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STUDY VARIABILITY OF TECHNOLOGICAL PROPERTIES LEAVES AND SEEDS OF SPECIES THE GENUS AMARANTHUS

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ABSTRACT. In one experiment tested four types of amaranth. Were tested for chemical and technological characteristics of leaves and seeds: the protein content of seeds, the protein content of leaves, the mineral of seeds, the mineral of leaves and the oil content of seeds. The results were analyzed using analysis of variance for the random system and calculate the components of variance, coefficient of variation and heritability of amaranthus.
In the examined technological characteristics can be seen relatively little variability, the protein content of seeds varies from 14.88% (A.caudatus) to 16.55% (A. cruentus), the protein content of leaves varies from 15.94% (A. moleros) to 20.10% (A. caudatus), the mineral of seeds varies from 2.32% (A. caudatus) to 2.73% (A. moleros), the mineral of leaves varies from 16.34% (A. caudatus) to 18.76%(mantegazzianus) and the oils content of seeds varies from 5.56% (A. mantegazzianus) to 6.16% (A. moleros).
Calculated values for the components of phenotypic variance and heritability, indicating that all features except for the mineral of seeds, more controlled genetic factor than ecological factors.

INTRODUCTION

The genus amaranthus has about 60 species of which are wild forms, while only a small number belong to the cultivated species. In less developed countries of Central and South America, Asia and Africa, amaranth leaves are used in raw and processed form. Different types of amaranth are divided to crop and vegetable crops. As the main vegetable crops appear in A. tricolor L A.graecizans L.and A. cruentus L., until the grains are used as A. cruentus L., A. caudatus L., A.hybridus L. and A.mantegazzianus L[1]. Health care and progress of the nation in any state associated with the production of sufficient quantities of quality food, which are the basic components of proteins. The deficit of protein in the daily ration was 26% and 50% of the vitamin[2]

The first studies on amaranth appeared eighty years of the twentieth century in the National Academy of Sciences USA. This research has rediscovered this ancient culture and confirmed its high nutritional value and productivity. Plants of the genus *Amaranthus L.* provide a rich yield and the cost of processing, which provides them with a successful introduction in many regions, which have previously been raised.[3]

Key words and phrases. Genotype, protein, seed.
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In terms of actual number of species of the genus Amaranthus in Europe, there are different data. Thus, in the Prodromus Florae peninsulae Balkanicae lists 9 species[4]. in Flora Europaea 12[5]. According to the Med-Checklist There are 21 species of amaranth, including non-European Mediterranean countries[6] The first data on the genus *Amaranthus* in Serbia, where he describes three species (*A. retroflexus, A. blitum* = syn. *A. lividus* and *A. paniculatus*), are related to capital work "Flora of the Principality of Serbia"[7] . In the still, the current edition of Flora of SR Serbia said 12 species of the genus *Amaranthus*[8]. The aim of this study was to determine the variability properties of the four major types of amaranth. These studies may help in further work on amaranthus, a separate divergent genotypes may serve as parents for further crossing.

MATERIALS AND METHODS

Selection of the 10 genotypes that belong to species A.molleros, A.caudatus, A.mantegazzianus and A.cruentus.From the technological-chemical properties in 1997.year were analyzed as follows:

- seed protein content (%)
- protein content in leaves (%)
- ash content in seeds (%)
- ash content in the leaf (%)
- oil content (%)

Proteins in seeds and leaves were analyzed by Kieldahl's method ISO 1871 (1992). Oil content by using Soxhet-in, and mineral content was determined by atomic absorption spectrometry

As indicators of variability of researched characteristics, calculated were: the mean value (x), standard deviation (S) and variation coefficient (Cv%).[9]

Sample mean value $$\bar{x} = \frac{\Sigma\ xi}{N}$$

Standard deviation $$S = \sqrt{\frac{\Sigma\ (x - \bar{x})^2}{N - 1}}$$

Coefficient of variance $$Cv = \frac{S \times 100}{\bar{x}}$$

For technological and chemical properties of seeds and leaves, analysis of variance was used for the random system.[9]

Sources of variation	Degrees of freedom	The sum of squares	The middle square (MS)	
Repetition	(b-1)	Qb	MS_3	Qb / (b-1)
Genotype (g)	(g-1)	Qg	MS_2	Qg / (g-1)
Error	(b-1) (g-1)	Qp	MS_1	Qp / [(b-1) (g-1)]
In total	bg - 1	Q		

Table. 1. Analysis of variance of the random system

Variance components are calculated by the following formulas:

$$\delta^2 g = (MS_2 - MS_1) / b$$

$\delta^2 f = \delta^2 g + \delta^2 p/b$

$\delta^2 g$ - genetic variance
$\delta^2 f$ - phenotypic variance
$\delta^2 p$ - variance of experimental error
MS_2 - mean square of genotype
MS_1 - mean square of experimental error
b - repetition

