RESEARCH ARTICLE **(Open Access)**

Four indigenous tomatoes with genetic and agro-economic values in Northern Albania

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Abstract

Tomato (*Lycopersicon esculentum* Miller) is cultivated in all home gardeners of the Albanian Alps area, mainly for domestic consumption. The growing presence of tourists in the area has increased the interest in the vegetable production. Because farmers are supplied with seedlings from areas far from their location, some cultivars without any scientific documentation are cultivated with poor yield and susceptible to various disease and frost damage. Farmers are looking for cultivars suitable for the area and seeking to produce local tomato varieties in order to attract consumers to retail farm operations. The existing tomato germplasm from Alps area was morpho-genetically characterized and agro-economically assessed during 2016 at experimental field of PGRI, AUT, to determine the variability among the cultivars. The purpose of the investigation was to document the germplasm for the future and to test production characteristics and their fresh market suitability in Alps area. The comparison was based on yield and growth characters, including plant height (153-198 cm), trusses per plant (4.2-8.6) flowers per truss (7.4 -13.4), flowers per plant (31- 95), fruits per truss (4.4- 8.8), number of fruits per plant (18.5-65.0), fruit size (30.8-65.0 mm), locules per fruit (2-4), and fruits weight (24.5 -137.0 g), found significant variability among cultivars. The investigation indicated that genetic diversity does exist among indigenous cultivars and the germplasm could be utilized for breeding new varieties suitable for the area and identified those that have the potential of fulfilling the specialty market niche.

Keywords: *characterization, evaluation, yield and growth characters.*

Introduction

The Albanian Alps, located in northern Albania and between the borders of Montenegro and Kosovo, are covering an area about 8% of the country. They are one of the most attractive and fascinating territories of the Albanian lands, with natural beauty and tourism assets [8]. With a mountainous landscape with multiple contrasts, traversed by river valleys with crystal waters, gorges and mountain saddles that invite to continue to further explore the nature, and with rich vegetation, the Albanian Alps represent a valuable and unique gem in Albania and even in the world. Topography of Albanian Alps is mainly hilly and mountainous with valleys and small planes at some places. The area has ample quantity of rainfall (1800-2500 mm) mostly in March-May and July-October. The temperatures range from +20º C to +26º C in July and go down to -14º C and -20º C in the freezing winters. Winter is very cold with snowfall and severe frost from November to March and to April sometime. The main activity of the local economy is agriculture and livestock farming. The topographical nature and small land holdings of the area does not suite for considerable production of cereal crops. However the area is very much suitable for the production of fruits, vegetables and medicinal herbs of economic value, which are abundant in the area. In recent years this area is attracting numerous tourists, both domestic and foreign. Tourists can entertain themselves by trekking, mountain climbing, skiing, or fishing for mountain trout. The locals pride themselves that their cuisine is only truly enjoyable for visitors when accompanied by their own fruits, vegetables and dairy products.

The main problems faced by growers are damaged through frost and non availability of supply quality seeds of local varieties of vegetables suitable for the climatic conditions of the area. With the problems and increasing need of the consumers for both quality and diversity of the vegetable crops, especially of the tomato products, there is a need to extensively collect, exploit and evaluate existing local tomato germplasm. An improvement of the tomato crop would enhance agricultural productivity and facilitate food security. However, most of the germplasm in the Northern Albania area is largely un-documented and have unknown morphological, agronomic and biochemical attributes. It has been noted that specialty market tomatoes are increasingly favored and local tomatoes have the potential of fulfilling the specialty market niche [11].

Morphological and agronomic parameters have been widely used in the evaluation of tomato cultivars for genetic diversity, breeding value and yield potential. The growth, yield and biochemical analysis techniques were utilized for the documentation of germplasm and determination of variability in different cultivars of tomato from Albanian Alps. The characterization thus will help in the identification of varieties and on their future utilization for varietal improvement using conventional techniques. This information would be of great value in the promotion of on-farm conservation of this diversity as well as to the provision of new information for the management of germplasm banks.

