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**STUDY ON THE USE OF QUALITY COMPOST
IN ORGANIC AGRICULTURE IN THE
REPUBLIC OF SAN MARINO
(second phase)**



SEGRETERIA DI STATO PER IL TERRITORIO,
L'AMBIENTE, L'AGRICOLTURA, LA PROTEZIONE
CIVILE E I RAPPORTI CON L'A.A.S.L.P.

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Introduction

- This work summarizes the results obtained in the entire territory of the Republic of San Marino on the management of organic waste from collection to use of the recovered good according to the basic principle of the circular economy.
- The door-to-door collection of the organic fraction and the fraction obtained from garden maintenance and the consequent treatment in a modular plant with a regular patent has made it possible to obtain a high quality fertilizer.
- In addition to improving the biodegradable waste collection service, the research envisaged the methods of use of the product obtained and the benefits this brings at an environmental level and in the improvement of agricultural production on some plants obtained with organic cultivation practices.
- The comparison between production obtained with the use of compost (mixed composted soil improver) and that without compost and a series of analyzes on the land and on the goods obtained, aided by a careful economic analysis, highlight the importance of a practice similar to the one here described for correct waste management.

Type of collection and treatment/production plant

- Door-to-door collection for individual users has been organized for all domestic users and for catering activities.
- To make collection easier, biodegradable bags were provided. The transport to the treatment plant was carried out with adequate means avoiding any dispersion during the journey.
- The canteen waste was then unloaded into a special box to be mixed in a suitable grinder-mixer with wood waste to allow a substrate with suitable C/N and humidity to be obtained.
- The substrate from the shredder was then discharged directly into the biocell for approximately 30 days.
- The biocell is equipped with a biofilter, ventilation system and mechanical and process monitoring and control system, including remotely
- At the end of the process the material was screened and sent directly to the place of use. During this period, analyzes were carried out in the waste and finished compost.

Collection of biodegradable waste and analytical quality checks



Treatment module and partial vision implantation in San Marino



Analysis on the benefits induced by the use of compost

- The research has highlighted the properties of the compost produced to maintain the fertility of the soil in optimal conditions and to ensure that certain plant species are cultivated without any addition of fertilizers and other chemical substances.
- Considering the second year of the experiment, a comparison was carried out between the data collected in 2022 with those of 2023.
- Analyzes were carried out on treated and untreated soil and on compost, on which its ecotoxicity was specifically assessed using biological tests.
- After the analytical checks, the preparation of the same soil used in 2022 followed and consequently the spreading of the soil.
- The quantity per m² to be distributed was determined on the basis of the chemical-physical characteristics of the soil and the nutritional requirements of the plant species used (vegetables).
- The calculation based on the law of minimum suggested adding 30 kg of compost per unit area. A normal manure spreader was used for distribution.

Field testes and results

- The research activity to be made more interesting after the planting of plant species having the so-called organic passport has ascertained through analytical procedures the possibility of using compost in organic farming.
- After detecting the vegetative phases of the vegetables, it performed chemical analyzes on the main active ingredients for the second year.
- Analyzes were carried out to determine the content of: vitamins, carotene compounds that make these foods effective for our health.
- To verify the effectiveness of the compost in this case too, the 2022 analyzes were compared with those of 2023.
- In addition to the analyzes on different vegetables, the research involved the analytical characterization of the soil with compost and without compost.
- In addition to the content of the main mineral macronutrients, those characteristics that define the fertility of a soil were particularly evaluated, namely; a) microbial activity b) water retention c) SAR value d) content in humic acids, fulvic acids.

Land preparation and planting



Results and discussion

- Two important considerations are at the basis of the results obtained with the experimentation carried out for the second year in San Marino regarding the correct management of the organic substance contained in domestic waste.
- The production of compost and above all its actual use has made it possible to improve the characteristics of the soil: better water retention capacity, increase in the microbiota activity of the soil, increase in organic substance and humified substances with consequent improvement in the structure of the soil.
- All these characteristics are highlighted through the comparison of soil analyzes with compost and without compost.
- As regards the benefits in agricultural production, in addition to an increase in the quantity of goods produced, the analyzes have highlighted, even if minimal, the increase in protein content at the expense of a decrease in fats
- The results on some active ingredients (vitamins, carotenes, and antioxidant substances) indicated in the certificates indicate very similar values for the two theses.
- The continuation of the activity will place greater attention on this at an analytical level

