UNIMORE
UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

Management of national volcanic rock scraps in new engineering materials

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EUROPOMICE

Turnover approx. 11 million euros - approx. 200 m^3/year of raw materials and ready mixes

More than 70% of products are sold in green markets, nursery gardening, agriculture, green infrastructure

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Pumice quarry – Poggio Nardeci, Pitigliano (GR)

Lapillus quarry – Monte Cellere (VT)

Pumice Quarry – Spiniccio, Arlena di Castro (VT)

Pumice and Zeolite Quarry – Riserva Muraccio, Tessennano (VT)

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LAPILLUS

NURSERY GARDENING:

- **SUBSTRATE FOR ROOTS**
- **SOIL CONDITIONING**
- **MULCHING**

BUILDING INDUSTRY:

- **STRUCTURAL LIGHTWEIGHT CONCRETES**

PUMICE

NURSERY GARDENING:

- **ROOT DEVELOPMENT SUBSTRATES**
- **SOIL CONDITIONING**
- **WATER RETENTION**

BUILDING INDUSTRY:

- **LIGHTWEIGHT CONCRETES**

ZEOLITE

ORGANIC FARMING:

- **LEAF TREATMENTS**
- **SOIL CONDITIONING**

BIOFILTERING:

- **WASTEWATER PURIFICATION**

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SCRAPS PRODUCTION

PUMICE AND LAPILLUS PRODUCTION FOR NURSERY GARDENING MARKET **(APPROX. 70% OF SALES**) INVOLVES SCREENING OF GRAIN GREATER THAN 3-4 mm

GRAIN SIZE **LESS THAN 3-4 mm**, RESULTING FROM SCREENING:

- ✓ ACCOUNTS FOR **50 - 70 % OF PRODUCTION**
- ✓ **APPLICATION (**SUBSTRATES, CONSTRUCTION, CERAMICS, ROAD SUBGRADES, FERTILIZERS) ACCOUNT FOR ABOUT **15% OF THE AMOUNT PRODUCED**
- ✓ ALL UNSOLD IS RETURNED TO QUARRY FOR BACKFILLING AND RESTORATION
- ✓ **STORAGE** IN MINING AREA, NOT USED FOR RESTORATION, IS TO DATE GREATER THAN **350 km³**

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SCRAPS MANAGEMENT COSTS

FINE FRACTION REPRESENTS A COST (MORE THAN 1.00 €/m^3) BECAUSE:

a) USED AS QUARRY RESTORATION AND SUBJECT TO AN ADDITIONAL COST OF TRANSPORT FROM THE PLANT TO THE QUARRY;
b) PILED IN AREAS WITHIN THE QUARRY'S JURISDICTION (AUTHORISED AS A LANDFILL WITHIN THE QUARRY), AND THEN RESOLD FROM THESE AREAS, SUBJECT TO PAYMENT OF A REGIONAL TAX.

IN A CONTEXT OF CIRCULAR ECONOMY, IT IS STRATEGIC TO FIND NEW APPLICATIONS

https://microjournal.microingranaggi.it/cosa-succede-si-costretti-ad-aumentare-costo-un-prodotto/

