plums". *Acta Hort.* 968: 205-210. 2012.
- [14] G. CAO, E. SOFIC, R.L. PRIOR. "Antioxidant and prooxidant behavior of flavonoids: Structure-activity relationships". *Free Rad. Biol. Med.* 22: 749-760. 1997.
- [15] M. STACEWICZ-SAPUNTZAKIS, P.E. BOWEN, E.A. HUSSAIN, B.I. DAMAYANTI-WOOD, N.R. FARNSWORTH. "Chemical composition and potential health effects of prunes: a functional food". *Crit. Rev. Food Sci. Nutr.* 41: 251-286. 2001.
- [16] S. HOOSHMAND, B.H. ARJIMANI. "Viewpoint: dried plum, an emerging food that may effectively improve bone health". *Aging Res. Rev.* 8: 122-127. 2009.
- [17] T. MILOSEVIC, N. MILOSEVIC. "Factors influencing mineral composition of plum fruits". *Journal of Elementology*. 17(3): 453-464. 2012.
- [18] S. KAYANO, H. KIKUZAKI, N. FUKUTSAKA, T. MITANI, N. NAKATANI. "Antioxidant activity of prune (*PrunusdomesticaL.*) constituents and a new synergist". J. Agric. Food Chem. 50: 3708-3712. 2002.
- [19] L.P. LEONG, G. SHUI. "An investigation of antioxidant capacity of fruits in Singapore markets". *Food Chem.* 76: 69-75. 2002.
- [20] D. WALKOWIAK-TOMCZAK. "Characteristics of plums as a raw material with valuable nutritive and dietary properties-a review". *Pol J Food Nutr Sci.* 58(4): 401-405. 2008.
- [21] R. KAZIMIERCZAK, K. SWIETLIKOWSKA, G. WASIAK-ZYS. "Owocekrajowe (Domestic fruit). Surowcespozywczepochodzeniaroslinnego (Food raw material of plant origin)". *Wyd SGGW Warszawa*. 258-266. 2006.
- [22] M.E. IONICA, V. NOUR, I. TRAVDAFIR, S. COSMULESCU, M. BOTU. "Physical and Chemical Properties of Some European Plum Cultivars (*PrunusdomesticaL.*)". Not. Bot. Horti. Agrobo. 41(2): 1-6. 2013.
- [23] C. ERTEKIN, S. GOZLEKCI, O. KABAS, S. SONMEZ, I. AKINCI. "Some physical, pomplogical and nutritional properties of two plum (prunusdomestica L.) cultivars". Journal of food Engineering. 75(4): 508-514. 2006.
- [24] E. LUCAS, L. HAMMOND, V. MOCANU, A. ARQUITT, A. TROLINGER, D. KHALIL, B. SMITH, D. SOUNG, B. DAGGY, B. ARJMANDI. "Daily consumption of dried plum by postmenopausal women does not cause undesirable changes in bowel function". J. Appl. Res. 4(1): 37-43. 2004.
- [25] L.F. TINKER, B.O. SCHNEEMAN, P.A. DAVIS, D.D. GALLAHER, C. R. WAGGONER. "Consumption of prunes as a source of dietary fiber in men mild hypercholesterolemia". *Am. J. Clin. Nutr.* 53: 1259-1265. 1991.
- [26] L.F. TINKER, P.A. DAVIS, B.O. SCHNEEMAN. "Prune fiber or pectin compared with cellulose lowers plasma and liver lipids in rats with diet induced hyperlipidemia". *J. Nutr.* 124: 31-40. 1994.
- [27] M. ZUZUNAGA, M. SERRANO, D. MARTINEZ-ROMERO, D. VALERO, F. RIQUELME. "Comparative study of two plum (*PrunussalicinaLindl.*) cultivars during growth and ripening". *Food Sci. Tech. Int.* 7: 123-130. 2001.
- [28] C.H. CRISOSTO, D. GARNER, G.M. CRISOSTO, E. BOWERMAN. "Increasing 'Blackamber' plum (*Prunussalicina*Lindell) consumer acceptance". *Postharv. Biol. Technol.* 34: 237-244. 2004.
- [29] D. WALKOWIAK-TOMCZAK, J. REGULA, G. LYSIAK. "Physico-chemical properties and antioxidant

