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THE ASSESSMENT OF SOME HOT PEPPERS ACCESSIONS BRED AT VEGETABLE RESEARCH DEVELOPMENT STATION BUZĂU

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Abstract

The Genetic, Breeding and Biodiversity Laboratory from Vegetable Research and Development Station Buzau has a valuable germplasm collection of hot peppers consisting in 287 genotypes, structured on 3 groups according to their genetic stability. The aim of this study was to assess 15 accessions with distinct phenotypic expressivity in terms of fruit shape, weight and colour. A great variability was observed at physiologically maturity in fruit colour passing from yellow, orange, different shades of red or brown. The fruits have distinct shapes like cherry type, elongated, angular, campanulate or blocky type. The fruit mass varies between 0.42 g (A270) to 65.29 g (A282). In order to establish the quality of fruit, the firmness, dry matter and total soluble solids content were measured at both maturity stages. The studied accessions represent valuable genotypes and will be subject to intensive breeding work. In this context, each genotype will be structured for different direction of use such as: chilli powder, fresh consumption, ornamental purposes or for pharmaceutical use.

Key words: *Capsicum sp., germplasm collection, phenotype, Romania.*

INTRODUCTION

Hot pepper (*Capsicum* spp.) is a Solanaceous crop cultivated and appreciated all over the world (Mushtaq et al., 2018; Virga et al., 2020). *Capsicum* species are used for culinary purposes but it can also be eaten fresh or used as spice or food colorant. Also, they are used to obtain cosmetic and pharmaceutical products. In addition to the medicinal importance and culinary uses, hot peppers have been widely used as decorative vegetables (Taychasinpitak and Taywiya, 2003; do Rêgo et al., 2012a; do Rêgo et al., 2012b; dos Pessoa et al., 2015; Ari et al., 2016; Laguovschi et al., 2016; Lagunovschi and Vînătoru, 2016; Vînătoru et al., 2019; Virga et al., 2020; Agapie et al., 2021).

Capsicum species are traditionally identified by morphological descriptors or related traits. For taxonomic description, flower morphology, including number of flowers per axil, flower colour, and calyx constriction is the most used. Anyway, other descriptors are considered essential for a more accurate germplasm characterization, such as the ones indicated by the UPOV and IPGRI Guidelines (Sudré et al., 2010; Mushtaq, 2018).

The characterization and the evaluation of the *Capsicum* spp. is a powerful tool in developing varieties, identifying traits in germplasm and utilizing it in research and development work (Sudré et al., 2010; Mushtaq, 2018).

Several authors have highlighted the importance of studies on the characterization of *Capsicum* germplasm, as well as its diversity, in order to make them available to researchers (do Rêgo et al., 2010; Sudré et al., 2010; Cvikić et al., 2011; Zakia et al., 2013; Vînătoru et al., 2014; dos Pessoa et al., 2015; Quresh et al., 2015; Lagunovschi et al., 2016; Xiao-min et al., 2016; Rahman et al., 2017; Mushtaq, 2018; Agapie et al., 2020a; Agapie et al., 2020b; Virga et al., 2020; Barcanu et al., 2021).

In this context, it is necessary to carry out studies aiming the understanding of the local landraces, the increase of production, disease and pests resistance and tolerance to adverse environments, among other abiotic and biotic factors that can affect the yield.

The Genetic, Breeding and Biodiversity Laboratory from Vegetable Research Development Station Buzau (VRDS) has a valuable germplasm collection of hot peppers consisting in 287 genotypes, structured on 3 groups according to their genetic stability. The assessment of those genotypes is necessary in order to provide better utilization of these genetic resources in breeding programs.

The aim of this study was to assess 15 accessions from the germplasm collection of VRDS Buzau with distinct phenotypic expressivity in terms of fruit shape, weight and colour. The researches will be helpful for future breeding programs and for establish the directions of use: chili powder, fresh consumption, ornamental purposes or for pharmaceutical use.