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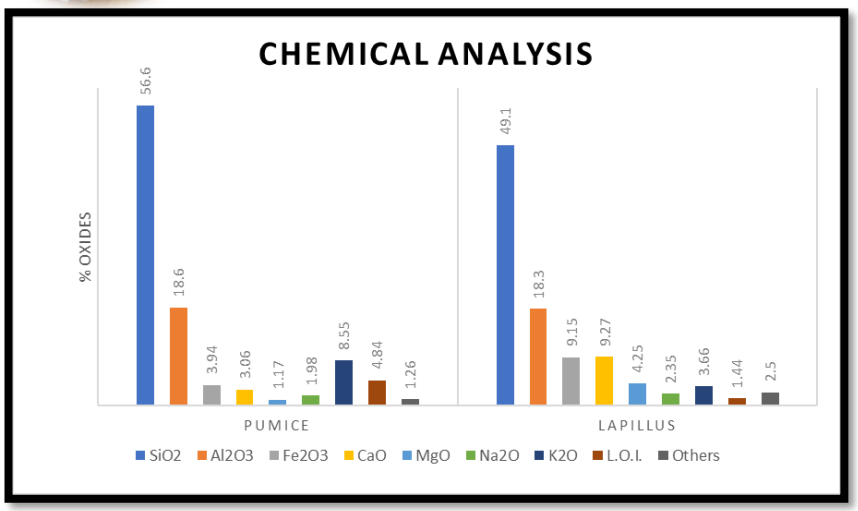
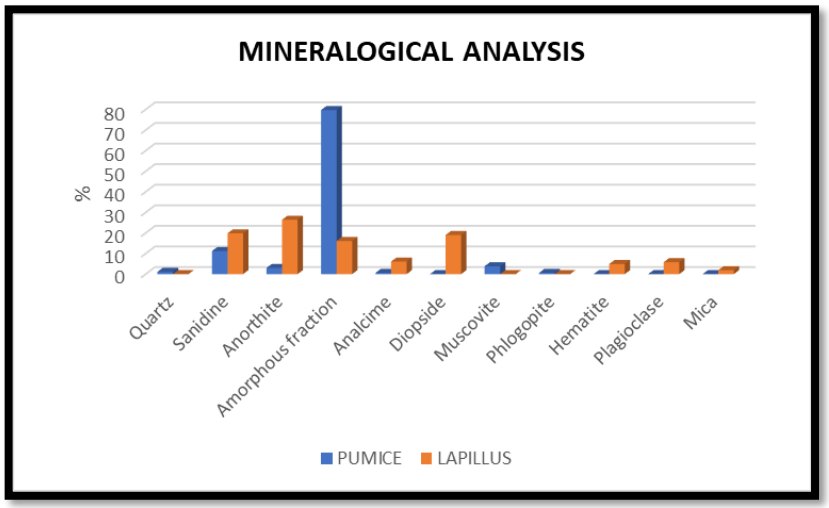
PUMICE

LAPILLUS





PUMICE:

- IT CONSISTS OF HIGHLY ALVEOLAR VOLCANIC GLASS
- IT HAS AN AMORPHOUS PHASE CONTAINING MAINLY SILICA AND ALUMINA

LAPILLUS:

- IT IS A STRONGLY DIMPLED MATERIAL
- THE MAGMA FROM WHICH IT DERIVES HAS A LOWER SILICA CONTENT AND IT IS THEREFORE LESS VISCOUS
- AS IT COOLS, SOME OF THE GASES ESCAPE AND LARGER CHANNELS ARE GENERATED THAN IN PUMICE

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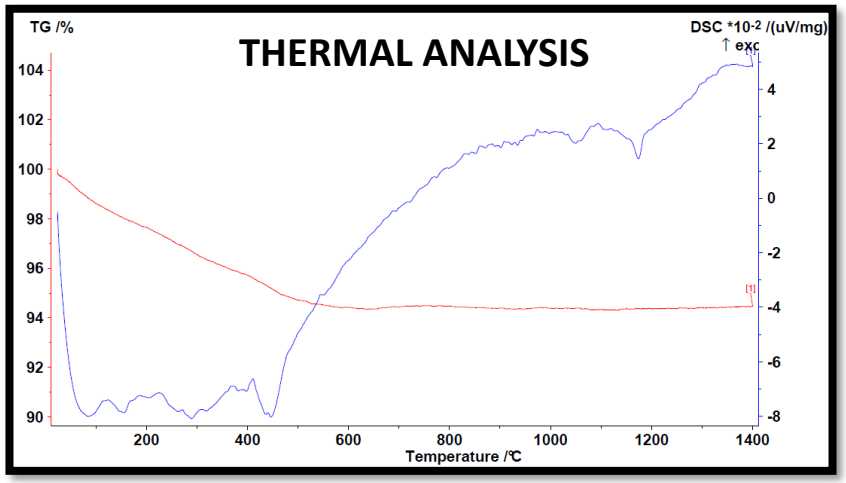
PUMICE

