5.12 Morphological and genetic characterization of traditional globe artichoke varieties from Northern Italy: a tool for germplasm identification and conservation

Giacomelli A. [1], Lopez Miceli M.A. [1], Ferrari F. [1], Rossi G. [1], Franzoni G. [1], Sonnante G. [2], Landoni M. [1]

[1]Department of Earth and Environmental Sciences (DSTA), University of Pavia, 27100 Pavia, Italy;

[2]National Research Council (CNR) - Institute of Biosciences and Bioresources - 70126 Bari

BACKGROUND

Globe artichoke (*Cynara cardunculus var. scolymus*) is an herbacius perennial plant cultivated for its edible immature flower head (capitulum), a key ingredient in the Mediterranean cusine. Numerous different varieties have evolved and have been maintained locally across Italy. During the establishment of a field collection of Northern Italian accessions, several accessions from different geographical origins showed remarkable morphological similarity, suggesting possible duplication or synonymy. To achieve an unambiguous identification of the collected germplasm, 34 accessions were characterized using UPOV morphological descriptors and simple sequence repeat (SSR) markers. The combined morphological and molecular approach enabled the reliable identification of traditional varieties, providing a robust basis for germplasm conservation, field collection management, and the preservation of local agro-biodiversity.

RESULTS

Morphological characterisation was carried out using the 18 UPOV (International Union for the Protection of New Varieties of Plants) descriptors for the characterisation of the artichoke flower head (TG/184/4 Rev.) (Figure 1, Figure 2 and Table 2).

Based on morphological characterisation, the 34 accessions analysed were divided into four groups (Table 3 and Figure 3). This grouping was retained in the presentation of the PCA and clustering analyses of the morphological data (Figures 4 and 5) and the PCoA analysis of the molecular data (Figure 6).

PCA analysis of morphological data showed a clear separation of spiny artichoke, group 2, from the other accessions (groups 1, 3 and 4) that appear to be quite distinct, but are more widespread than group 2 (Figure 4).

The cluster analysis confirms the clear separation of the spiny artichoke group from the others, whilst also showing that the other morphological groups are fairly well defined (figure 5).

Genetic analysis based on 20 SSR markers showed the clear separation of the green group (group 1) of artichokes from the other accessions, while the spiny group appeared more diffused. The most distantly related accessions, 31 and 42, correspond respectively to a cardoon and an artichoke propagated from seed, whilst accession 14 – which is very close to two purple artichoke accessions – is a purple spiny artichoke, as are accessions 18 and, to some extent, 10, which are close to the Purple accession 29 (Figure 6).

ID	Variety name	Place of origin
1	Carciofo di Monbercelli	Mombercelli (AT)
2	Carciofo di Rovescala viola inerme	Rovescala (PV)
3	Carciofo di Rovescala verde inerme	Rovescala (PV)
5	Carciofo di Rovescala viola spinoso	Rovescala (PV)
7	Carciofo di Mondondone	Mondondone (PV)
8	Carciofo di Codevilla	Codevilla (PV)
9	Carciofo di Malegno	Malegno (BS)
10	Carciofo Violetto San Luca	Bologna (BO)
11	Carciofo Moretto di Brisighella	Ravenna (RA)
12	Carciofo globoso Oliva Gessi	Oliva Gessi (PV)
13	Carciofo spinoso Oliva Gessi	Oliva Gessi (PV)
14	Carciofo di Parma (Val Stirone)	Salsomaggiore (PR)
17	Carciofo di Montalto Pavese	Montalto Pavese (PV)
18	Carciofo Violetto di Sant'Erasmo	Venezia (VE)
19	Carciofo di Codevilla	Codevilla (PV))
20	Carciofo di Mornico Losana	Mornico Losana (PV)
22	Carciofo di Mongardino	Mongardino (AT)
23	Carciofo inerme di Santa Sofia	Santa Sofia (FC)
25	Commerciale Romanesco	-
26	Commerciale Violetto	-
27	Carciofo spinoso	La Spezia (SP)
29	Carciofo inerme	S. Giulia Lavagna (GE)
31	Cardo gigante di Romagna	-
33	Carciofo inerme	Costigliole d'Asti (AT)
34	Carciofo spinoso di Albenga (varietà tradizionale, di famiglia)	Albenga (SV)
35	Spinoso sardo (commerciale)	Albenga (SV)
36	Carciofo spinoso di Albenga	Ortovero (SV)
41	Carciofo di Perinaldo violetto, globoso, inerme	Perinaldo (IM)
42	Carciofo di Perinaldo inerme (da seme)	Perinaldo (IM)
43	Carciofo spinoso	Glorie di Mezzano (RA)
44	Carciofo violetto spinoso	Fusignano (RA)
46	Carciofo violetto inerme	Alfonsine (RA)
47	Carciofo violetto inerme	Alfonsine, Fiumazzo (RA)
48	Carciofo violetto spinoso	Mezzano (RA)

