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MEDITERRANEAN CULTURE OF CARDOON, *CYNARA CARDUNCULUS* L.: ELEMENTARY COMPOSITION AND BIOLOGICAL FUNCTION

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RESUMEN

SAN EMETERIO, L.; LÓPEZ, M. L. & CAVERO, R. Y. (2000). Cultivo mediterráneo de cardo, *Cynara cardunculus* L.: composición elemental y función biológica. *Publ. Bio. Univ. Navarra, Ser. Bot.,* 13: 43-49.

El estudio de la concentración de 18 elementos químicos a lo largo de 6 estadíos del ciclo agrícola del cardo, *Cynara cardunculus* L., muestra que son las semillas el estadío más contrastado de todo el ciclo de la planta, es decir, el estadío que más elementos presenta en concentraciones máximas o mínimas. Si se comparan estos resultados con los obtenidos en las semillas de *Capsicum annuum* L. (pimiento) y en las zuecas de *Cynara scolymus* L. (alcachofa), se obtienen resultados similares, y que, además, contrastan con la diferentes concentraciones elementales del resto de los estadíos de las tres plantas comparadas. Esta evidencia permite concluir que la influencia unificadora de la función multiplicativa y diseminadora, sea sexual o vegetativa, es más fuerte que la diversidad biológica encontrada en los estadíos vegetativos.

Palabras clave: Cardo, Pimiento, Alcachofa, Semillas, Composición elemental.

SUMMARY

SAN EMETERIO, L.; LÓPEZ, M. L. & CAVERO, R. Y. (2000). Mediterranean culture of cardoon, *Cynara cardunculus* L.: elementary composition and biological function. *Publ. Bio. Univ. Navarra, Ser. Bot.,* 13: 43-49.

Multielementary studies applied to a mediterranean edible plant, *Cynara cardunculus* L., along 6 different stages of its agricultural cycle, show that seeds are the most contrasted stage of development -that is, the stage in which higher number of elements are at their highest or their lowest concentration values of all its biological cycle-. Similar results have been found in bibliography for seeds of *Capsicum annuum* L. -pepper- and for the vegetative multiplication units, "zuecas", of *Cynara scolymus* L. -artichoke-. Instead, big dissimilarities have been found in the elementary composition of vegetative growth stages. Thus, the influence of the multiplying and dispersing function, either sexual or vegetative, is stronger than the biological diversity found in the vegetative growth stages.

Key words: Cardoon, Pepper, Artichoke, Seed, Elementary Composition.

INTRODUCTION

Going on with the multielemental analysis on horticultural products of interest for Navarra (CAVERO *et al*., 1992, 1993a, 1993b, 1997, 2000; CAVERO y LÓPEZ, 1993; MARCO, 1999; MARCO *et al*., 1997 y 1998; SAN EMETERIO *et al*., 1998), in the present work, we go depply into the study of the concentrational peculiarities of the seed stage on Cardoon and we compare it with similar stages of other horticultural cultures.

Cynara cardunculus has been sampled along six different and succesive stages of its agricultural cycle, and then submitted to elementary analysis techniques (SAN EMETERIO, *et. al.*, 1998). Previous studies in Pepper (CAVERO & LÓPEZ, 1993) and Artichoke (MARCO *et al.*, 1997) have shown that the multiplying-disseminating stage, both natural -Pepper seeds- or artificially prepared by man -artichoke cuttings "zuecas"-, is the stage with the biggest number of elements in their highest or lowest concentration values. Such "compositional plant behaviour" has been compared among the three cultures, looking for possible coincidences.

MATERIAL AND METHODS

Entire Cardoon plants were sampled from normal land cultures carried out in two villages of Navarra County, Cadreita and Peralta, along six different developmental stages of its agricultural cycle: seeds -A-, seedlings -B-, young rooted plants -C-, vegetative plants -D-, big field plants before tiing -E-, and mature field plants before harvesting -F-. Details of plant sampling dates and kinds of

manipulations are indicated in SAN EMETERIO *et al*., 1998. Plant samples were submitted to Kjeldahl (N), Colorimetry (P), AAS (Mg, Fe, y Cu), INAA (Na, Cl, K, Ca, Sc, Mn, Co, Zn, Br, Rb, W y Au) and AES/ICP (B): 18 elements as a whole. Statistical analysis by bifactor ANOVA without repetition -first factor, stages; second factor, localities-, as well as Orthogonal Contrast Tests, resulted in significant concentration variations according to the stages and were useful to discover the highest and the lowest concentration stages for each element.

Our results with Cardoon were compared with similar stages in Pepper (CAVERO & LÓPEZ, 1993) and Artichoke (MARCO *et al*., 1997). For Pepper, seed -A and H-, seedling -B-, young rooted plant -C-, initial flowering plant -D-, fully flowering plant -E-, initial fruiting plant -F- and fully fruiting plant -G-had been sampled. For artichoke, cutting -"zuecas", A and G-, young rooted plant -B-, first-sprouting plant -C-, rosete stage plant -D-, second-sprouting plant -E-, and fully yielding plant -F-, had been sampled. Examples of the evolution in elementary concentrations along different stages of the agricultural cycle of the three cultures are given in Figures 1, 2, 3 & 4, in which the highest and lowest elementary concentrations can be observed. Elementary composition results of both Pepper and Artichoke were statistically analysed in the same way as those of Cardoon. Comparations have been carried out among the following stages: first, the multiplying-disseminating stage of Cardoon and Pepper -seeds- and Artichoke -cuttings-; and second, vegetative stages of Cardoon and Pepper -seedlings and young rooted plants-, if we need strict comparisons, or stages two to four of the three cultures, if we try looser comparisons.