T up to 450°C → RETICULAR WATER LOSS

T between 600°C AND 1000°C → STABILITY DURING HEATING

T approx. 1200°C → FUSION OF THE CRYSTALLINE PHASES

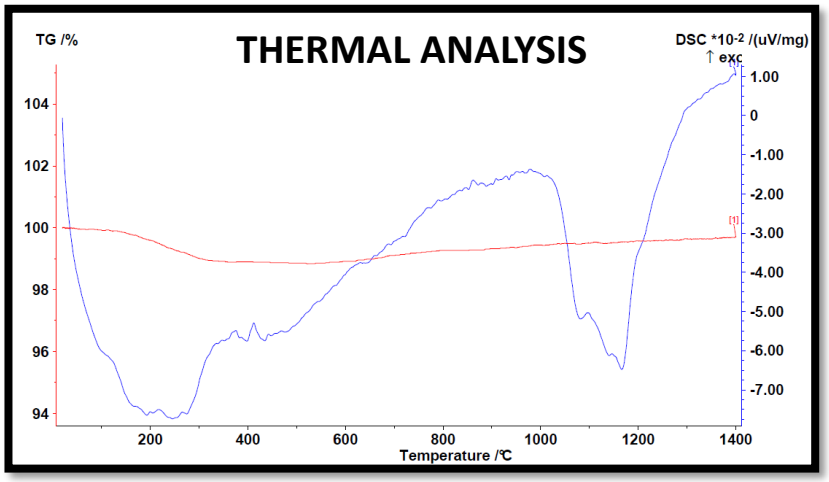


LAPILLUS

T up to 200°C → RETICULAR WATER LOSS

T between 500°C AND 1000°C → STABILITY DURING HEATING

T approx. 1200°C → FUSION OF THE CRYSTALLINE PHASES



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What are the possible solutions?

https://pixabay.com/it/illustrations/punto-interrogativo-domanda-risposta-1020165/

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TILES

SUBSTRATES

CONCRETE

MORTAR

GEOPOLYMERS

LIGHTWEIGHT AGGREGATES (LWAs)

https://www.inc.com/nir-eyal/what-do-you-do-when-someone-steals-your-amazing-idea.html

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TILES

STANDARD COMPOSITION:

- 40% KAOLINITE AND BALL CLAYS
- 45% FELDSPARS
- 15% QUARTZ

KAOLINITE AND BALL CLAYS MIX DESIGN:

- GERMAN BALL CLAYS
- **ITALIAN** KAOLINITE

STANDARD COMPOSITION:

- 40% KAOLINITE AND BALL CLAYS (refractory, plasticity)
- 45% FELDSPARS (fluxes)
- 15% QUARTZ (structural)

FELDSPARS MIX DESIGN:

- **ITALIAN** PUMICE or LAPILLUS **SCRAPS**
- **ITALIAN** FELDSPAR **SCRAPS**
- CHAMOTTE

STANDARD COMPOSITION:

- 40% KAOLINITE AND BALL CLAYS
- 45% FELDSPARS
- 15% QUARTZ

QUARTZ MIX DESIGN:

- **ITALIAN** QUARTZ SAND

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TILES

SCOPE: OBTAIN A NATURALLY COLORED SUPPORT

KEY PARAMETER COMPARISON

FLOW TIME: < 30''

- REFERENCE SAMPLE 20-30''
- PUMICE SAMPLE 20-30''
- LAPILLUS SAMPLE 15-20''

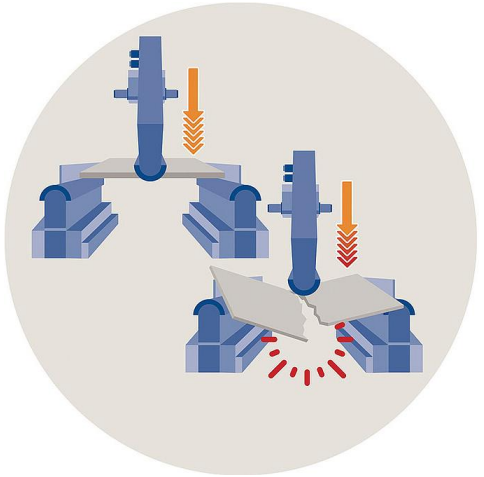
TENSILE STRENGTH (UNFIRED PIECE): > 35 MPa