MATERIALS AND METHODS

The researches were carried out at the Genetic, Breeding and Biodiversity Laboratory from VRDS Buzau. The study aimed the assessment of 15 accessions of hot peppers noted A93, A138, A241, A243, A245, A246, A250, A257, A261, A268, A269, A270, A272, A281, A282. The breeding method used was repeated individual selection. The crop technology applied was the one described by us in our previous studies (Barcanu et al., 2019; Agapie et al., 2020a; Agapie et al., 2020b). The descriptors used were proposed for Capsicum by International Plant Genetic Resources Institute, renamed Biodiversity International (IPGRI, 1995) and by International Union For The Protection of New Varieties OF Plants (UPOV 2006, 2015).

The qualitative traits (Table 1) were noted based on visual evaluation. The quantitative traits targeted in this study were fruit length (FL), fruit width (FW), base fruit diameter (BFD), middle fruit diameter (MFD) and blossom end fruit diameter (BED), fruit weight (W), weight of fruit pulp (WP), weight of fruit receptacle (WR), pedicel length (PDL), pedicel diameter (PD), pericarp thickness (PT), these were counted, measured using metric rulers, calliper and weighed using.

For statistical analysis, ANOVA one way was used followed by the Duncan test.

In order to establish the quality of fruit, the firmness, dry matter and total soluble solids content were measured at both maturity stages. Fruit firmness was determined by measuring the penetration force using a fruit pressure tester FT011, equipped with a piston of 3 mm diameter. The dry matter content (DM) was determined with KERN DBS60-3 thermo balance and the soluble solids (TSS) were measured with digital refractometer KERN OPTICS ORF 1RS (Agapie et al., 2020c).

Table 1. The qualitative characters targeted in this study

Descriptors	**Polymorphism**
Calyx margin (CM)	1. entire 2. intermediate 3. dentate 4. other
Calyx annular constriction (CC)	0. absent 1. present
Fruit: anthocyanin coloration (FAC)	1. absent 9. present
Fruit:colour before maturity (FCBM)	1. white 2. yellow 3. green 4. orange 5. purple 6. dark purple 7. other 8. light green 9. dark green
Fruit: colour at maturity (FCAM)	1. white 2. lemon yellow 3. pale orange-yellow 4. yellow orange 5. pale orange 6. orange 7. light red 8. red 9. dark red 10. purple 11. brown 12. black 13. other
Fruit: shape (FS)	1. elongate 2. almost round (cherry tyoe) 3. angular 4. campanulate 5. blocky 6. other
Fruit: shape at pedicel attachment (FSP)	1. sharp 2. obtuse 3. truncated 4. cordate 5. lobed
Fruit: neck at base (FNB)	0. absent 1. present
Fruit: shape of blossom end (FSB)	1. sharp 2. bont 3. deep 4. deep and sharp 5. other
Fruit: blossom end appendage (FA)	0. absent 1. present
Fruit: sinuation of pericarp at basal part (FSPB)	1.absent or very weak 3.weak 5.medium 7.strong 9.very strong
Fruit: sinuation of pericarp excluding basal part (FSPEB)	1.absent or very weak 3.weak 5.medium 7.strong 9.very strong
Fruit: glossiness (FG)	1. absent or very weak 3. Weak 5. medium 7. strong 9. very strong
Fruit: shape in cross section (FSCS)	3. eliptic 5. angular 7. circular
Fruit: shape in longitudinal section (FSLS)	1. oblate 2. circular 3. cordate 4. square 5. rectangular 6. trapezoidal 7. moderately triangular 8. narrowly triangula r9. hornshaped
Fruit: number of locules (FNL)	
Fruit: texture of surface (FTS)	1. smooth or very slightly wrinkled 2. slightly wrinkled 3. strongly wrinkled
Placenta: length (PL)	1. <1/4 fruit 2. ¼-1/2 fruit 3. >1/2 fruit

RESULTS AND DISCUSSIONS

The qualitative traits and their descriptor values used in this study are found in Table 2 and they have been used to establish the variability among the studied germplasm. The greatest variability was recorded by the fruit shape (Figure 1).

Figure 1. Fruit shape of studied accessions

The studied genotypes have distinct shapes like elongated for 53.3% of genotypes (A138, A241, A243, A245, A246, A250, A261, A282), angular for 13.3% genotypes (A257, A269), cherry type for 13.3% of genotypes (A270, A281). The accessions A270 and A281 present campanulate fruit shape (13.3%), while A93 are blocky type (7.1%).