Fig. 1: Cl evolution along artichoke agricultural cycle

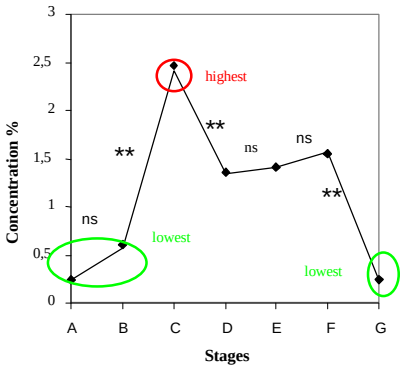


Fig. 2: Cl evolution along cardoon agricultural cycle

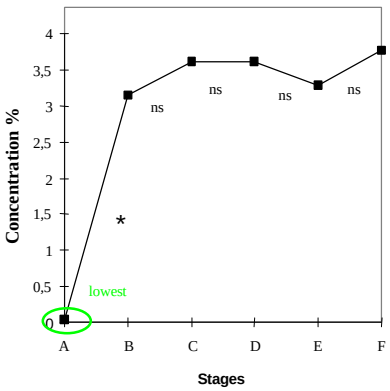


Fig. 3: B evolution along pepper agricultural cycle

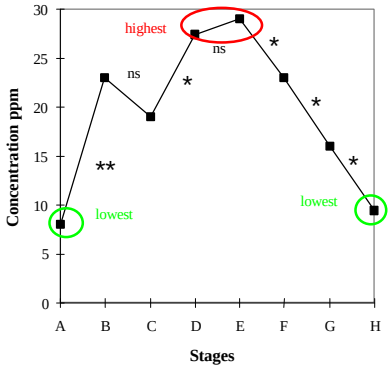
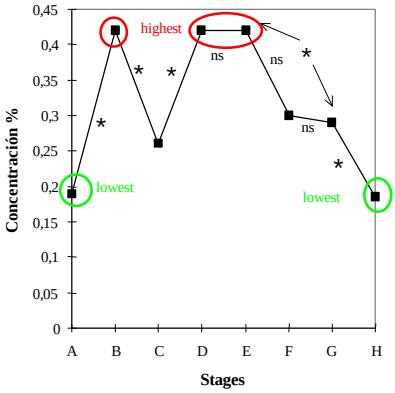


Fig. 4: Mg evolution along pepper agricultural cycle



Leyend: ns, not significant, p>0,05; *, significant, p=0,05; **, very significant, p=0,01

RESULTS AND DISCUSSION

Statistically significant results for the highest and lowest concentrations of each of the 18 elements, in each of their considered agricultural stages, are shown in Table 1, 2, and 3 for Cardoon, Pepper and Artichoke, respectively.

Table 1: Extreme concentrations of elements in each of the agricultural stages of Cardoon.

Conc.	A	B	C	D	E	F
Lowest	B, Cl, K, Ca, Sc	N, Ca, Mn, Zn				N
Highest	P, Zn, N		N, Ca, Mn, Zn			
Total	8	4	4	0	0	1

Leyend: A, Seed; B, Seedling; C, Young rooted plant; D, Vegetative plant; E, Big field plant before tiing; F, Mature field plant.

Table 2: Extreme concentrations of elements in each of the agricultural stages of Pepper.

Conc.	A, H	B	C	D	E	F	G
Lowest	B, Na, Mg, Cl, K, Ca, Sc, Mn, Fe, Br, Rb		N, P, Au				
Highest	P, Au	Na, Mg, Cl, K	Na, Sc, Fe, Rb	B, N, Mg	B, N, Mg		
Total	13	4	7	3	3	0	0

Leyend: A, H, Seed; B, Seedling; C, Young rooted plant; D, Initial flowering plant; E, Fully flowering plant;F, Initial fruiting plant; G, Fully fruiting plant.

Table 3: Extreme concentrations of elements in each of the agricultural stages of Artichoke

Conc	A, G	B	C	D	E	F
Lowest	B, N, Na, P, Cl, K, Ca, Mn, Fe, Br, Rb, W	B, P, Cl, K, Br			Sc	Sc, Mn, Fe, W
Highest	Cu	Sc, Fe, Cu, Rb	B, N, Cl, K, Br	W	Br	Br
Total	13	9	5	1	2	5

Leyend: A, G, Cutting "zuecas"; B, Young rooted plant; C, First-sprouting plant; D, Rosete stage plant; E, Second-sprouting Plant; F, Fully yielding plant

If we compare the number of elements which show their highest or lowest concentrations in each of the agricultural stages of the three considered cultures we notice that the multiplying-disseminating stage, both natural seeds or man made cuttings, is the most contrasted stage, that is, the stage with the highest number of elements in extreme concentration -8, 13 and 13 elements, respectively-. Moreover, many of those elements coincided in the three species: B, Cl, K and Ca show minimal concentration in the three cultures; Sc, minimal concentration in Pepper and Cardoon; Na, Mn and Rb minimal concentration in Artichoke and Pepper; and, finally P, the highest concentration in Pepper and Cardoon. It can be concluded that

the elementary concentrational behaviour of the multiplying-disseminating stage is rather similar for the three species.

Regarding the vegetative stages, great divergences appear among the compositional elementary behaviour of the three cultures.

CONCLUSION

The strong differences found in the compositional elementary behaviour between the multiplying-disseminating stage and the vegetative stages of the three analysed cultures, Cardoon, Pepper and Artichoke, allow the following statements: The multiplying-disseminating stage unifies the elementary composition of the three species, meanwhile the elementary composition of the vegetative stages reflects the biological diversity of the three species.

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