- REFERENCE SAMPLE 35-50 MPa
- PUMICE SAMPLE 40-45 MPa
- LAPILLUS SAMPLE 38-43 MPa

TEST EN ISO 10545-3

ISO 13006
EN 14411

BIa GROUP



WATER ABSORPTION: < 0.5%

- REFERENCE SAMPLE 0-0.5%
- PUMICE SAMPLE 0-0.5%
- LAPILLUS SAMPLE 0-0.5%

LINEAR SHRINKAGE: 4.6-4.9%

- REFERENCE SAMPLE 4.6-4.9%
- PUMICE SAMPLE 4.8-5.0%
- LAPILLUS SAMPLE 4.2-4.5%

https://www.seedex.it/prodotto/picnometro/

https://www.zschimmer-schwarz-ceramco.it/zs-lab/lo-sapevi-che/09-resistenza-meccanica-delle-piastrelle-in-verde-e-in-essiccato

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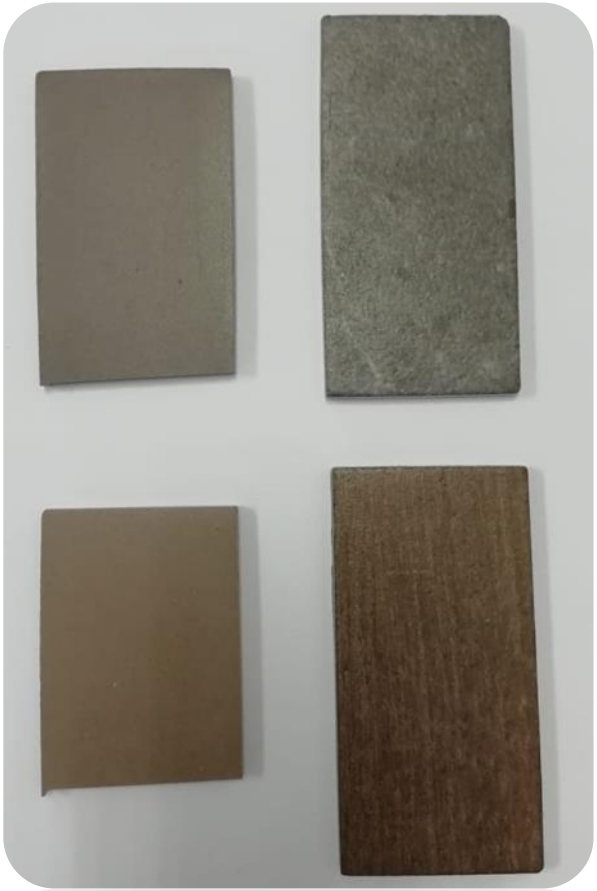
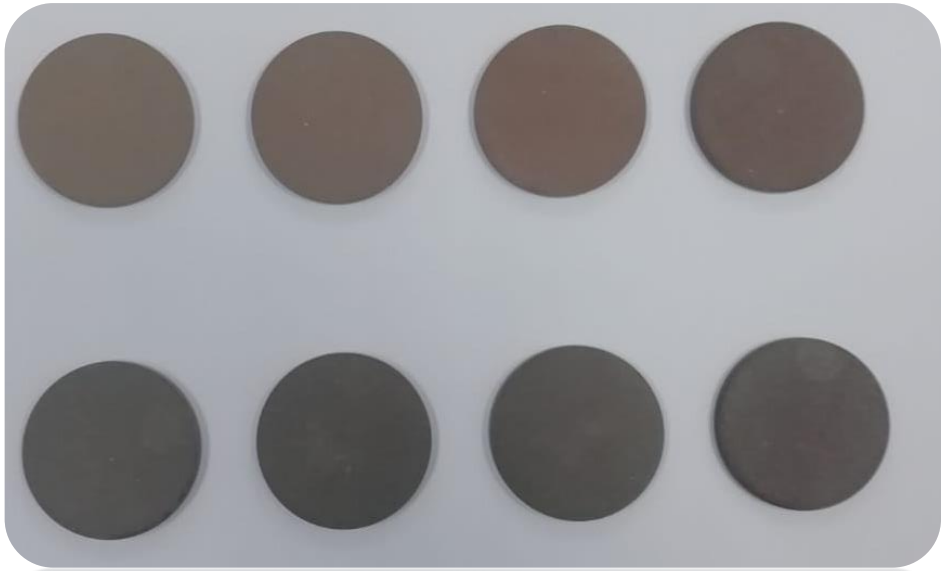
RESULTS

