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The variability in qualitative determinants of Greek bitter vetch landraces

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Abstract. Bitter vetch (*Vicia ervilia* (L.) Willd.) is one of the eight Neolithic founder crops of the Fertile Crescent. Once extensively cultivated, nowadays is growing on a small scale around the Mediterranean Basin for its forage and grain, mainly as feed for ruminants. Efforts for conservation and quality determinants assessment have been intensified in the recent years, due to increased attention for underutilized crop species and their effect to global food security and the forthcoming climate change. Seed nutritional quality varied significantly (P<0.001), among forty-one Greek bitter vetch landraces. Ash content averaged at 2.66 g/100 g DM. Crude protein content ranged from 15.5 to 23.31 g/100 g DM and crude fiber from 2.79 to 4.05 g/100 g DM. NFEs also varied with an average of 62.03 g/100 g DM. Straw quality characteristics were also varied among six studied accessions. Crude protein and crude fiber contents ranged from 5.10 to 9.84 g/100 g DM and 32.06 to 43.06 g/100 g DM, respectively. ADF and NDF contents averaged at 39.02 g/100 g DM and 52.63 g/100 g DM, respectively. The seeds and straw of the Greek bitter vetch local populations studied revealed on average a nutritional value similar to that of collections studied elsewhere. However, local populations of interesting performance were identified which need further study.

Keywords. *Vicia ervilia* – Nutritional quality – Population diversity – Underutilized crop.

La variabilité dans les déterminants qualitatifs des races locales de vesces amères grecques

Résumé. *La vesce amère (*Vicia ervilia *(L.) Willd.) est l'une des huit cultures fondatrices néolithiques du Croissant fertile. Autrefois largement cultivée, elle est trouvée aujourd'hui à petite échelle autour du bassin méditerranéen, pour la production de fourrage et de grain, principalement pour nourrir les ruminants. Les efforts en matière d'évaluation de la conservation et des déterminants de la qualité se sont intensifiés ces dernières années en raison de l'attention accrue portée aux espèces cultivées sous-utilisées ainsi que de leurs effets sur la sécurité alimentaire mondiale et du changement climatique à venir. La qualité nutritionnelle des semences variait de manière significative (P<0,001) parmi quarante-et-une races locales grecques de vesces amères. La teneur en cendres était en moyenne de 2,66 g/ 100 g de MS. La teneur en protéines brutes variait de 15,5 à 23,31 g/ 100 g de MS et la fibre brute de 2,79 à 4,05 g/ 100 g de MS. Les NFEs ont également varié avec une moyenne de 62,03 g/ 100 g de MS. Les caractéristiques de qualité de la paille variaient également parmi six accessions étudiées. Les teneurs en protéines brutes et en fibres brutes variaient respectivement de 5,10 à 10,47 g/ 100 g de MS et de 32,06 à 43,07 g/ 100 g de MS. Les teneurs moyennes en ADF et en NDF étaient en moyenne de 39,02 g/ 100 g de MS et de 52,63 g/ 100 g de MS, respectivement. Les graines et la paille des populations locales de vesce amère grecque étudiées ont révélé en moyenne une valeur nutritionnelle semblable à celle des collections étudiées ailleurs. Cependant, des populations locales présentant des performances intéressantes ont été identifiées et nécessitent une étude plus approfondie.*

Mots-clés. Vicia ervilia – *Qualité nutritionnelle – Diversité de la population – Culture sous-utilisée.*

I – Introduction

Sheep and goats constitute a vital source of income for the rural population of many Mediterranean areas, contributing greatly to family and also to national economies through their products (meat, milk, skins wool, etc.), while they provide a range of ecosystem services. Although the main source of feed for these animals is the forage grazed on extensive rangelands, cereal straw and stubble, as well as grains cropped locally (Porqueddu *et al*., 2017), the climatic conditions prevailing there, and the poor soils lead to feed scarcity and finally to low productivity. This situation can be reversed by selecting crops adapted to drought and by improving soil condition and fertility mainly through forage legumes cultivation, integrating them into the mixed crop-livestock or agro-pastoral farming systems as multi-purpose crops to improve seasonal supply of quality feed and soil productivity (Baxevanos *et al*., 2017).