Fruit shape at the pedicel attachment was obtuse (60%), sharp (13.3%), truncate (13.3%) cordate (6.7%) and lobate (6.7%). A neck at the base of fruit was present in 20% of accessions. A blossom end appendage was present at 26.6%.

The accessions presented between two and four locules per fruit and the number was related to fruit shape. A wide variability can also be found in the colour of fruit. The colours of fruit at harvest maturity were yellow, green, dark purple, light green and dark green. The yellow colour of unripe fruits was observed in accessions A246, A268, A269 and A272 (26.7%).

The accessions A93, A138, A281, A282 present green fruit (26.7%). Also 26.7% of genotypes present dark green colour, while 13.2% of genotypes were light green and 6.7% were dark purple. At the physiological maturity fruit colour was lemon (20%), orange (20%), red (33.3%) and dark red (26.7%).

Table 2. The qualitative descriptors and their value on studied accessions

Accession	A93	A138	A241	A243	A245	A246	A250	A257	A261	A268	A269	A270	A272	A281	A282
CM	2	3	2	3	3	3	3	3	2	2	2	3	2	3	3
CC	1	0	1	0	1	1	1	1	0	0	0	1	1	0	1
FAC	1	1	1	9	9	1	1	1	1	1	9	1	1	1	1
FCBM	3	3	9	6	2	9	9	8	9	2	2	8	2	3	3
FCAM	9	2	6	8	8	2	8	6	8	6	9	2	8	9	9
FS	5	1	1	1	1	1	1	3	1	4	3	2	4	2	1
FSP	5	2	2	2	2	2	1	3	2	2	3	2	2	1	4
FNB	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0
FSB	4	4	1	1	1	1	3	2	2	1	1	5	1	3	4
FA	1	0	0	0	0	0	0	0	0	1	1	0	0	1	0
FSPB	9	7	1	2	1	1	5	2	1	1	1	1	1	1	2
FSPEB	9	7	1	5	1	3	7	1	1	1	1	1	1	1	1
FTS	3	3	1	2	1	1	3	2	1	1	1	1	1	1	1
FG	5	3	5	5	7	5	5	7	5	9	7	9	9	7	9
FSLS	1	7	8	9	8	9	7	7	7	7	7	3	7	2	7
FSCS	7	5	3	3	3	3	3	3	3	3	3	3	3	7	7
FNL	4	3	3	2	2	2	2	2	2	3	3	3	3	2	2
PL	1	3	3	3	3	3	3	2	3	3	3	3	3	3	3

Note: The abbreviations are explained in Table 1.

The quantitative traits were the subject to ANOVA followed by Duncan test and their results can be found in Table 3.

A very highly significant difference ($p<0.01$) was found among the studied quantitative parameters. It reflected the existing of large diversity among studied genotypes and this variability can be further utilized in the chilli pepper improvement program.

The Duncan multiple range test was applied to know the variation between accessions for all the traits. Performance of all the genotypes using the Duncan multiple range test indicated that A282 accession attained maximum fruit length (19.50 cm), fruit weight (65.29 g), weight of fruit pulp (50.25 g), weight of fruit receptacle (15.03 g) and pedicel length (3.53 cm). The accession A270 recorded the smallest values for fruit length (1.37 cm), fruit base diameter (0.48 cm), fruit weight (0.42 g) weight of fruit pulp (0.29 g), weight of fruit receptacle (0.13 g). The fruit wall thickness values ranged from 0.96 to 4.55 cm and the accession A93 showed the highest value, while the accession A270 showed the smallest value followed very close by A245 with 1.01 cm. Pedicel length varied between 1.79 (A270) and 3.53 cm (A282).