TILES





TILES

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CONCLUSIONS

- REDUCTION IN THE NUMBER OF RAW MATERIALS USED TO OBTAIN THE CERAMIC BODY
- INTRODUCTION OF 50% EXTRACTION SCRAPS INTO THE MIXTURE, 15-20% OF THE TOTAL AMOUNT ARE VOLCANIC SCRAPS
- OBTAINING PRODUCTS WITH SIMILAR CHARACTERISTICS OF COMMERCIAL ONES
- REDUCTION IN THE USE OF DYE PIGMENTS

https://www.simpaticotech.it/blog/Economia-circolare-la-quarta-rivoluzione-industriale_5.php

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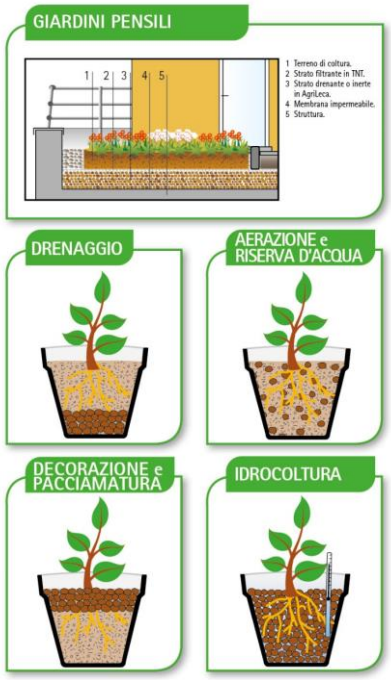
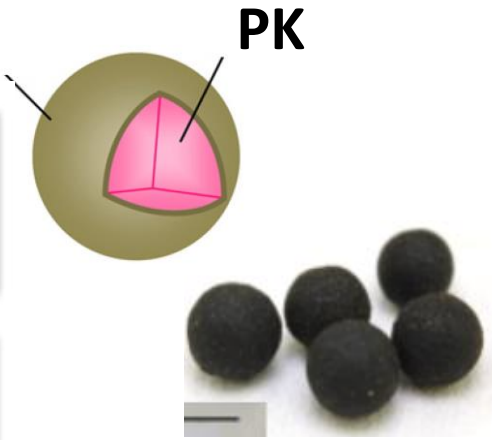
LIGHTWEIGHT AGGREGATES (LWAs)

Design of a new integrated fertilizer-growing box system through the synergistic application of innovative environmentally sustainable fertilizers based on reclaimed and slow-release nutrient raw materials, and LED lighting.





POROUS INORGANIC MATERIALS (PIMs)

CORE TAILORING

Red Clay and Pumice Scraps + Spent Coffee Grounds (SCG)

K_2CO_3 (K) + Animal Bone Flour Ash (P)

Pumice Scraps

Melting → Yes → Fertilizer Glass (FG)

No

Mixing and firing

Porous Inorganic Materials (PIMs)

APNUT: 85 wt% Red Clay/Pumice and 15 wt% SCG + no- vitrified nutrients

APV50: 85 wt% Red Clay/Pumice and 15 wt% SCG + vitrified nutrients

Shell

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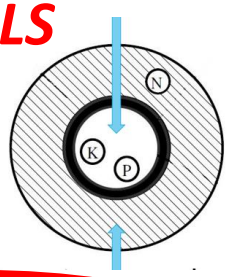
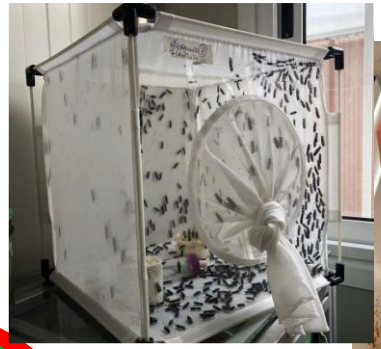
POROUS INORGANIC MATERIALS (PIMs)





SHELL TAILORING

AFTER FIRING

Degreased from biomass of prepupae of Black Soldier Flies (BSF) rich in chitin and N

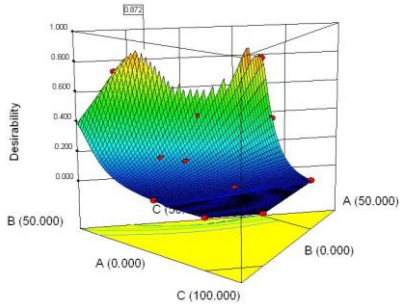
Water (solvent)