Towards this goal, and in view of global warming, bitter vetch (*Vicia ervilia* (L.) Willd.) presents an interesting option. Bitter vetch is one of the eight Neolithic founder crops of the Fertile Crescent. Once extensively cultivated, nowadays is growing on a small scale around the Mediterranean Basin due to low productivity and contents of antinutritional components. However, conservation and quality assessment efforts have been intensified in the recent years, due to increased interest towards global food security and the forthcoming climate change. Therefore, this study aimed to assess seed and straw nutritional quality of a collection of bitter vetch accessions with Greek origin.

II – Materials and methods

1. Samples for seed quality determination

Seed samples of thirty-two bitter vetch accessions with Greek origin, kindly provided by the Genebank of Leibniz Institute of Plant Genetics and Crop Plant Research (IPK) (*coded* ERV), in Germany, as well as nine landraces from different parts of Greece (*coded* AUA), collected on-farm, during expeditions of the laboratory of Plant Breeding and Biometry of Agricultural University of Athens were assessed regarding their seed qualitative determinants. For the analysis, two replications of fifty seeds each, were used per accession.

2. Samples for straw quality determination

Six of the accessions were further analyzed for their straw qualitative determinants. For that purpose, a field experiment was carried out in the Agricultural University of Athens (N 37º59'10'', E 23º42'29'', altitude 24 m). A Randomized Complete Block Design (RCBD) was followed with 4 blocks, each plot containing a total number of 40 plants. For the analysis, straw of ten central completely mature plants of each replication was used.

3. Analytical methods

Straw quality was assessed after it was pre-ground on a hammer mill to pass a 6 mm sieve. Seeds and the ground straw were finished on a laboratory mill using a 1 mm screen. Analyses were conducted for moisture (AOAC method 930.15), crude protein concentration (CP) by the Kjeldahl method (AOAC method 984.13), ash content (Ash) by ashing overnight at 550º C (AOAC method 942.05), ether extracts (EE) as Fat by the Soxhlet method (AOAC method 920.39), crude fiber (CF), Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) on an ANKOM 220 (AOAC 978.10, AOAC 2002:04 and AOAC 973.18 respectively). Moreover, Nitrogen Free Extracts (NFE) were determined by difference using the equation NFE= 100– (CP + Ash+ CF + EE).

4. Statistical analysis

All data were subjected to a one-way Analysis of Variance (ANOVA) and Least Significant Difference (LSD) at 0.05 level was applied to define significantly different means among the accessions. Pearson correlation coefficients were computed to assess correlations among seed as well as straw nutritional traits studied, using Statgraphics Centurion 16 statistical package.

III – Results and discussion

Seed nutritional quality varied significantly (P<0.001), among forty-one bitter vetch landraces which were collected either from on farm cultivation in Greek rural areas or preserved *ex-situ* with Greek origin. Ash content ranged from 2.21 (ERV28) to 3.26 (ERV16) and averaged at 2.66 g/100 g DM. Crude protein content ranged from 15.5 (AUA5) to 23.31 (AUA9) g/100 g DM. Crude fiber from 2.79 to 4.05 g/100 g DM in ERV27 and ERV65, respectively. NFEs also varied from 57.98 (AUA3) to 65.01 (AUA5), with an average of 62.03 g/100 g DM (data not shown).

Straw quality characteristics were also varied among six studied accessions. Crude protein and crude fiber contents ranged from 5.10 to 9.84 g/100 g DM and 32.06 to 43.06 g/100 g DM, respectively. ADF and NDF contents averaged at 39.02 g/100 g DM and 52.63 g/100 g DM, respectively (Table 1). Greek accessions seed and straw nutritional value found to be similar to other bitter vetch collections (Hadjipanayiotou *et al*., 1985; Makkar *et al*., 1996; Tabatabaei *et al*., 2000; Sadeghi *et al*., 2009; Larbi *et al.*, 2011; Okba *et al*., 2014).