Table 1. List of the 34 artichoke accessions analysed.

No.	Descriptors
20	Central flower head: Length
21	Central flower head: Diameter
22	Central flower head: Shape in longitudinal section
23	Central flower head: Shape of apex
24	Central flower head: Anthocyanin coloration of inner bracts
25	Central flower head: Density of inner bracts
26	Receptacle: Diameter
27	Receptacle: Thickness
28	Receptacle: Shape in longitudinal section
30	Central flower head: Time of beginning of opening
31	Outer bract: Violet color on external side
32	Outer bract: Apex shape
33	Outer bract : Depth of emargination
34	Outer bract : Reflexing of tip
35	Outer bract: Length of spine
36	Outer bract: Mucron
37	Outer bract: Shape
38	Outer bract: Length of base

Table 2. List of the 18 morphological traits relating to the flower head, as set out in the specific UPOV data sheet for artichokes, used to characterise the 34 accessions under study.

Group	Diagnostic description
I - green	Green artichokes with compact heads, predominantly emarginate outer bract apices, absent or very short spines, and mainly ovate heads in longitudinal section.
II - spiny	Spiny artichokes characterized by predominantly acute outer bract apices, medium to long spines, and mostly ovate to oblong heads in longitudinal section.
III - purple	Purple artichokes with compact, rounded heads, predominantly emarginate outer bract apices, and absent or very short spines.
IV -miscellaneus	Intermediate and morphologically heterogeneous materials, including cardoon-like accessions, showing variable outer bract morphology and intermediate head shape.

Table 3. morphological criteria for classifying the 34 accessions into 4 distinct groups.

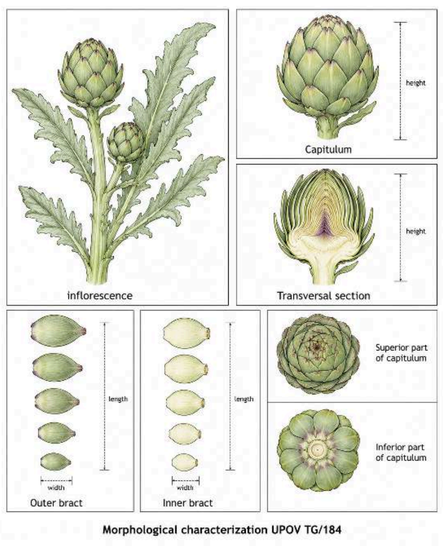


Figure 1. Drawing illustrating some the flower head traits analysed for the characterisation of the 34 artichoke accessions.

