Assessment of the variability for some cooking quality traits in dry bean varieties

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Abstract: *The aim of this study was to evaluate some culinary quality traits of six Romanian bean varieties during three years, in order to find suitable genotypes for different climatic conditions and which can also be used in different programs for breeding of culinary value of dry bean. The environmental conditions of the three years have had the highest contribution on the variability of coat proportion, while the variability of hydration capacity and cooking time was affected in a low extent. The values of TGW and hydration capacity are due mainly to the effect of variety, but in the case of coat proportion the genetic component had a low contribution. The genotype x environment interaction had the highest effect on cooking time. 'Ardeleana', 'Diva' and 'Vera' varieties showed the best stability of the TGW associated with low values, below the mean. 'Star' and 'Ami' varieties showed the highest genotype x environment interaction and parallel to the favourability of weather conditions. The hydration capacity showed the highest stability for the studied varieties. Under the background of values below the mean, 'Ami', 'Ardelena' and 'Vera' varieties registered the best stability of the coat proportion. 'Avans' variety showed the best boiling capacity, associated with a superior stability. In the case of 'Ami' and 'Ardeleana' varieties, the boiling capacity was strongly influenced by the genotype x environment interaction.*

Introduction

To use the rich nutritional value of dry bean, long cooking times are generally required. The cooking process is necessary for gelatinizing starch, enhancing protein digestibility, and inactivating the lectins and trypsin inhibitors [10; 20]. For the industrialization of dried grains, they must absorb as much water as possible in order that the obtained product to have the necessary fragility, which is dependent on both the genotype and used water . In order to improve the culinary quality of beans, the aim is to decrease the coat proportion, meaning that the maximum permissible value should be below 6%. The improvement of coat proportion is quite difficult, especially when it is desired to obtain genotypes with large grains. The cooking time of the grains in common bean, among others, is influenced by two phenomena: the hardness of the coat and the "boiling resistance". Cooking time is affected both by grain type and storage time, considering that refrigeration is the best storage type. The aim of this study was to evaluate some cooking quality traits of six Romanian bean varieties during three years, in order to find suitable genotypes for different climatic conditions and which can also be used in different programs for breeding of culinary value of dry bean.

Material and method

The experiments were conducted at the Faculty of Horticulture and Forestry, Banat's University of Agricultural Sciences and Veterinary Medicine Timisoara, on a black chernozem, during 2017-2019. Depending on the average temperatures and rainfall regime, 2018 was considered the most favourable year and 2019 the least favourable for cultivation of common bean. During the study a conventional cultivation practices for this crop, was applied. The experiment was organized in a randomized block design with four replications and 30 harvestable plants per plot. The biological material was composed by six Romanian varieties of common bean: 'Ami', 'Ardeleana', 'Avans', 'Diva', 'Star' and 'Vera'.

From each plot were randomly selected three samples of 100 grains in order to determine the 1000 grains weight (TGW). Subsequently, the respective grains were used to determine the other quality traits: hydration capacity, coat proportion and cooking time.

Results and discussions

The means of the varieties for the whole period showed a variability of 22.32% for TGW, at amplitude of 131.84 g, with the limits from 148.69 g for 'Vera' up to 280.53 g for 'Avans' variety. 'Ardeleana', 'Diva' and 'Vera' varieties showed a good adaptation to the conditions from 2017-2018, achieving values

close of TGW and significantly higher than those from 2019. During the study, the average values of the water absorption capacity achieved by the six varieties showed amplitude of 16.75%, with the limits from 98.53% for 'Diva' to 115.28% for 'Ardeleana', on the background of a low inter-genotypic variability .