IV. CONCLUSIONS

- There is a wide variation between the studied shrubs in terms of their chemical properties (total sugars%, total acidity%, TSS%, dry matter%).
- The fruits of the studied shrubs contain significantly higher percentages of TSS and dry matter compared to the results of previous studies, in addition to containing good amounts of TS% and moderate TA%.
- Various chemical contents of some fruits of the studied shrubs within a single site. This is a preliminary indicator of the existence of genetic variation between the studied shrubs due to excluding the effect of the surrounding environmental conditions and soil characteristics in creating the variation between the chemical content of the shrub fruits of a single site.

REFERENCES

- [1] P. MOUTERDE. "Nouvelle flore du Liban et de la Syrie". *Dar el Mechreq*, *Beyrouth. Liban*. 1966.
- [2] E. GOMEZ-PLAZA, C. LEDBETTER. "Handbook of fruit and vegetable flavors". *In: Y.H. Hui, John Wiley & Sons Inc.* 2010.
- [3] N. MILOSEVIC, E. MRATINIC, S.I. GUSIC, T. MILOSEVIC. "Precocity yield and postharvest physical and chemical properties of plums resistant to Sharka grow in Serbian conditions". *ActaScientiarumPolonorum, HortorumCultus*. 11 (6): 23-33. 2012.
- [4] F. VISANU, I. BOTU, A. BACIU. "Assessment of production of capacity for some Plum, Myrobolan and Sloe Cultivars and Selections Grown in Northern Oltenia". Acta Hort. 968: 75-80. 2012.
- [5] M. BOTU, F. VISANU, I. STEFANESCU, A. VICOL, M. CERNATESCU. "Structure of the plum cultivar assortment for region of Oltenia-Romania". *Acta Hort.* 968: 115-120. 2012.
- [6] H. NISAR, M. AHMED, M.A. ANJUM, S. HUSSAIN. "Biodiversity in morpho-physiological characteristics of indigenous plum germplasm from Azad Jammu and Kashmir, Pakistan". *Zemdirbyste-Agriculture*. 102 (4): 423-430. 2015.
- [7] C. KOLE. "Genome Mapping and Molecular Breeding in Plants, Fruits and Nuts". Springer-Verlag Berlin Heidelberg. 4: 370. 2007.
- [8] W. CHANDLER. "Chilling requirement for open of buds on deciduous orchards". *Third edition, London.* 1958.
- [9] J. KAISER. "Personal communication state plant materials specialist, USDA, NRCS". *Plant Materials center, Elsberry, Missouri*. 1999.
- [10] H.MAHFOUD. "Taxonomic study of the species and types of *PrunusL*. in the northwestern region of Syria". *Master thesis, Department of Horticultue, Faculty of Agriculture, Tishreen University, Syria.* P.123.2003.
- [11] S. LAIKA, A. DEEB, H. MAHFOUD. "A taxonomic study of some species and types of *Prunus L*. in Lattakia province". *Journal of Tishreen University for scientific* studies and research, Agricultural science series. 7(3): 2003.
- [12] Z.S. GRZYB, E. ROZPARA. "Nowoczesnauprawasliw [Modern plum growing]". *Hortpress.* 2000.

nutritional values of plums (*Prunusdomestica* L.) typical of the White Carpathian Mountains". *Scientia Hort*. 122(4): 545-549. 2009.