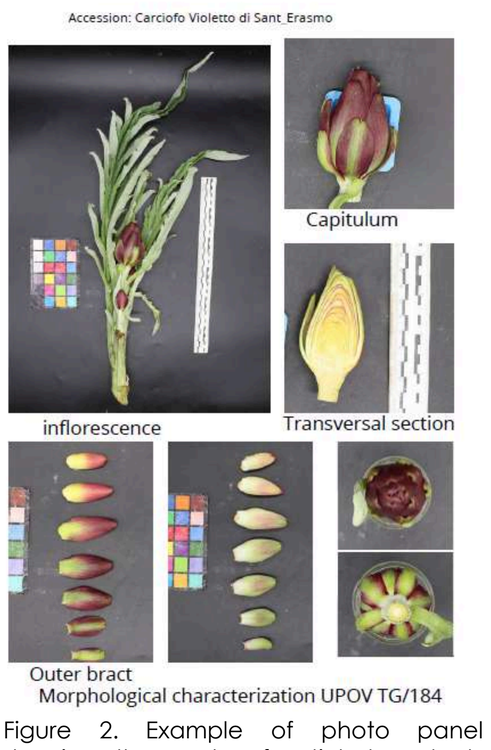


Figure 2. Example of photo panel showing the parts of artichoke plants used for the morphological classification of the 34 accessions.



Figure 3. Representation of the 34 accessions divided into 4 groups based on the descriptive traits of the flower head, according to the UPOV data sheet.

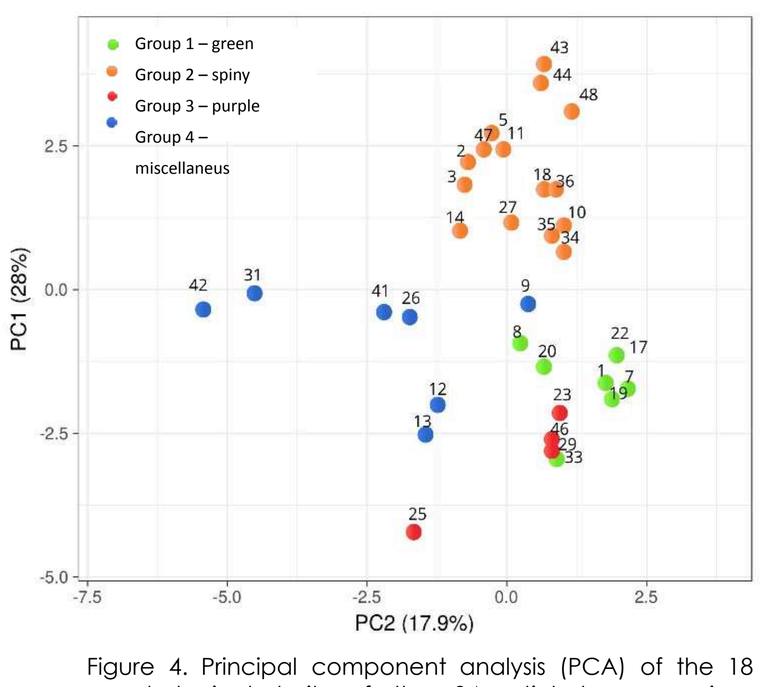


Figure 4. Principal component analysis (PCA) of the 18 morphological traits of the 34 artichoke accessions performed using ClustVis software. Prior to analysis, data were centered and unit variance scaled. The score plot shows the distribution of accessions according to the first two principal components.

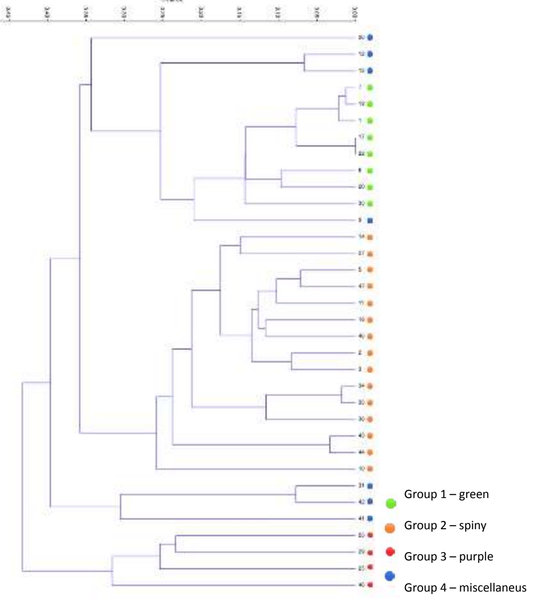


Figure 5. Hierarchical cluster analysis of the 18 morphological traits of the 34 artichoke accessions generated using ClustVis software. Clustering was based on Euclidean distances calculated from unit variance-scaled data using the complete linkage algorithm.