Table 3. Quantitative traits of the studied genotypes

Accessions	A93	A138	A241	A243	A245	A246	A250	A257	A261	A268	A269	A270	A272	A281	A282
FL	3.10± 0.12ef	4.8± 0.43d	8.14± 0.28c	4.75± 0.61d	3.02± 0.15ef	10.29± 2.50b	5.07± 0.21d	3.59± 0.30de	2.2± 0.42ef	2.73± 0.23ef	1.82± 0.22f	**1.37± 0.42f**	2.53± 0.27ef	1.79± 0.42f	**19.50± 0.73a**
BFS	**6.03**± 0.12a	1.2± 0.07def	1.64± 0.25d	0.56± 0.27g	0.69± 0.03g	1.17± 0.06ef	1.10± 0.11ef	2.44± 0.28c	0.66± 0.06g	0.86± 0.21 fg	1.31± 0.21de	**0.48**± 0.04 g	0.67± 0.04g	2.55± 0.14c	3.54± 0.39b
MFS	**6.18**± 0.05a	1.6± 0.12d	1.65± 0.13 d	**0.55**± 0.31 g	0.82± 0.14fg	1.25± 0.20e	1.34 ± 0.08de	2.08± 0.23c	0.62± 0.07 g	1.04± 0.14ef	1.01± 0.25ef	0.82± 0.09fg	0.74± 0.16fg	2.63± 0.12b	2.91± 0.09b
BED	**5.98**± 0.06a	0.52± 0.11de	0.25± 0.06fgh	0.60± 0.3cd	**0.20**± 0.06gh	0.21± 0.08fgh	0.79± 0.04c	0.57± 0.07cde	0.23± 0.05fgh	0.22± 0.04fgh	0.35± 0.09efg	0.18± 0.06gh	0.07± 0.02h	2.55± 2.37b	0.45± 0.03def
W	44.0± 1.32b	3.86± 0.87fgh	11.37± 2.67c	2.17± 0.13gh	1.63± 0.29gh	9.82± 0.96cd	4.59± 0.28efg	7.50± 2.04de	0.82± 0.26gh	1.56± 0.26gh	1.65± 0.41gh	**0.42**± 0.02h	1.18± 018gh	7.08± 1.61def	**65.29**± 4.81 a
WP	36.58 ±1.47b	3.28± 0.74 de	8.11± 1.59 c	1.64± 0.14 ef	0.93± 0.17ef	7.59± 0.59 c	3.24± 0.30 de	5.30± 1.64 d	0.57± 0.19f	1.3± 0.24 ef	1.09 ±0.36ef	**0.29**± 0.01f	1.04± 0.18ef	4.68± 1.46d	**50.25**± 2.73 a
WR	7.47± 0.16b	0.57± 0.17ef	3.26± 1.14c	0.53± 0.02ef	0.70± 0.12def	2.22± 0.55cde	1.35± 0.04def	2.20± 0.40cde	0.24± 0.07f	0.16± 0.02f	0.55± 0.05ef	**0.13**± 0.02f	0,14± 0.01f	2.39± 0.50cd	**15.03**± 2.52a
PDL	3.09± 0.12bc de	3.01± 0.13cde	3.25± 0.21bcd	3.44± 0.20bc	2.85± 0.08de	3.27± 0.10bcd	4.49± 0.12 a	2.76± 0.30e	2.08± 0.05f	2.20± 0.02f	3.11± 0.08bcd e	3.07± 0.53bcd e	2.01± 0.08f	**1.79**± 0.78f	**3.53**± 0.25b
PD	**0.96**± 0.01a	0.15± 0.02de	0.34± 0.09b	0.16± 0.02d	0.130± 0.01^{defg}	0.35± 0.02b	0.36± 0.02b	0.35± 0.02b	0.10± 0.01efg	0.06± 0.01g	0.14± 0.02def	**0.08**± 0.01g	**0.08**± 0.01fg	0.24± 1.35c	0.39± 0.03b
PT	**4.55**± 0.28a	1.13± 0.08fgh	2.20± 0.44de	1.40± 0.07fgh	1.01± 0.09h	1.48± 0.21fg	1.54± 0.09f	2.13± 0.27de	1.09± 0.11gh	2.51± 0.24cd	1.28± 0.15fgh	**0.96**± 1.03h	2.04± 0.18e	2.94± 0.16b	2.76± 0.13bc

Note: Values are mean ± SD. Means within the same row carrying different superscript letter were significantly different at $p < 0.01$ according to a Duncan`s multiple range test; FL - fruit length, BFS - base fruit diameter MFS - middle fruit diameter, BED-blossom end fruit diameter, W-fruit weight, WP-weight of fruit pulp, WR-weight of fruit receptacle, PDL-pedicel length, PD-pedicel diameter, PT-pericarp thickness.

