

Original Article

The *In Situ* and *Ex Situ* Conservation of Pepper Landraces (*Capsicum annuum* L.)

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Abstract

The general objective of our research, targets the agrobiodiversity conservation and the diminishing of genetic erosion on crops. The specific objectives of the research consist in the collection, the identification and the pepper seed production. The resulted seed was intended both in *on farm* conservation and also in *ex situ* conservation in the USAMV Cluj-Napoca's genebank. In the genebank every sample of seed is accompanied by the passport descriptors and the characterization descriptors. They were collected and cultivated 18 landraces of pepper (*Capsicum annuum* L.), two of which were bell pepper (*C.annuum* L. *spp.annuum* convar. *grossum* (L.) var. Filov. *Tetragonum* Miller), two of sweet pepper (*C. annuum* L. *spp. annuum* convar. *grossum* (L.) Filov. var. *grossum*), two of cayenne papper (*C. annuum* L. *sp. annuum* convar. *longum* (DC.) *Terp.*) și and 12 landraces of hot pepper (*C. annuum* L. *sp. Annuum* convar. *microcarpum* Filov.). The seed was obtained from nine Romanian counties, seven being from Transylvania. During the vegetation period observations and measurements have been made to determine the characterization and agronomic morphology of landraces. IPGRI (Institute for Plant Genetic Resources) descriptors have been used. In this article eight morphological features are described (plant's habitus, colour and leaves dimension, colour and flowers position on the plant, shape and colour of the fruits (mature or immature), respectively seven agronomic aspects (plant height, fruits average weight (g), fruits dimensions (cm), average production per plant, fruits nur 558 plant, resistance to diseases and pests, taste qualities).

Keywords: agrobiodiversity, genetic erosion, *ex situ* conservation, *on farm* conservation, landraces, seed, gardens.

1. Introduction

Landraces have received in time various definition. One of which was stated by Villa et al. (2005): "a landrace is a dynamic population (s) of a cultivated plant that has historical origin, distinct identity and lacks formal crop improvement, as well as often being genetically diverse, locally adapted and associated with traditional farming systems" [11].

The benefits of landraces are numerous. Maxim et al. (2012) summarize the following: "satisfaction of the market requirements, supplying population with a more diversified diet, superior quality of products, that could compensate lower production, reducing the pesticide quantity, increase the efficiency of the pollinator insects being well known their genuine diversity and understood, preferences for certain combinations of volatile substances produced by flowers, improvement of the decomposition process of dead vegetal material

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and circuit of elements in nature, increase of the efficiency of biological fixation of the atmospheric molecular nitrogen, increase, by long term, of the agro-ecosystem stability in conditions of global climatic changes” [6].

In the 1960s has begun a massive action to obtain a modern varieties through hybridization. This action targeted especially the main crops (wheat, corn, rice), and the main quality of the new varieties must be a higher productivity. The success obtained came followed by a pronounced genetic erosion, with all the dangers in relation to agriculture, and for dietary security on a medium and long term. In this context, in 1974 the International Board for Plant Genetic Resources (IBPGR) has been created wick took the initiative in founding a global genebanks in the headquarters of the Consultative Group on International Agricultural Research (CGIAR).

According to the FAO documents from 1998, in the year 1995, the number of genebanks has reached 1300 throughout the world [2]. This method is the *ex situ* conservation of the agrobiodiversity. Portis et al. (2004) points the fact that most researches have been made on *ex situ* conservation, and very few on *in situ* conservation [9].

Whereas the conservation of seeds in genebanks has numerous disadvantages, in the 1990s the *in situ* or *on farm* genetic diversity conservation has begun to extend more, namely in the natural habitat. The conservation of all landraces in genebanks is not possible, the peasants, the farmers and the improvers have a very important rol in plant genetic diversity conservation.