To test the significance of differences between mean values of the traits were calculated by the least significant difference (LSD - test), the significance threshold of 1% and 5% for levels of error according to the formula:

LSD - Se "t" SE - standard error of the treatment environment
Se - $(2MSe/b)^{1/2}$ t - tabulation value of the degrees of freedom for error

The coefficient of genetic (GCV) and phenotypic (PCV) of variance for all traits analyzed, representing the degree of genetic relationship phenotypic variation, compared to the average value of the trait.

$$GCV = \frac{(\delta^2 g)^{1/2}}{\bar{x}} \cdot 100$$

$$PCV = \frac{(\delta^2 f)^{1/2}}{\bar{x}} \cdot 100$$

Percentage of genetic variability in the total phenotypic variability of the analyzed traits was determined on the basis of heritability.

The coefficient heritability can be used to determine the probability of whether a particular form can provide the same or similar offspring:

$$h^2 = \frac{\delta^2 g}{\delta^2 f} \cdot 100$$

TECHNOLOGICAL PROPERTIES OF AMARANTHUS

THE PROTEIN CONTENT OF SEEDS

Mean percentage value, the protein contentin of seeds, varied in tne range of 14.88% (A. caudatus) to 16.55% (A. cruentus). The coefficient of variation within the analyzed species amaranthus, ranged within 0.70% to 1.32%. A. lower coefficient of variation (0.70%) had a type of A.molleros or a higher value for this index of variability (1.32%) showed the species A.mantegrazzianus. Coefficient of variation between the studied species was 5.29% (Table 2). Analysis of variance showed that the analyzed species are very significant differences in protein content in seed. (Table 3).

The average percentage of protein contantent of seeds of A. cruentus 17.8%, A. caudatus 14.9%, A.hypochondriacus 15.6% and A.flavus 15.9%[10].The average percentage of protein content in seeds amaranthus is in A. teuniflionus 19% - 23%, A. cruentus 15% - 18%, A. spinosus 11%, and A.polygainous only 5%[11].

THE PROTEIN CONTENT OF LEAVES

The protein content of leaves, in addition to the protein content of seeds are the most important qualitative traits of amaranthus. The average value of the percentage the protein content of leaves varied in the range from 15.94% to 20.10%. The smaller the average value

(15.94%), for this particular property types showed A.molleros or A. caudatus had a higher average value (20.10%) of these featurestraits (Table 2).

Indicators of variability within the analyzed species varied in a very small range of 0.35% (A. mantegazzianus) to 0.95% (A. caudatus), while among the analyzed species coefficient of variation is much higher and 9.95% (Table. 2).

Influence of the type is highly significant for protein content of leaves of amaranth (Table 3).

Accumulation of protein in amaranth is a result of belonging to C4 plants (12% in the stem, 15-18% in the seed, 30-50% in the leaves)[12].

THE MINERAL OF SEEDS

Among the analyzed species of amaranthus are no significant differences in the mineral of seeds (Table 2). The average value of the mineral of seeds varied in a very narrow interval (2.32% - 2.73%). Type A. caudatus had a lower average value (2.32%) for the property, or the average value recorded for the species A. molleros (2.73%) (Table 2.)

The coefficient of variation within the analyzed species varied in the range of 2.56% (A. molleras) to 16.14% (A. mantegazzianus) between the studied species was 7.24% (Table 2). In relation to the mineral of seeds, analysis of variance, no statistically signific difference between the studies species of amarantus (Table 3).

THE MINERAL OF LEAVES

The mean total minerals of leaves, the analyzed species of amaranthus, varied from 16.34% to 18.76%. The minimum average value of the said properties, was observed in A.caudatus-a (16.34%), while the maximum value (18.76%) recorded for the species A.mantegazzianus (Table 2). The coefficient of variation within the analyzed species amaranthus was between 0.62% and 2.14% and a lower coefficient of variation was the type of A. moleros, while the higher value of the coefficient of variation showed species A.caudatus. The value of the coefficient of variation between the studied species was 5.89% (Table 2). In relation to the mineral of leaves, according to results of the analysis revealed a significant difference between the studied species (Table 3).

THE OIL CONTENT OF SEEDS

The average percentage value the oil content of seeds varied slightly from 5.56% (A. mantegazzianus) to 6.16% (A. molleros) (Table 2). Within the analyzed species of amaranth, the highest coefficient of variation was observed in the species A. mantegazzianus (7.19%) and lowest coefficient of variation was observed in A. molleros (1.45%) (Table 2).

Standard deviation is consistent with the value of the coefficient of variation. Analysis of variance showed that the analyzed species there are no statistically significant differences for a given property (Table 3).