Materials and methods

The study was conducted during the years of 2015 and 2016 at the Experimental field of Institute of Plant Genetic Resources, Agricultural University of Tirana, located at the Northern part of Tirana, at 41º 24'04,30''N latitude and 19º 43'59,90''E longitude with an altitude of 39 m above sea level. The objective of this study was to characterize and evaluate four different local tomato varieties grown under commercial production practices. The seeds of "Qafëgradi - Shkrelit", "Lekbibaj", "Nënmavriqi - Shalës" and "Gimaj - Shalës" tomatoes were collected from the farmers and were maintained at the Gene bank of Institute of Plant Genetic Resources. The seeds were sown in polystyrene trays. Seedlings were produced in the nursery greenhouses and were carefully transplanted after 6 weeks to the experimental plots in the field, the second week of May. The experimental plots were laid out in a randomized complete block design with three replications for each cultivar, at a recommended spacing of 90 cm between rows and 40 cm between plants. Each variety was represented by 60 plants divided into 3 plots (20 plants accommodated in two rows with 10 plants / row). The experimental field was flat and homogenous for texture and nutrients. The soil was a sandy-clay-loam. The soil was tilled, bedded and plastic mulched before planting. Standard agronomic practices such as weeding, drip irrigation, fertilizer application, pruning and staking were carried out uniformly during the growing season for all plots. Diseases were managed. Fruits were harvested at the mature stage. Field data were collected in this experiment, such as plant growth and yield parameters (including date of sowing, dates of germination, transplanting, flowering, fruiting and harvesting were recorded when 50% of the plants reached at these stages), plant characters, and yield components and fruit yield of tomato plant. For morphological studies ten plants from each replication were taken for plant characterization and evaluation according to tomato descriptors [4, 6].

The data were analyzed statistically using the method of ANOVA (1980).

Result and discussion

For ease of communication with the reader, the names of local tomatoes, in fact are names of the villages that they are collected from local gardens, we have labeled respectively: E-1= Qafëgradi - Shkrelit; E-2 = Lekbibaj; E-3= Nënmavriqi - Shalës; E-4= Gimaj - Shalës.

Morphological characters of plants and fruits

The results for different morphological characters investigated among the tomato cultivars are compared in tables 1 and 2. The results indicated that most of the characters compared among four cultivars depict significant variations. This variability among cultivar prevailed both in growth and yield characters. The data regarding plant descriptors, such as plant growth type, foliage density, leaf attitude and leaf type (Table 1) revealed non-significant variation among the cultivars compared.

The data regarding the immature and mature fruit characters however revealed significant differences among cultivars (Table 2). Excluding "E-4", in which dominates the ellipsoidal fruit shape (plum shaped), all others have rounded shape (recorded after the fruits turn color). The exterior color of immature fruit is another distinctive character among the studied cultivars. The exterior color of immature fruit was greenish-white in case of E-1 and green in E-2, and light green in two other cultivars (E-3 and E-4). Excluding "E-3" that produced fruits of intermediate size (5.1-8 cm), three other cultivars have produced fruits of very small size (<3 cm). Fruit size homogeneity (within a plant) was high in all cultivars, except “E-3” in which this character was intermediate.

Table 1. Plant descriptors

Nr	Cultivars	Plant growth type (*)	Foliage density (**)	Leaf attitude (***)	Leaf type (***)
1	E-1	3	5	5	3
2	E-2	3	5	5	3
3	E-3	3	5	5	3
4	E-4	3	5	5	3

(*)Plant growth type(7.1.2.1): 1- Determinate; 2- Semi-determinate, 3-Indeterminate;
(**)Foliage density (7.1.2.6.): 3-Sparse, 5-Intermediate, 7-Dense.
(***)Leaf attitude (7.1.2.8): 3-Semi-erect, 5- Horizontal, 7-Droping.
(****)Leaf type (7.1.2.9): 1- Dwarf, 2-Potato leaf type, 3-Standard, 99- Other.

Table 2. Fruit descriptors

Nr	Cultivars	Immature fruit(*)				Mature fruit(**)				
		PFS	ECIF	FS	FSH	ECMF	IEC	SCRF	FCP	FF
1	E-1	3	1	1	7	5	5	2	5	3
2	E-2	3	5	1	7	5	5	2	5	3
3	E-3	3	3	3	5	5	5	2	5	5
4	E-4	8	3	1	7	5	5	2	5	5

*) PFS-Predominant fruit shape:1-Flattened/oblate, 2-Slighty flattened, 3- Rounded, 4 - High rounded, 5- Heart-shaped, 6 – Cylindrical (long oblong), 7- Pyriform, 8 – Ellipsoid (plum shaped), 99 -Other;
ECIF- Exterior color of immature fruit: 1- Greenish-white, 3- Light green, 5- Green, 7- Dark green, 9- Very dark green;
FS–Fruit size: 1-Very small (<3 cm), 2-Small (3-5 cm), 3-Intermediate (5.1-8 cm), 4 –Larges (8.1-10 cm), 5-Very large (>10 cm); FSH- Fruit size homogeneity: 3-Low, 5- Intermediate, 7-High.
**)ECMF- Exterior color of mature fruit: 4-Pink, 5-Red; IEC- Intensity of exterior color: 3 – Light, 5- Intermediate, 7- Dark; SCRF- Skin color of ripe fruit: 1- Colorless, 2-Yellow; FCP- Flesh color of pericarp (interior):1-Green, 2-Yellow, 3-Orange, 4- Pink, 5- Red; FF- Fruit firmness (after storage):3- Soft, 5- Intermediate, 7- Firm.