The method of *on farm* cultivation is cheaper than genebank conservation, and the landraces can be exploited immediately by the local population [1]. The *on farm* conservation creates permanent adaptability for the landraces through the aspect of different genes combinations and the selection by the farmers of the most valuable. Maxted et al. 1997 suggests that this two methods are complementary [7]. Montesano et al. (2012) studies the genetic diversity in the Basilicata region, in the southern Italy, for the species *Capsicum annum*, *Lycopersicon esculentum* and *Phaseolus vulgaris* (350 accesions) [8]. He found that in the last 30 years, the genetic erosion was extremely pronounced in this region. The landraces were best preserved in the small gardens of the population. With the preservation of this landraces the traditional knowledge related to this local varieties were also preserved.

The current situation implies the extension of research in agrobiodiversity area and its conservation in traditional agricultural systems. Whitout these components we can not speak about a

sustainable agriculture [5]. In the European Union, *on farm* conservation of landraces is encouraged by the Commission Directive 2008/62/EC and through Regulation (EC) No 74/2009 amending Regulation (EC) No 1698/2005 on support for rural development [13, 14, 15].

One of the vegetables species that represents a particularly interest for greengrocers is the pepper (*Capsicum sp.*). According to Sudre et al. (2010), Brazil is considered the center for genetic diversity of the *Capsicum* genus [10]. Ibiza et al. (2011) argue that there are 27 species of *Capsicum* from wick only 5 are used for fresh vegetables and spices: *C. annum* L., *C. chinense* Jacq., *C. frutescens* L., *C. baccatum* L. and *C. pubescens* R and P [4].

The pepper was cultivated by the indigenous pre-colombian people, roughly 1000 years before the contact with Europe. The pepper arrived in Europe in 16th century and it spread at first in Spain and Portugal. The pepper varied very much from a genetic point of view from its region of origine, adapted to local conditions. The main features after which they were selected by the agronomists and horticulturists are size, colour, fruit colour and earliness [12].

2. Material and Method

UASMV Cluj Napoca, in coloboration with the Non-Governmental Organisation ECO Ruralis has undertaken in the last years a collection process of crop landraces from miscellaneous countries and Romanian regions. These are cultivated in the solar house and in the field, depending on the case, for their characterization and seed production. A part from the obtained seed is conserved (*ex situ*) in the USAMV Cluj Napoca's genebank, and another part is distributed for the cultivation to the small interested Romanian gardeners.

In the genbank, the seed samples are accompanied by the passport descriptors and characterization descriptors. During the vegetation period, morphological and agronomic features have been observed, according to the IPGRI (Institute for Plant Genetic Resources). From the first category belong: plant's habitus, leaves colour and dimension, colour and the flowers position on the plant, shape and colour of the fruits (mature or immature). Agronomic features have been studied: plant height, fruits average weight (g), fruits dimensions (cm), average production per plant, fruits number per plant, resistance to diseases and pests, taste qualities. These informations have been necessary both for completing the characterization descriptors and also for the gardeners interested in the seeds.

Table 1. Pepper landraces studied in the year 2014 in Cluj-Napoca

Landraces code	Species	Type of fruit	County
CJ 319	<i>Capsicum annuum</i> L. ssp.	Bell pepper	Cluj
AB 329	<i>annuum</i> convar. <i>grossum</i> (L.) Filov. var. <i>tetragonum</i> Miller		Alba
CJ 320	<i>Capsicum annuum</i> L. ssp.	Sweet pepper	Cluj
BZ 318	<i>annuum</i> convar. <i>grossum</i> (L.) Filov. var. <i>grossum</i>		Buzău
BZ 333	<i>Capsicum annuum</i> L. sp. <i>annuum</i> convar. <i>longum</i> (DC.) Terp.	Cayenne pepper	Buzău
BH 336	<i>Capsicum annuum</i> L. ssp.	Hot pepper	Bihor
VL 342	<i>annuum</i> convar. <i>microcarpum</i> Filov.		Vâlcea
CJ 331			Cluj
HR 338			Harghita
MM 339			Maramureş
SM 340			Satu-Mare
SM 348			Satu-Mare
SJ 325			Sălaj
VL 341			Vâlcea
CJ 332			Cluj
SJ 326			Sălaj
MM 327			Maramureş

The 16 landraces of pepper were collected from 9 Romanian counties: Alba, Buzău, Bihor, Cluj, Harghita, Maramureş Satu-Mare, Sălaj și Vâlcea (Table 1). Every landrace of pepper received a code. The experiences have taken place during the year 2014.