Mean values of hydration capacity for common bean varieties during 2017-2019

Varieties	Years			Means (%)	
	2017	2018	2019	$\bar{x} \pm s_{\bar{x}}$	$S_\%$
Ami	x 110.76 b	x 110.12 a	x 107.85 b	109.57+2.06 B	6.54
Ardeleana	x 116.84 a	x 113.25 a	x 115.75 a	115.28+1.82 A	5.48
Avans	x 112.39 ab	x 110.75 a	x 114.65 a	112.60+1.92 AB	5.88
Diva	x 99.12 c	x 96.51 b	x 99.97 c	98.53+1.76 C	6.18
Star	x 102.84 c	x 98.90 b	x 104.16 bc	101.96+2.26 C	7.66
Vera	xy 114.71 ab	y 109.73 a	x 119.48 a	114.64+3.08 A	9.30
$\bar{x} \pm s_{\bar{x}}$	109.44+2.84 X	106.54+2.90 Y	110.31+3.20 X	108.76+1.74	
$S_\%$	12,72	13.32	14.22	13.58	

-Years LSD$_{5\%}$=2.30　LSD$_{1\%}$=3.49　LSD$_{0,1\%}$=5.60 (X,Y,Z)
- Varieties LSD$_{5\%}$=3.52　LSD$_{1\%}$=4.70　LSD$_{0,1\%}$=6.15 (A,B,C,D,E,)
- Years x Varieties LSD$_{5\%}$=5.86　LSD$_{1\%}$=7.81　LSD$_{0,1\%}$=10.19 (x,y,z)
- Varieties x Years LSD$_{5\%}$=6.09　LSD$_{1\%}$=8.14　LSD$_{0,1\%}$=10.65 (a,b,c,d,e,)

Regarding the genotype x environment interaction, it was found that generally the hydration capacity was not significantly influenced by the variation of the weather conditions during the study. Only in the case of 'Vera' variety it was noted a significant increase of hydration capacity in 2019 compared to 2018. Regarding the effect of the bean variety on the manifestation of this trait, it was found that the varieties achieved a coat proportion with values from 7.57 for Ami to 8.74 for Diva, on the background of a low inter-population variability.

During the study, the mean boiling time values of the six varieties showed amplitude of 20.64 min., ranging from 79.07 min. in case of 'Avans' up to 99.71 for 'Diva', under a low (8.55%) inter-genotypic variability. Thus, 'Avans' variety registered in this period a significantly higher boiling capacity than most other varieties. Also, 'Ami' variety showed a significantly shorter cooking time than 'Diva' and 'Star' varieties. Considering the genotype x environment interaction, it was found that the six varieties showed a different reaction in terms of boiling capacity to the variability of weather conditions.

Mean values of cooking time for common bean varieties during 2017-2019

Varieties	Years			Means (min.)	
	2017	2018	2019	$\bar{x} \pm s_{\bar{x}}$	$S_\%$
Ami	z 70.46 d	y 77.62 e	x 98.03 a	82.03+3.68 CD	15.55
Ardeleana	y 86.80 abc	z 74.31 e	x 95.73 a	85.61+2.85 C	11.54
Avans	x 84.95 bc	x 85.16 d	y 67.10 c	79.07+2.70 D	11.85
Diva	y 92.31 a	x 108.47 a	y 98.34 a	99.71+2.33 A	8.10
Star	y 91.17 ab	x 100.27 b	z 81.31 b	90.92+2.62 B	9.98
Vera	xy 83.91 c	x 90.17 c	y 77.74 b	83.94+1.96 C	8.09
$\bar{x} \pm s_{\bar{x}}$	84.93+1.65 Y	89.33+2.65 X	86.38+2.56 XY	86.88+1.35	
$S_\%$	9.51	14.56	14.85	13.15	

-Years LSD$_{5\%}$=4.09　LSD$_{1\%}$=6.19　LSD$_{0,1\%}$=9.95 (X,Y,Z)
- Varieties LSD$_{5\%}$=4.01　LSD$_{1\%}$=5.35　LSD$_{0,1\%}$=7.00 (A,B,C,D,E,)
- Years x Varieties LSD$_{5\%}$=7.17　LSD$_{1\%}$=9.56　LSD$_{0,1\%}$=12.51 (x,y,z)
- Varieties x Years LSD$_{5\%}$=6.94　LSD$_{1\%}$=9.26　LSD$_{0,1\%}$=12.13 (a,b,c,d,e,)

Conclusions

The environmental conditions of the three years have had the highest contribution on the variability of coat proportion, while the variability of hydration capacity and cooking time was affected in a low extent. Avans' variety showed the best boiling capacity, associated with a superior stability. In the case of 'Ami' and 'Ardeleana' varieties, the boiling capacity was strongly influenced by the genotype x environment interaction.