

GENETIC EROSION QUANTIFICATION IN ULLUCUS (*Ullucus tuberosus* Caldas), OCA (*Oxalis tuberosa* Mol.) AND MASHUA (*Tropaeolum tuberosum* R.&P.) IN AGROECOSYSTEMS OF THE PROVINCES OF CAÑAR, CHIMBORAZO AND TUNGURAHUA – ECUADOR

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An alarming loss of genetic variability of three Andean tubers (*Ullucus tuberosus*, ullucus; *Oxalis tuberosa*, oca; and, *Tropaeolum tuberosum*, mashua) has been observed during the last decades due to many factors such as the introduction of new varieties, droughts, changes in food habits, encroaching agriculture, deforestation and the migration from rural to urban areas. Thus, a pilot study was carried out to determine levels and rates of genetic erosion in these Andean crops by means of both morphological and molecular characterisations of these species, as well as a socioeconomical survey in highland communities from the provinces of Cañar, Chimborazo and Tungurahua (Ecuador).

The present study included a field and laboratory stage. For the field stage, tubers from the three species were collected and identified with the code *CEG* (=cuantificación erosión genética). The resulting germplasm was comparatively analysed with *ex situ* conserved accessions (coded *ECU*) since 1978 by the National Department of Plant Genetic Resources and Biotechnology (DENAREF, the national germplasm bank); to this purpose, the descriptors tuber main colour, secondary colour and tuber shape were recorded. All available information included in the *ECUCOL* passport database and the *Catalogue of Genetic Resources of Andean Root and Tuber Crops* (Tapia *et al.*, 1996) was also used. Furthermore, information of a total of 64 socio-economical questionnaires (30 in Cañar, 24 in Chimborazo and 10 in Tungurahua) was compiled and analysed so as to confirm (or reject) the occurrence of genetic erosion in the three tuberous species.

For statistical analysis of the socio-economic survey four parameters were taken into account: farmers no longer cultivating the species, reasons for abandoning the crop, morphotypes no longer cultivated and morphotypes that have been recently lost at the collecting localities compared with those described in the *ECUCOL* passport database.

Ullucus showed an average loss of variability of 37,6%. Regarding provinces, Cañar exhibited the highest level of genetic erosion with an average value of 45,5%. Oca accounted an average of 33,3%, being Tungurahua the province reaching the highest level of erosion (47,7%). An average value of 46,5% loss of variability was determined for mashua, with Cañar as the province revealing the highest percentage (61,1%).

The laboratory stage used the RAPD technique (Randomly Amplified Polymorphic DNA) to compare *ECU* and *CEG* accessions on the basis of molecular polymorphisms

revealing genetic relationships between *on-farm* conserved materials and *ex situ* accessions from the germplasm bank. DNAs from the three species under study were amplified with primers of arbitrary sequence; of these, seven, 10 and 12 primers rendered polymorphic products for ullucus, oca and mashua, respectively. All DNA amplifications generated consistently a larger number of RAPD polymorphic fragments in the *CEG* accessions (compared to *ECU* materials) of the three species. Therefore, new RAPD alleles have been generated in the genomes under study (possibly due to nucleotide substitution, deletions, insertions, inversions, etc.) in the period of time elapsed between the original collecting and the one carried for this study (~20 years), discarding the occurrence of partial mismatching and PCR artifacts such as “ghost” bands.

The binary matrices obtained after molecular survey of the three species were phenetically analysed using both Neighbour-Joining (NJ) and UPGMA techniques with Jaccard's coefficient. In addition, a phylogenetic approach (parsimony) was used, taking into account time elapsed. These three methodologies rendered dendrograms which classified *ECU* and *CEG* accessions of each crop as closely related, “semi”- related or distant genetically.

For final interpretation of the laboratory data, attention was focused on the results and dendrograms generated by the NJ technique since it considers analysis of genetic relatedness with different mutation rates along the plant genome (time elapsed). In this framework, ullucus showed seven accessions (i.e. morphotypes) which have undergone genetic erosion (25%, out of a total of 28 *ECU* materials), seven accessions with no genetic erosion occurrence and 14 accessions which have undergone germplasm flow (i.e. man-made dispersal from one community to another). Oca showed 11 accessions which have undergone erosion (45,8% out of a total of 24 *ECU* accessions) and 13 accessions with germplasm flow. Mashua exhibited 10 cases of genetic erosion (43,4% out of 24 accessions studied), whereas two accessions displayed no erosion and two cases were recorded as germplasm flow.

In terms of species, mashua reached the highest levels of genetic erosion: 45% average value for both field and laboratory stages. On the other hand, Cañar is the province with the highest loss of variability for the three species with an average of 46,4% taking into account data from the socio-economical survey, morphological characterisation and the *ECUCOL* data base.

Finally, detection of a larger number of RAPD fragments on all *on farm*- conserved materials (= *CEG* accessions) in comparison with *ex situ* materials (= *ECU* accessions) confirms the nature of *in situ* conservation, i. e. a complementary methodology to *ex situ* techniques which allows continuation of evolutionary processes, natural and man-made selection, thus creating and enhancing genetic diversity in agroecosystems.