The seedlings were produced in pots in the tunnel. The peppers were planted in the field with the soil from the pot. The planting distances were 75 cm between rows and 25 cm between peppers on the row. The pepper landraces were planted in the UASMV Cluj Napoca's experimental garden and in an independent garden. A minimum input technology was applied. No pesticides were used.

3. Results and Discussions

Regarding the morphological features of the 17 pepper landraces we can observe that in the plant's habitus, "medium" category predominates. Only four landraces of hot pepper have their habitus "very small": HR 338, MM 339, SM 340 și SM 348. The colour of the leaves varies between green (the most landraces), dark green and light green.

The dimensions of the leaves are also very different. The length of the leaves varies between 3.6 cm at SM 340 and 13 cm at BZ 333. The width of the leaves oscillates between 0.8 cm at MM 339 and 7.5 cm at BZ 333. The average surface of the leaves is between 3.2 cm² at MM 339 and 97,5 cm² at BZ 333. The flowers of the studied landraces are greenish-white, except for

BZ 318, where flowers are white. For the 82.4% of the landraces the position of the flower on the plant is prone or slightly prone, except for BZ 318 and SM 340, where the position is erect. For BH 336 the position of the flowers on the plant is horizontal (Table 2).

For the bell pepper the form of the fruit is flattened, for the sweet pepper is cone-shaped or barrel-shaped with sharp tip and for the cayenne pepper is cone-shaped.

The biggest fruit form diversity we can observe is at the hot pepper: stretched at BH 336, VL 341 and VL 342; cone-shaped with different variations at CJ 331, MM 339, HR 338 and SJ 325; round at SM 340 and SM 348; ovoid-shaped at MM 327; bell-shaped at CJ 332; mushroom shaped at SJ 326.

The immature fruits have different shades of green for all 17 studied landraces, while the mature fruits have a high diversity of colours: red with different shades, yellow-orange, yellowish-gold. The most interested colours are from hot pepper landraces, where we can encounter fruits with various colours on the same plant. And so, at BH 336 we have goldish-yellow fruits, dark green fruits and green with purple fragments fruits; at SM 340 we have red fruits, orange fruits, yellowish with purple stains, dark green with redish stains fruits, all on the same plant.

All the landraces taken into study presented green strains, except for sweet pepper BZ 318 which has purple strains with a high intensity colour at the internode.

Table 2. The main morphological features of the pepper landraces studied in Cluj Napoca, 2014