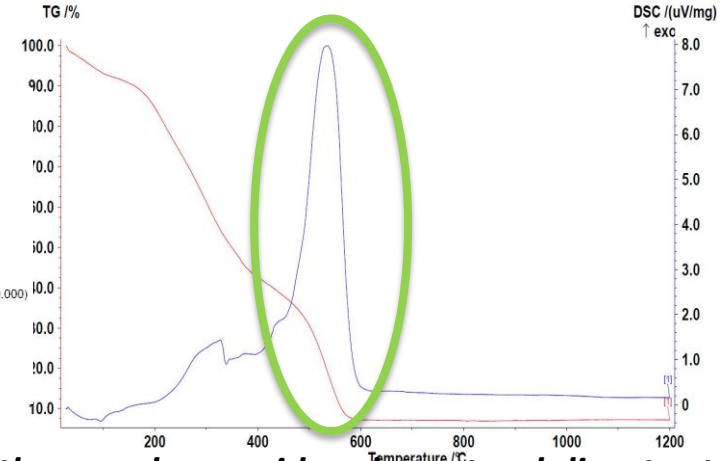
Glycerol (plasticizer)

Organic biomass Combustion at 550 °C

DSC and TG CURVES

PIMs with a core coating composition obtained through multivariate statistical regression (DoE)





Black soldier flies are not ubiquitous local raw wastes, however they can be considered a natural digestor to valorize organic, and agri-food wastes. Bioconversion through insects using manure or other types of organic waste/byproducts as a rearing substrate is a much more sustainable alternative to manage this waste and reduce GHG emissions.

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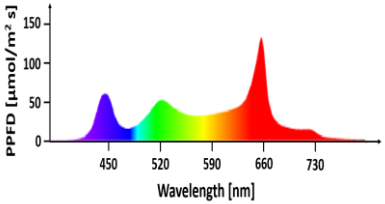
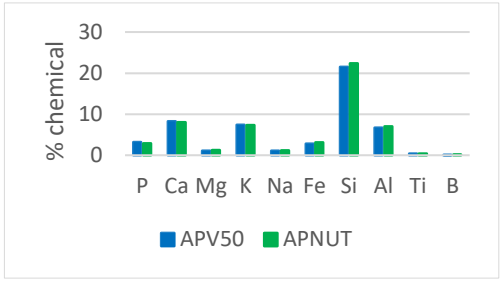
LWAs: PROJECT IN PICTURES

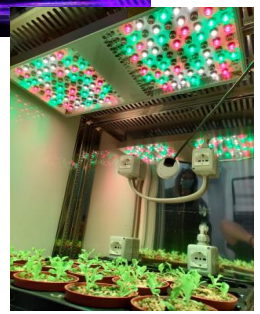


RAW MATERIALS

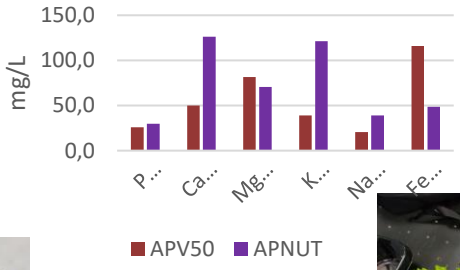
CHARACTERIZATION OF PROTOTYPES

Compositions	Bulk density (g/cm3)	Skeletal density (g/cm3)	Porosity (%)	pH	EC (dS/m)
APNUT	1.146	2.6497	56.14	7.38	0.220
APV50	1.260	2.6523	51.88	6.60	0.268





POROUS MATERIAL



Thank you for your attention!!!

EUROPOMICE

What you see depends on how you view the world.
To most people, this is just dirt.
To a farmer, it's potential.
Doe Zantamata

www.europomice.it

THANK TO THE INDUSTRIAL TECHNICAL PARTNER:
CERAMICHE CCV CASTELVETRO SPA
(Technical Direction: Ing. Pier Paolo Benassi)

Waste Management Europe

18 – 20 Aprile 2023
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Looking forward to meet you!!!

Venite a trovarci!!!

UNIVERSITAS STUDIORUM MUTINENSIS ET REGIENSIS 1175

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