Fruit firmness (kgf/cm^2) was measured for both unripe and fully ripen fruit (Figure 2). In this study, a decrease of fruit firmness during fruit ripening has been observed for the accessions A93, A241, A246, A268, A269, A270, A281, A282 while for the other accessions an increase of fruit firmness was observed (Figure 2).

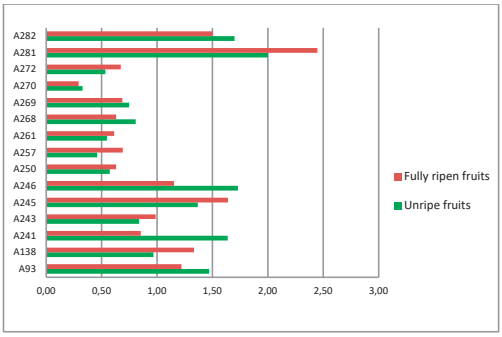

Figure 2. Fruit firmness (kgf/cm^2) of the investigated *Capsicum* accessions

According to Barcanu et al. (2021), pepper fruits with a high firmness are suitable for fresh consumption and have a long shelf life.

Throughout the vegetation period the soluble solid content (TSS) increased for all studied accessions with the exception of A241 whose content in TSS decrease from 9.75°Brix to 7.55°Brix.

The highest contents of TSS for fruits at physiological maturity were observed in the accessions A245, A261, A281 presenting 9.75°Brix, 9.99°Brix and 10.22°Brix (Figure 3).

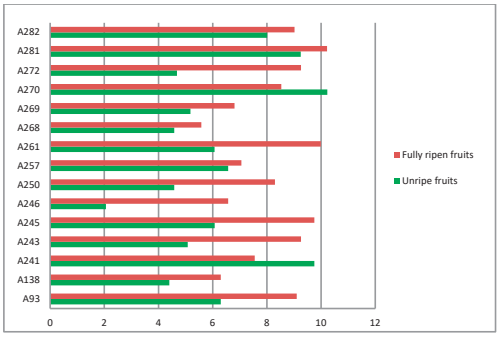

Figure 3. TSS content (°Brix) of the investigated *Capsicum* accessions

Lannes et al. (2007) states that the TSS content is inversely proportional with water content in fruit. For this reasons, the cost of dehydration of the fruit will be lower, this trait being very important in *Capsicum* breeding aiming industrial use (do Rêgo et al., 2011).

Ribes-Moya et al. (2018), in one of their study states that the high content in dry matter is an important quality descriptor in food industry for obtaining chili powder. This trait can be also used by breeders for setting the directions of use of chili peppers fruit.

According to do Rêgo et al (2011), the dry matter content is oppositely related to the fruit weight. The results of this study, regarding fruit length and dry matter content, are in agreement with these authors. In Figure 4, the accession A270 has the shortest fruit length (1.37cm), and with a dry matter content of 13.8%, while the accessions A282 has the longest fruit length

(19.20 cm) and the dry matter content (13.51%) similar to result of accession A270.

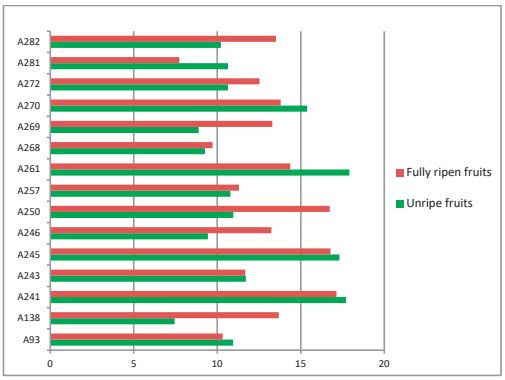

Figure 4. Dry matter content (%) of the investigated *Capsicum* accessions

CONCLUSIONS

The obtained results showed that there is a great variability among the studied accessions.
In order to obtain cultivars for fresh market accessions, A241, A246 are recommended due to the hight firmness, while the accessions A93, A281, A282 are recommended for obtaining chili powder, since they recorded high total soluble solids and dry matter contents and showed the highest values for pericarp thickness.
VRDS Buzau has a large variety of genotypes in chili peppers and the research will continue by enriching the germplasm collection in order to add new genotypes for different directions of use. Also the diversity found can be used in the next *Capsicum* breeding programs.

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