No. crt.	Variety Code	Plants habitus	Leaves		Flowers		Shape	Fruits	
			Colour	Size (LxI) - cm	Colour	Position on the plant		Immature fruits colour	Mature fruits colour
Bell pepper - <i>Capsicum annuum</i> L. ssp. <i>annuum</i> convar. <i>grossum</i> (L.) Filov. var. <i>tetragonum</i> Miller									
1.	CJ 319	medium	dark green	10x4	greenish -white	prone	flattened, typical	dark green	dark red
2.	AB 329	medium	green	10x5	greenish -white	prone	flattened, typical	dark green	dark red
Sweet pepper - <i>Capsicum annuum</i> L. ssp. <i>annuum</i> convar. <i>grossum</i> (L.) Filov. var. <i>grossum</i>									
3.	CJ 320	medium	light green	9x5.5	greenish -white	prone	cone-shaped	light green	yellow-orange
4.	BZ 318*	medium to large	green	6 x 4.5	white	erect	barrel-shaped, sharp tip	whiteish green	light red
Cayenne pepper - <i>Capsicum annuum</i> L. sp. <i>annuum</i> convar. <i>longum</i> (DC.) Terp.									
5.	BZ 333	medium	green	13 x 7.5	greenish -white	prone	cone-shaped, curved towards the caliceal region	green	dark red
Hot pepper - <i>Capsicum annuum</i> L. ssp. <i>annuum</i> convar. <i>microcarpum</i> Filov.									
6.	BH 336	medium	green	5 x 3	white-green	horizontal	lengthen	green	goldish-yellow, green with purple stains
7.	VL 342	medium	green	8 x 3.5	white-green	prone	lengthen	green	yellow-orange
8.	CJ 331	medium	dark-green	6 x 2.5	white-green	prone	cone shaped with round tip	light green	yellow-orange
9.	HR 338	very small	green	5 x 2	white-green	slightly prone	barrel shaped	green	red
10.	MM 339	very small	green	4 x 0.8	white-green	slightly prone	coned shape round in the caliceal region	light green	light red
11.	SM 340	very small	green	3.6 x 1.8	white-green	erect	round	different shades of green	red, orange, yellowish with purple stains, dark green with brown
12.	SM 348	very small	green	4 x 1.7	white-green	slightly prone	round	light green	yellow, greenish with purple stains
13.	SJ 325	medium	green	6 x 2.3	white-green	prone	coned shaped – lengthen	dark green	red, green on the shaded part
14.	VL 341	medium	green	6 x 2.5	white-green	prone	lengthen	dark green	bright red
15.	CJ 332	medium to large	light green	10 x 7	white-green	prone	bell shaped	light green	redish-yellow
16.	SJ 326	medium	green	8 x 5	white-green	prone	mushroom shaped	light green	red
17.	MM 327	medium	light green	8 x 4	white-green	slightly prone	round-flattened	green	dark red

*Observation: The strain is purple, cu high intensity colour near the internode

Data from Tabel 3 shows that average height of the plants has the lowest values (14-16 cm) in four landraces of hot pepper: HR 338, MM 339, SM 340 and SM 348. The sweet pepper has a height of 64 cm, this being the highest value. The average weight of the fruit varies from

cultivar to cultivar depending on the type of the fruit: for the sweet pepper, from 104 to 230 g, for the sweet pepper from 63 to 110 g, and for the cayenne pepper BZ 333 the average weight of the fruits is 74 g. The highest fruits weight differences were recorded for the hot pepper.

Here, the values varies from 1 g/fruit at SM 348 to 28 g/fruit at CJ 332. Similar variations between the 17 landraces are present also in the fruit dimensions. The peppers yield per plant varies within very wide limits depending on the type of the fruit but also in the same category: 0.62-1.38 kg for the bell pepper; 0.315-0.77 kg for the sweet pepper; 0.056-0.952 kg for the hot pepper. For the sweet pepper BZ 333 variety the

average yield per plant is 0.67 kg. The precocity of fruiting within the studied cultivars is semi-early, semi late and late.

Part of the last category is only one variety, the hot pepper SM 348. For the bell pepper, sweet pepper and cayenne pepper, the taste of the fruits is pleasant and typical. For the hot pepper the fruit spiciness varies very much, from less spicy to very spicy.

Table 3. The main morphological features of the pepper landraces studied in Cluj Napoca, in the year 2014