The data regarding mature fruit descriptors, such as exterior color, intensity of exterior color, skin color and flesh color of pericarp (interior) revealed non-significant variation among the cultivars compared.

However, the fruit firmness (after storage) did not show much variability among the cultivars but some minor differences were found to be in two groups. Thus, traditional tomatoes of Dukagjini area ("E-3" and "E-4") have an intermediate level of the fruit firmness, while two tomatoes (“E-1” and”E-2”) of Shkreli - Lekbibaj area are soft.

Growth parameters and plant characters

The results for different growth parameters and plant characters investigated among the tomato cultivars are compared in table 3.

Plant height was significantly ($P<0.01$) different among two tomato groups: small fruit tomatoes (“E-1”, “E-2” and “E-4”) and “large” fruit tomato (“E-3”). The mean value of the cultivars compared lay between 153.00 and 198.00 cm; to three tomatoes of "small fruit” group were between 178.00 and 198.00 cm, while in tomato of “large” fruit was

153.00 cm. The tallest plant was “E-4” (198.00 cm) followed by “E-1” (183.00 cm) and “E-2” (178.00 cm) while the shortest was “E-3” (153.00 cm). The length of internodes of a plant lay between 5.00 and 7.00 cm and revealed non-significant variation among the cultivars compared. Leaf sizes are different in cultivars compared. Leaf length and width greater had “E-3”, followed by “E-1” and “E-2”. The smallest leaf size was investigated in “E-4” (Table 3).

Tabela 3. Agronomic parameters of the plant

Cultivars	Plant height, cm	Length of internodes, cm	Leaf size, cm		Days to	
			Length	Width	Flower	Maturity
E-1	183	5.5	32.6	25.8	26	66
E-2	178	6.0	30.0	19.4	26	66
E-3	153	7.0	33.6	31.2	32	69
E-4	198	5.0	25.0	19.0	23	61
P<0.05	5.4	0.56	2.1	2.3	1.44	1.92
P<0.01	8.5	ns	3.4	3.7	2.42	3.21

Days to flowering and maturity were significantly (P<0.01) different among cultivars (Table 3). The period between transplanting and flowering ranged from 23 to 32 days. Among the different cultivars, “E-4”, “E-1” and “E-2” showed earliest flowering whereas “E-3” showed statistically late flowering. “E-4” was earliest to fist harvest compared to all cultivars. Its period of first harvest was 61 days to transplanting, or 8 days earlier compared with “E-3”. “E-3” was late by about 3 days to first harvest compared to “E-1” and “E-2”, which had similar days to harvest.

Yield components and fruit yield

The data regarding the number of trusses per plant, flowers per truss and per plant, fruit set per truss and per plant, revealed significant differences among cultivars (P<0.01).

The cultivar “E-1” produced maximum trusses per plant (8.6); whereas “E-3” showed statistically lower (4.2). The cultivars “E-2” and “E-4” produced maximum number of flowers per truss (respectively 13.00 and 13.4) which was significantly different among the cultivars compared (P<0.01). Again the “E-4” and “E-1” produced maximum number of flowers per plant (respectively 95.00 and 93.00) whereas “E-3” was at lower side. The tables also revealed significant variation (P<0.01) among the cultivars when number of fruits per plant were compared (Table 4).

Table 4. Growth and yield component

Cultivars	Setting distance of trusses		No. of trusses/ plant	No. of flowers in II^{-nd} truss	No. of Flowers /plant	No. of fruit/ in II^{-nd} truss	No. of fruits /plant
	I^{-st} , from the soil level	II^{-nd} , from the I^{-st}					
E-1	34.8	21.6	8.6	10.0	93.0	7.6	65.0
E-2	35.6	15.2	6.6	13.0	74.0	8.6	52.0
E-3	32.0	21.2	4.2	7.4	31.0	4.4	18.5
E-4	35.8	13.2	6.8	13.4	95.0	8.8	60.0
P<0.05	ns	3.36	1.08	1.68	9.37	0.74	2.82
P<0.01	ns	5.62	1.82	2.81	15.62	1.20	4.73

The maximum number of fruit per plant was observed in “E-1” and “E-4” followed by “E-2” while the minimum was observed in “E-3” cultivar (18.5 fruit/ plant). The cultivar “E-1” (65.0) was at the top followed by “E-4” (60.0) and “E-2” (52.0 fruit/ plant). When fruit size was compared, although the difference among cultivars was significant (P<0.05) but the trend changed with this character among "small fruit" cultivars. The size of the fruit was larger in case of “E-3” compared to the smaller in "small fruit" cultivars (“E-1”, “E-2” and “E-4”).

