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Abstract

Morphological analysis of pepper fruits (*Capsicum annuum* L.) represents a valuable source of information on phenotypic traits of genotypes, which constitute important genetic resources for adaptation. This study evaluated key morphological characteristics in 10 local and domesticated varieties of dried pepper, including fruit length, fruit width, fruit index, peduncle length, and calyx length.

The morphological characterization revealed significant phenotypic variability among the analysed fruits, allowing classification into two main groups. The first group comprised long pepper types, with fruit lengths ranging from 15 to 17.5 cm, widths from 1.6 to 3 cm, and a fruit index between 5.1 and 10.6. Capsaicin was absent in two varieties, while four exhibited its presence. The second group included medium-length peppers, with fruit lengths ranging from 5 to 10 cm, widths from 1.5 to 3.5 cm, and a fruit index between 1.43 and 3.3. The shortest peduncle length (2 cm) was observed in a sweet medium-length variety, while the longest (4.5 cm) was recorded in the “bukovka” type.

These findings highlight the dual agronomic and nutritional value of traditional pepper varieties and emphasize the importance of conserving and utilizing local germ plasma as a sustainable approach for improving productivity, nutritional quality, and resilience across diverse cultivation systems.

Key words : Pepper (*Capsicum annuum* L.), morphological analysis, fruit lengths, fruit widths, fruit index

Introduction

Pepper (*Capsicum annuum* L.) production in the Republic of North Macedonia has a long tradition dating back to the 16th century and represents an important segment of agricultural production and agrobiodiversity. This species is characterized by considerable genetic variability, with local populations and varieties differing in morphological and physiological traits such as fruit shape, size, color, and chemical composition. Such diversity represents a valuable genetic resource for selection, adaptation, and improvement of yield and quality under changing agroecological conditions.

Pepper (*Capsicum annuum* L.) has high nutritional and functional value, as it is a rich source of vitamins (especially vitamin C), minerals, antioxidants, and biologically active compounds such as carotenoids and phenolic components. Due to these properties, it is widely used in human nutrition, both as a fresh product and in various processed forms (drying, thermal processing, and canning).

Studies by McCoy et al. (2023) indicate that domestication processes and continuous selection for desirable traits in cultivated plants have had a negative impact on genetic diversity.

The level and distribution of genetic variability in plant species depend on cultivation practices, evolutionary processes over time, natural and topographical conditions, climatic extremes, and, to a large extent, anthropogenic factors (Rao & Hodgkin, 2002).

Morphological characterization of *Capsicum* species (pepper) germplasm is a prerequisite in crop improvement programs (Baba et al., 2016; Fasikaw et al., 2019; Nankar et al., 2020).



Results and Discussion

The aim of this paper is to perform a morphological analysis of the fruits of selected pepper genotypes, in order to determine their variability and identify significant traits relevant for further selection and sustainable use. The research was conducted on 10 pepper genotypes (*Capsicum annuum* L.), grown in the Kumanovo region using standard agrotechnical measures. The morphological analysis was performed on dry fruits, where the following parameters were evaluated: fruit length (cm), fruit width (cm), fruit index, presence of capsaicin, fruit stalk length (cm), calyx shape. The morphological characterization showed significant phenotypic diversity in the fruits, whereby a classification was made into two groups: the first group long peppers with a length of 15 to 17.5 cm, fruit width from 1.6 to 3 cm and fruit index from 5.1 to 10.6. According to the presence of capsaicin in the fruits, it is absent in 2 varieties, while it was present in 4. The second group is medium-long peppers with a length of 5 to 10 cm, a fruit width of 1.5 to 3.5 cm and a fruit index of 1.43 to 3.3. The length of the fruit stalk is the shortest in mild medium-long pepper, 2 cm, and the longest in oyster mushroom, 4.5 cm (Tab.1)

No.	Fruit length (cm)	Fruit width (cm)	Shape index	Peduncle length (cm)	Calyx shape
1	16.0	3.0	5.30	3.0	non-enveloping
2	15.0	2.4	6.25	4.0	enveloping
3	8.5	3.0	2.80	2.0	semi-enveloping
4	17.0	1.6	10.60	3.0	semi-enveloping
5	15.5	3.0	5.16	3.5	semi-enveloping
6	17.5	3.0	5.80	3.5	semi-enveloping
7	17.2	2.5	6.80	3.0	semi-enveloping
8	5.0	1.5	3.30	2.7	semi-enveloping
9	10.0	2.8	2.57	4.5	semi-enveloping
10	5.0	3.5	1.43	2.5	semi-enveloping

Tab. 1 Average values for the quantitative properties of the tested varieties

QUALITATIVE CHARACTERISTICS	VARIETY NUMBER
LENGTH	
VERY SHORT 1	
VERY SHORT TO SHORT 2	
SHORT 3	5,8,10
SHORT TO MEDIUM 4	3
MEDIUM 5	9
MEDIUM TO LONG 6	
LONG 7	
LONG TO VERY LONG 8	1,2,4,5,6,7
VERY LONG 9	
RATIO LENGTH/DIAMETER	
VERY LOW 1	
VERY LOW TO LOW 2	
LOW 3	3,8,9,10
LOW TO MEDIUM 4	
MEDIUM 5	1,5,6
MEDIUM TO HIGH 6	
HIGH 7	
HIGH TO VERY HIGH 8	2,7
VERY HIGH 9	4
CAPSAICIN IN PLACENTA	
ABSENT 1	1,3,5
PRESENT 2	2,4,6,7,8,9,10
STALK: LENGTH	
VERY SHORT 1	
VERY SHORT TO SHORT 2	
SHORT 3	3,8,10
SHORT TO MEDIUM 4	1,4,7,5,6
MEDIUM 5	
MEDIUM TO LONG 6	2,9
LONG 7	
LONG TO VERY LONG 8	
VERY LONG 9	
CALYX	
NON ENVELOPING 1	1
SEMI ENVELOPING 2	3,4,5,6,7,8,9,10
ENVELOPING 3	2

Tab. 2 Classification of qualitative characteristics of the tested varieties according to UPOV descriptor

Conclusions

A study of 10 commercial pepper cultivars revealed genetic diversity across morphological and agronomic traits, confirming the exceptional value of the different cultivars as genetic resources for sustainable agriculture.

These findings highlight that several cultivars can serve as base material for the development of climate-resilient varieties that meet consumer demands for high-quality products. Integrating this germplasm into molecular characterization, genome-guided breeding schemes and participatory breeding will accelerate the exploitation of local biodiversity. Overall, the conservation and sustainable use of local Greek pepper cultivars should be seen not only as a cultural heritage priority, but also as a strategic path towards climate-smart, resilient and nutritionally enriched agri-food systems.

References

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