No. crt	Variety code	Plant height (cm)	Average weight (g)	Fruits Size L(h) x l (cm)	No./plant	Average production/plant (kg)	Earliness	Taste qualities
Bell pepper - <i>Capsicum annuum</i> L. ssp. <i>annuum</i> convar. <i>grossum</i> (L.) Filov. var. <i>tetragonum</i> Miller								
1.	CJ 319	40	230	5x10	6	1.38	semiearly	excelent typical
2.	AB 329	53	104	4.5x10	6	0.62	semiearly	very good, typical
Sweet pepper - <i>Capsicum annuum</i> L. ssp. <i>annuum</i> convar. <i>grossum</i> (L.) Filov. var. <i>grossum</i>								
3.	CJ 320	50	110	11x5	7	0.77	semiearly	sweet, typical
4.	BZ 318	64	63	9x5	5	0.315	semiearly	sweet, typical
Cayenne pepper - <i>Capsicum annuum</i> L. sp. <i>annuum</i> convar. <i>longum</i> (DC.) Terp.								
5.	BZ 333	40	74	14x7	9	0.67	semiearly	very sweet, pleasant, typical
Hot pepper - <i>Capsicum annuum</i> L. ssp. <i>annuum</i> convar. <i>microcarpum</i> Filov.								
6.	BH 336	50	6	60 x 1.8	62	0.372	semiearly	moderated spicy taste
7.	CV 342	55	16	12 x 2.2	33	0.528	semiearly	the spicy taste is medium to very
8.	CV 331	44	2	3 x 1.1	140	0.282	semiearly	the spicy taste intensity is very low
9.	HR 338	16	2	3 x 1.1	28	0.056	semiearly	very spicy
10.	MM 339	15	3	2.5 x 2.3	41	0.123	semiearly	the spicy taste is moderated
11.	SM 340	14	3	2.1 x 2.2	130	0.39	semiearly	the spicy taste is moderated
12.	SM 348	16	1	1.5 x 1.5	125	0.125	early	the spicy taste is moderated to very spicy
13.	SJ 325	44	22	7 x 2	38	0.836	semiearly	the spicy taste is moderate to low
14.	VL 341	41	6	8.5 x 1.2	47	0.282	semiearly	very spicy
15.	CJ 332*	65	28	4 x 6	34	0.952	semiearly	the core is spicy and the "fins" are sweet with low spiciness
16.	SJ 326	48	27	5 x 5	22	0.594	semiearly	very spicy
17.	MM 327	54	13	2.5 x 4	25	0.325	semiearly	the spiciness is low

*Observation: The fruit is bell-shaped, with 4 "fins"; 4 cm in peduncle region, and 6 cm in the lower part (caliceal region)

In the year 2014's conditions in Cluj-Napoca no conclusion related to pepper landraces resistance to diseases and pests could have been drawn because there were only sporadic mites attacks recorded.

Similar results were obtained by the Sudre et al. in 2010 [10] who studies 56 accession of pepper originated from the Universida de Estadual do Norte Fluminense Darcy Ribeiro (UENF)'s genebank.

The morphological and agronomic features established by these showed that studied landraces belong to four species of pepper: *C. annuum*, *C. frutescens*, *C. baccatum*, and *C. chinense*. In our research has been used biological material from 9 Romanian counties, from small private seed producers.

One of the objectives was the production of seed which had two purposes: the conservation in the genebank and the distribution to different interested gardeners. Therefore, our research has also a participative character. Also, our activities contributes effective to the maintaining of *on farm* genetic diversity. We observe the same work method and same objectives at Montesano et. al. 2012, in the region Basilicata in Italy.

All the 17 landraces studied belong to the *Capsicum annuum* L. species, aspect considered normal because Europe is not the center of origine of the pepper, as it is Brasil. Similar to Sudre et al. (2010) research, for the characterization of the biological material, we used IPGRI descriptors, respectively morfological and agronomic features.

Franco et al. (2005) also considers, that despite the characterizations precision accomplished with the help of the molecular markers, phenotypically knowledge of the landraces remains very important [3].

4. Conclusions

The objectives of our research are the collection, identification and the production of pepper seed, with the purpose of their conservation in the genebanks and *on farm*.

They were 17 pepper landraces (*Capsicum annuum* L.) collected and cultivated from which two of bell pepper, two of sweet pepper, one of cayenne pepper and 12 landraces of hot papper.

The seed was obtained from nine Romanian counties from small producers of seed.

The landraces were cultivated in two experimental fields and they were morphological and agronomic characterized after IPGRI descriptors.

The obtained seed was destined for conservation in the UASMV's genebank and also for the distribution for the small gardeners.

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