- [39] V. USENIK, F. STAMPAR, R. VEBERIC. "Anthocyanins and fruit colour in plums (*Prunusdomestica* L.) during ripening". Food Chem. 114(2): 529-534. 2009.
- [40] S.O. AJENIFUJAH-SOLEBO, J.O. AINA. "Physicochemical properties and sensory evaluation of jam made from black-plum fruit (*Vitexdoniana*)". *African J. Food Agricult. Nutr. Develop.* 11: 4772-4784. 2011.
- [41] K. VURSAVUS, H. KELEBEK, S. SELLI. "A study on some chemical and physico-mechanic properties of three sweet cherry varieties (*Prunusavium* L.) in Turkey". J. Food Engin. 74: 568-575. 2006.
- [42] A. KHADDAM, G. YAKOUB. "Fundamental of statistics and design of agricultural experiments". Directorate of Books and University Publications, Faculty of Agriculture, Tishreen University, Syria. P.296.1994.
- [43] AOAC. "Official methods of Analysis". 17th Ed. Association of Official Analytical Chemists, Washington D.C., USA. 2000.
- [44] S. RANGANNA. "Handbook of analysis and quality control for fruits and vegetable products". Tata McGraw-Hill publishing company limited. New Delhi (India). 11-12. 1986.
- [45] P. MELGAREJO, A.C. SANCHEZ, F. HERNANDEZ, A. SZUMNY, J.J. MARTINEZ, P. LEGUA, R. MARTINEZ, A.A. CARBONELL-BARRACHINA. "Chemical, functional and quality properties of Japanese plum (*Prunussalicina*Lindl.) as affected by mulching". *Sci. Horticult.* 134: 114-120. 2012.
- [46] C. NERGIZ, H. YILDIZ. "Research on chemical composition of some varieties of European plums (*Prunusdomestica*) adapted to the Aegean district of Turkey". J. Agricult. Food Chem. 45: 2820-2823. 1997.

activity of selected plum cultivars fruit". Acta Sci. Pol. Aliment. 7(4): 15-22. 2008.

- [30] S. ERCISLI. "A short review of the fruit germplasm resources of Turkey". *Gen. Res. Crop Evol.* 51: 419-435. 2004.
- [31] M. AHMED, M.A. ANJUM, M.A. RUBBANI, L. HASSAN. "Characterization of indigenous Pyrusgermplasm of Azad Jammu and Kashmir revealed by SDS-PAGE analysis". *African J. Biot.* 8: 6442-6452. 2009.
- [32] G. BILGU, G. SEFEROGLU. "The determination of growing performances of the some plum cultivars in Aydinecological conditions". ADU, Agricultural Faculty Journal. 2(2): 95-100. 2005.
- [33] Y. ERTURK, S. ERCISLI, M. TOSUN. "Physicochemical characteristics of wild plum fruits (*Prunusspinosa* L.)". *International Journal of Plant Production.* 3(3): 89-92. 2009.
- [34] M.I. GIL, F.A. TOMAS-BARBERAN, B. HESS-PIERCE, A.A. KADER. "Antioxidant capacities, phenolic compounds, carotenoids, and vitamin C contents of nectarine, peach, and plum cultivars from California". *J. Agricult. Food Chem.* 50: 4976-4982. 2002.
- [35] I. VITANOVA, S. DIMKOVA, D. IVANOVA. "Vegetative and reproductive parameters of introduced plum cultivars". *Journal of Fruit and Ornamental Plant Research.* 12: 257-262. 2004.
- [36] E. VANGDAL, S. FLATLAND, R. NORDBO. "Fruit quality changes during marketing of new plum cultivars (*Prunusdomestica* L.)". *HortSci* (*Prague*). 34: 91-95. 2007.
- [37] M. LOZANO, M.C. VIDAL-ARAGON, M.T. HERNANDEZ, M.C. AYUSO, M.J.; BERNALTE, J.; GARCIA, B. VELARDO. "Physicochemical and nutritional properties and volatile constituents of six Japanese plum (*Prunussalicina*Lindl.) cultivars". *Europ. Food Res. Technol.* 228: 403-410. 2009.
- [38] O. ROP, T. JURIKOVA, J. MLCEK, D. KRAMAROVA, Z. SENGEE. "Antioxidant activity and selected