SELECTION OF IMPROVED CULTIVATED CARDOON GENOTYPES FOR SUSTAINABLE EXPLOITATION IN A BIOECONOMY CONTEXT

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INTRODUCTION

The transition away from a fossil-based society to the bioeconomy, based on the sustainable exploitation and on the efficient use of biological resources, plays an important role for a social, economic and ecological development. Replacing fossil resources for the production of energy, chemicals and materials with renewable and bio-based feedstocks is a major challenge for policy, research and industry. For this purpose, the sustainable exploitation of crops as renewable sources of raw materials for different industrial applications is profitable. The selection of appropriate low input crops that can be grown in marginal areas and in stressful conditions is required in order to avoid increased use of fertilizers and pesticides, negative impacts from land-use changes and additional pressure on water resources. Cultivated cardoon (*Cynara cardunculus* var. *altilis* DC.), native to Mediterranean basin areas, is a promising industrial crop very suitable for environmental conditions characterized by drought and soil salinity, and its sustainable agricultural management can reduce input and soil erosion. Cardoon, a perennial herbaceous plant with annual growth cycle, produces high quantity of biomass rich in several biomolecules and can be considered an ideal multi-purpose and versatile crop with a large variety of new and alternative applications. The selection of suitable genotypes and the setup of an appropriate cultivation protocol to an efficient exploitation of this crop are required. In order to develop an efficient and competitive biorefinery based on the exploitation of this crop, a plant breeding program for the development of improved cardoon genotypes is still necessary.

OBJECTIVES

Within the framework of COMETA (Autoctone Mediterranean Crops and Their Valorisation with Advanced Green Chemistry Technologies) project, research activities have been carried out by ENEA and Novamont in order to develop new cardoon genotypes characterized by high amounts of oleic acid in seeds and inulin in roots, suitable for the production of different bio-based products.

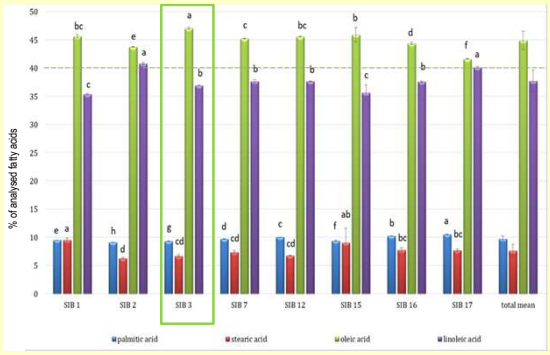
Plant material

Eight cardoon genotypes, selected from a screening of 56 initial genotypes and then obtained by several intercrosses among high oleic acid SIB progenies, were characterized on the basis of the seed fatty acid profile, the biomass production, and the inulin content of the roots.
Seeds were produced by manual pollination (May-June 2021) after immature inflorescences isolation with anti-aphid net cap. At the optimal stage of maturation (August 2021), seeds were harvested and threshed by CICORIA mod. Plot 2375. Root samples were collected during the spring (March 2022), before the emission of flower heads.

SEEDS FATTY ACIDS PROFILE

Methods

- Trans-esterification protocol: Phippen *et al*., 2006 (Doi:10.1016/j.indcrop.2006.02.001)
- Gas-cromatographic protocol: GC System 7890B (AGILENT Technologies) equipped with FID detector, autosampler and column Omegawax 250 – 30 m x 0,25 mm I.D. x 0,25 µm (SUPELCO). For identification and quantification of fatty acids, the F.A.M.E. Mix RM-2 (SUPELCO) was used; heptadecanoic acid (Merk) was used as external standard.



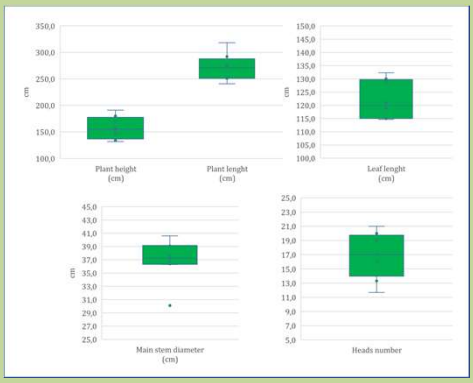
Results

- **Oleic acid > 40%** in all selected genotypes
- **SIB 3** showed the highest oleic acid concentration (**47.06 ± 0.19 %**)

BIOMASS PRODUCTION

Methods

Three similar plants of each genotype were selected and morphologically characterized before flowering by using some selected UPOV descriptors (CPVO-TP/184/2 Final - 27/02/2013, Protocol for tests on distinctness, uniformity and stability of *Cynara cardunculus* L.)



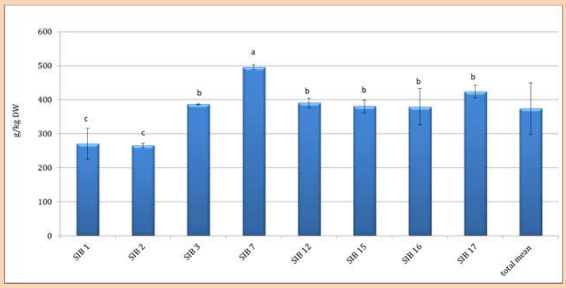
Results

- Plant height total mean: 158.1 ± 21.3 cm
- Plant length total mean: 271.5 ± 25.0 cm
- Leaf length total mean: 122.1 ± 7.4 cm
- Main stem diameter total mean: 37.0 ± 3.2 cm
- Heads number total mean: 16.9 ± 3.2
- **SIB 17** produced tall and broad plants with many heads

ROOTS INULIN CONTENT

Methods

- Inulin extraction protocol: Pandino *et al*., 2011 (Doi: 10.1007/s11130-011-0247-z)
- HPLC protocol: 1260 Infinity (Agilent Technologies) equipped with autosampler, quaternary pump, evaporative light scattering detector (ELSD), column Agilent Hi Plex Ca (30 x 0.77 cm; 9 µm) and precolumn with Carbo-Ca filter (4.0 x 3.0 mm) (Phenomenex).



Results

- Average inulin content: **374.1 ± 76.1 g/kg DW**
- **SIB 7** showed the highest inulin content (**495.95 ± 6.77 g/kg DW**)

CONCLUSIONS

✓ Based on the present knowledge, this is the first breeding program focused on cultivated cardoon in order to select genotypes with desirable chemical traits and high biomass production.

✓ New 8 cardoon genotypes were selected and characterized by oleic acid percentage (> 40%) higher than in common cultivated cardoon lines (about 25%) and by good inulin content in roots.

✓ Total biomass produced by these selected genotypes might be exploited to different biorefining applications in a bioeconomy context.

AKNOWLEGEMENTS
The authors would like to acknowledge financial support from the Ministry of Education, Universities and Research (MIUR) PON R&I 2014-2020 and FSC.