Table 1. Variability of straw chemical composition among 6 bitter vetch accessions (g/ 100 g of DM)

Accession	CP	Ash	CF	NDF	ADF	NFEs
AUA2	6.33±0.64^{cd}	11.74±1.40	36.21±1.88^{b}	50.49±2.62	38.49±2.39	38.66±0.99^{b}
AUA5	9.44±0.82^{ab}	9.69±0.24	36.57±2.71^{ab}	51.06±4.15	37.99±3.62	36.39±1.63^{b}
ERV35	5.10±0.47^{d}	10.43±0.42	32.23±0.44^{b}	49.14±1.39	35.19±1.09	52.90±7.77^{a}
ERV45	5.77±0.42^{cd}	8.78±0.90	37.90±1.98^{ab}	57.08±2.34	42.32±1.78	40.60±0.75^{b}
ERV53	9.84±1.00^{a}	10.81±0.72	32.06±0.01^{b}	51.93±2.86	37.50±2.47	41.14±0.01^{ab}
ERV65	7.51±0.96^{bc}	9.51±1.08	43.06±2.03^{a}	57.22±6.96	43.84±5.51	32.98±1.16^{b}
Mean	7.33	10.13	36.88	52.63	39.02	40.71
Significance	***	ns	*	ns	ns	*

Values are given as mean ± SE of four replicates. Means in columns with different letters are significantly different at P<0.05 by Least Significant Difference. ns. Non-significant at 0.05, *. Significant at the 0.05 level, **. Significant at the 0.01 level, ***. Significant at the 0.001 level.

In seeds, a strong positive correlation was defined only between fat content with NFEs (r=0.66, P<0.05), while negative correlation was observed between CP with NFEs content (r=-0.84, P<0.05) and with fat content (r=-0.85, P<0.05) (Table 2) indicating difficulties in breeding both for high CP content and high general nutritional value.

Table 2. Correlations among seed nutrient traits studied (P<0.05)

	DM	Ash	Fat	CF	CP	NFEs
DM	1.00	-0.46	-0.12	0.01	0.07	0.44
Ash		1.00	-0.17	-0.01	0.16	-0.49
Fat			1.00	0.48	-0.85	0.66
CF				1.00	-0.44	0.25
CP					1.00	-0.84
NFEs						1.00

Regarding straw nutritional traits studied, a strong positive correlation was observed between NDF and ADF content (r=0.98, P<0.05) as well as between CF with NDF and ADF (r=0.81, P<0.05 and r=0.88, P<0.05, respectively). High negative correlations were defined between CF and NFEs (r=-0.69 P<0.05) and ash content with NDF (r=-0.65 P<0.05) (Table 3). Therefore, our results indicate that, since ADF values have a proven negative correlation with ruminant digestion (Van Soest, 1991) and lower values of ADF are preferable for the animal production, a selection for a lower ADF, NDF and total CF straw content, like in accessions ERV35 and ERV53 is possible due to their strong positive correlations. Moreover, a selection for low CF content could lead to an increased NFE content (r=-0.69, P<0.05), however the correlations among other nutritive value traits were moderate or weak.

Table 3. Correlations among straw nutrient traits studied (P<0.05)

	DM	CP	Ash	CF	NDF	ADF	NFEs
DM	1.00	-0.32	-0.23	0.66	0.63	0.65	-0.17
CP		1.00	0.28	-0.21	-0.41	-0.39	-0.38
Ash			1.00	-0.53	-0.65	-0.58	0.11
CF				1.00	0.81	0.88	-0.69
NDF					1.00	0.98	-0.33
ADF						1.00	-0.40
NFEs							1.00

IV – Conclusions

The seeds and straw of the Greek bitter vetch local populations studied revealed on average a nutritional value, similar to that of collections studied elsewhere. However, local populations of interesting performance that were identified need further study regarding the appropriate feeding regimes and the necessary processing techniques in order to be implemented in animal feeding diets. Moreover, selection for preferable nutritional traits of bitter vetch, like CP in seeds, low CF in parallel to high NFE content in straw, could be feasible.

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