Fruit yield per plant lay between 1.33 and 2.58 kg (Table 5). “E-3” had superior fruit yield per plant (2.58 kg/plant) than (“E-1”, “E-2” and “E-4”) which had the lowest yield (1.33-1.86 kg/plant). Superiority of “E-3” in yield per plant was due to average fruit weight that was highest of all cultivars compared. It showed also that among "small fruit" cultivars had variation in yield per plant that fall between 1.33 and 1.86 kg. The higher yield per plant in this group was observed in “E-4” (1.86 kg) followed by “E-1” (1.62 kg) while the lowest was observed in “E-2” (1.33 kg). This variation in yield was due to differences in number of trusses per plant and number of fruit per trusses and per plant that contributed to difference in the yield potential of the crop.

Total fruit yield per hectare were significantly ($P<0.05$ and $P<0.01$) different among the cultivars (Table 5). The mean values ranged between 34.58 and 72.25 t/ha. Total yield was superior in “E-3” (72.25 t/ha) followed by “E-4” (52.78 t/ha) while “E-2” had lowest yield (34.58 t/ha).

Table 5. Fruits parameters and fruit yield

Cultivars	Fruit size, mm		No. of locules /fruit	Average fruit weight, g	Fruit weight per plant, kg	Yield(t/ha)	
	Height	Diameter				Total	Marketable
E-1	31.0	32.5	2	24.5	1.62	44.45	33.78
E-2	26.0	28.0	2	25.5	1.33	34.58	26.36
E-3	66.0	65.0	3	137.0	2.58	72.25	59.25
E-4	34.0	30.8	2	31.0	1.86	52.78	41.27
P<0.05	1.86	1.56		3.96	0.16	5.53	4.35
P<0.01	3.00	2.43		6.60	0.27	9.20	7.24

Marketable and unmarketable fruit yield per hectare were significantly ($P<0.05$) different among cultivars (Table 5). The mean values of marketable yield fall between 33.78 and 59.25 t/ha. It was superior in “E-3” (59.25 t/ha) followed by “E-4” (41.27 t/ha). The lowest marketable yield had “E-2” (26.36 t/ha) followed by “E-3” (33.78 t/ha).

The variation in yield ability of the tomato cultivars studied could be attributed to differences in the number of trusses per plant, fruits per trusses, average fruit weight and yield per plant.

The leaf area (leaf size), fruit size and fruit weight were found to be higher in “E-3” compared to “E-2”. This finding is in agreement with other researcher indicated that the characters like leaf area, plant height, fruit size and weight are discriminative genetic characters and may have value in breeding good quality tomato cultivars[3,5,7,9]. The leaf area alone may have some significance in this trend as more the leaf area more the sun energy is captured and it may be the reason for “E-3” to produce fruits of larger size and larger weight [1]. Other researcher also indicated positive correlation between fruit size, fruit weight and yield [3, 5, 9].

Conclusions

Tomato is one of the most widely accepted fruits in the world. The growers need to grow tomato cultivars with high yield and good quality adapted to their environment. Data analysis indicated that yield per plant and marketable yield per hectare was higher for “E-3” and “E-4”, two indigenous tomatoes founded in Dukagjini villages. This study demonstrates that there is potential for some indigenous tomatoes to produce similar amounts of marketable fruit as the garden commercial hybrids fitting both for direct food offer on-site and for local markets. There is the potential for traditional tomatoes to offer the shape, taste and color that consumers desire within specialty markets. Growers that produce value added products may also find that the color of some of the traditional (local) tomatoes is beneficial. It is important to study and to identify the values of the numerous indigenous tomatoes so that growers can increase production efficiency. Further testing of indigenous varieties is necessary before appropriate recommendations can be made concerning the use of indigenous tomatoes for a commercial market in

CABRA area (Albanian Alps). Year to year meteorological conditions tend to play an important role in the quality of fruit produced by these cultivars.

Acknowledgements

We acknowledge GIZ-CABRA (Conservation of Agrobiodiversity in Rural Albania) project for funding the research work and we would like to thank their staff Mr. Luan Dervishej for the cooperation and support during exploration and collection missions. We are grateful to all the people giving us fruit and seed of indigenous tomato, which may help in preserving this particular tomato populations selected for centuries by our ancestors.

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