Species	The protein content of seeds		The protein content of leaves		The mineral of seeds		The mineral of leaves		The oil content of seed	
	$\bar{x}$	Cv (%)	$\bar{x}$	Cv (%)	$\bar{x}$	Cv (%)	$\bar{x}$	Cv (%)	$\bar{x}$	Cv (%)
A. molleros	14,89	0,26	15,94	0,37	2,73	2,56	17,63	0,62	6,16	1,45
A. caudatus	14,88	0,70	20,10	0,92	2,32	8,18	16,34	2,14	5,76	3,56
A. mantegazzianus	15,13	1,32	17,03	0,35	2,54	16,14	18,76	0,69	5,56	7,19
A. cruentus	16,55	0,68	18,06	0,47	2,39	10,46	18,26	0,82	6,05	3,38
S	0,79		1,77		0,18		1,045		0,23	
Cv (%)	5,29		9,95		7,24		7,24		4,64	

Tab.2 Second Mean values ($\bar{x}$), coefficients of variation (Cv) for protein, mineral and oil (%) in seeds and leaves of species of the genus Amaranthus

Sources of variation	DF					
		The protein content of seeds	The protein content of leaves	The mineral of seeds	The mineral of leaves	The oil content of seeds
Species	3	1,906**	9,392**	0,09	3,28**	0,22
Error	8	0,016	0,012	0,07	0,04	0,06

Tab. 3 Analysis of variance of the random system for protein content, mineral, oil seeds and leaves of the genus Amarantus

THE COMPONENTS OF VARIANCE, COEFFICIENT OF VARIATION AND HERITABILITY OF AMARANTHUS

Technological characteristics: the protein content of seeds, the protein content of leaves and the mineral of leaves are more controlled genetic basis, while the influence of ecological factors lower (Table 4):

In terms of the percentage of genetic variance to total phenotypic variance for these three traits (0.63%, 3.12% and 1.08%), and also the relation of genetic and ecological variance in the phenotypic variance.

Heritability (Table 4) was high for these three traits, which confirms a pronounced influence on the variability of genotypes.The lowest value of genetic coefficient of variation was 5.16% (the protein content of seeds), and the highest value of 9.93% (the protein content of leaves). Phenotypic coefficient of variation was varied in the range of 5.18% (the protein content of seeds) to 9.94% (the protein content of leaves). Little difference genetic and phenotypic coefficient of variation indicates a greater impact genetic factors on the expression of the respective properties.

For traits, the oil content of seeds, the proportion of genetic variance to total phenotypic variance is 72%. This value indicates that in addition to genetic factors, the inheritance of oil content of seeds of amaranthus, have a significant impact and ecological factors. The value of genetic and phenotypic coefficient of variation, or difference between these values confirms the significant influence of the ecological factors on the variability of these traits (Table 4).

Of all the technological characteristics analyzed, only the traits of the mineral of seeds has a low heritability (29%) or low heritability indicates that the traits is controlled by a small

number of genes. Phenotypic coefficient of variation (7.16%) is significantly different from the genetic coefficient of variation (3.92%), which indicates that the variability of these traits have a strong influence of ecological factors

Traits	δ^2 g	δ^2 e	δ^2 f	h^2 (%)	GCV (%)	PCV (%)
The protein content of seeds	0,63	0,005	0,635	99	5,16	5,18
The protein content of leaves	3,12	0,004	3,124	99	9,93	9,94
The mineral of seeds	0,0096	0,023	0,0326	29	3,92	7,16
The mineral of leaves	1,08	0,014	1,094	98	5,85	5,89
The oil content of seeds	0,054	0,021	0,075	72	3,95	4,65

Tab. 4. Genetic (δ^2 g), ecological (δ^2 e) i phenotypic(δ^2 f) variance; coefficients of genetic(GCV) and phenotypic (PCV) variance and heritability (h^2) tehnological properlies of amaranthus

CONCLUSION

The research results provide us the ability to perform the following conclusions:

For indicators of technological characteristics observed variability of the narrow, the protein content of seeds varies from 14.88% (A. caudatus) to 16.55% (A. cruentus), the protein content of leaves varies from 15.94% (A. molleros) to 20.10% (A. caudatus), the mineral of seeds varies from 2.32% (A. caudatus) to 2.73% (A. molleros); the mineral of leaves varies from 16.34% (A. caudatus) to 18.76% (A.mantegazzianus) and the oil content of seeds varies from 5.56% (A. mantegazzianus) to 6.16% (A. molleros). These values indicate that the variability of these characteristics largely affect genetic basis.

Heritability was high for these three traits, which confirms a pronounced influence on the variability of genotypes. For trait, the oil content of seeds, the proportion of genetic variance to total phenotypic variance is 72%. This value indicates that in addition to genetic factors, the inheritance the oil content of seeds amaranthus, have a significant impact and ecological factors. Of all the technological characteristics analyzed, only the mineral of seeds has a low heritability (29%), low heritability indicates that the property is controlled by a small number of genes.

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