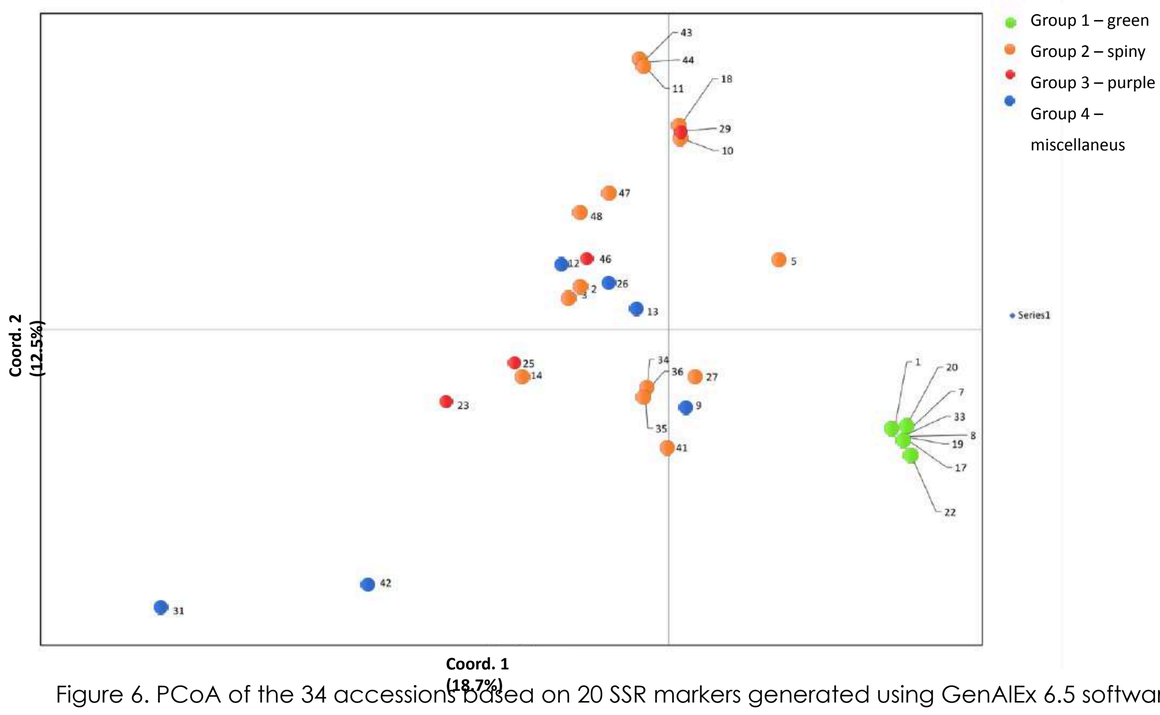


Figure 6. PCoA of the 34 accessions based on 20 SSR markers generated using GenAlEx 6.5 software.

SUMMARY AND PROSPECTS

The comparison between morphological and molecular analyses highlights the importance of integrating both approaches when characterizing traditional germplasm. Morphological descriptors are essential for identifying traits of agronomic and commercial interest, whereas SSR markers provide a more robust assessment of genetic diversity and relatedness. The combined use of these complementary datasets improves the identification of duplicate accessions, supports the recognition of genetically distinct landraces deserving priority for conservation, and provides valuable information for the selection of parental material in future breeding programs. The groups that appear quite similar in the genetic analysis will undergone a deeper analysis based on WGS to disambiguate the accessions.

FUNDING

This research was funded by «PSR 2023-2027 Regione Lombardia, intervento SRA16- ACA16 - Conservazione agrobiodiversità - banche del germoplasma», project ARTICIOC (cARciofo TradIzionale e Cardo In lOmbardia Cercasi) (Prof. G. Rossi)