Analytical results

Soil and compost analysis 2023		Compost	No Compost
PARAMETER DESCRIPTION	U.M.	VALUE	VALUE
Fine Silt	%	40,00	71,70
Coarse Silt	%	37,10	12,90
Fine Sand	%	16,40	13,80
Coarse Sand	%	1,40	0,70
Clay	mg/kg	5,10	0,90
Total Limestone	%	21,00	25,00
Cation Exchange capacity	meq/100g	28,50	20,70
Assimilable Phosphorus	mg/kg	238,20	86,80
PH degree of realisation	U. pH	8,69	8,51
Electrical conductivity	µS/cm	230,20	260,00
Residue at 105°C	mg/kg	89,30	88,3
Skeleton between 2 cm and 2 mm	%	< 1	< 1
Humidity	%	10,70	11,7
Organic carbon	%	0,20	0,20
Ashes	mg/kg	86,70	84,90
Total nitrogen	mg/kg	4.190,00	4.010,00
Calcium	mg/kg	52.640,00	57.830,00
Iron	mg/kg	12.400,00	14.000,00
Magnesium	mg/kg	4.772,00	5.166,00
Manganese	UFC/g	410,00	460,00
Potassium	UFC/g	2.230,00	1.767,00
Copper	UFC/g	23,50	20,50
Sodium	UFC/g	1.457,00	940,80
Zinc	%	50,00	43,80
SAR (Sodio Asorbent ratio)	meq/100g	0,20	0,10
Yeast and hyphomycetes counter	UFC/g	1.900,00	4.900,00
Microbial load count	UFC/g	> 10 ⁵	1 x 10 ⁷
Aerobic bacteria count	UFC/g	2,3 x 10 ⁶	3,6 x 10 ⁵
Anaerobic bacteria count	UFC/g	9.800,00	5.200,00
Microaerofili count	UFC/g	3 x 10 ⁵	2,9 x 10 ⁵

Nutritional values per 100 g	LACTUGA S.		LYCOPERSICUM E.	
	NO Compost	Compost	NO Compost	Compost
Medium weight (g)	360,00	540,00	95,00	165,00
Production per square metre kg/m ²	2,10	4,10	5,90	9,50
Water content %	88,74	94,10	90,88	91,11
Energy (kJ/100g)	87,86	86,80	19,80	18,80
Carbohydrates (g/100g)	3,10	1,30	6,10	5,40
Sugars (g/100g)	0,90	0,76	4,20	4,50
Protein (g/100g)	1,79	2,37	1,10	1,29
Fat (g/100g)	0,39	0,23	0,05	0,04
Fiber (g)	2,70	2,20	3,60	3,80
Iron (mg/kg)	230,00	140,00	4,90	4,00
Calcium (mg/kg)	2.100,00	1.400,00	66,00	68,00
Sodium (mg/kg)	1,30	6,90	18,00	28,00
Potassium (mg/kg)	4.900,00	6.000,00	2.700,00	3.100,00
Phosphorus (mg/kg)	310,00	418,00	290,00	260,00
Magnesium (mg/kg)	370,00	330,00	130,00	130,00
Vitamin A (IU/kg)	< 2000	< 2000	< 1000	< 1000
Vitamin D (IU/kg)	< 2000	< 2000	< 2000	< 2000
Vitamin E, α - tocopherol (mg/kg)	13,60	9,00	< 1,00	1,20
Vitamin E (mg/kg)	12,40	8,20	1,48	1,50
Vitamin B1 (mg/kg)	0,05	0,05	0,04	0,04
Vitamin B2 (mg/kg)	0,18	0,21	0,18	0,18
Vitamin B3 (mg/kg)	0,70	0,78	0,62	0,59
Vitamin B6 (mg/kg)	n.r	n.r	n.r.	n.r.
Folate (µg/100g)	51,80	58,90	7,40	7,30
Vitamin C (mg/kg)	9,20	10,00	33,00	10,00
Vitamin B12 (µg)	n.r.	n.r	n.r.	n.r.

Nutritional values per 100 g	CHICORIUM I.		PHASEOLUS V.	
	NO Compost	Compost	NO Compost	Compost
Medium weight (g)	215,00	365,00	16,00	21,00
Production per square metre kg/m ²	2,80	3,40	0,42	0,75
Water content %	89,80	86,90	89,50	87,18
Energy (kJ/100g)	12,20	11,90	134,00	137,00
Carbohydrates (g/100g)	3,80	3,80	2,40	1,90
Sugars (g/100g)	2,10	2,10	1,60	2,15
Protein (g/100g)	2,15	3,06	2,10	2,18
Fat (g/100g)	0,40	0,40	0,20	0,21
Fiber (g)	2,80	3,60	2,90	7,20
Iron (mg/kg)	69,00	33,00	2,00	37,00
Calcium (mg/kg)	2.000,00	730,00	37,00	1200,00
Sodium (mg/kg)	69,00	82,00	6,00	17,00
Potassium (mg/kg)	9.800,00	7.900,00	211,00	4400,00
Phosphorus (mg/kg)	450,00	580,00	380,00	410,00
Magnesium (mg/kg)	1.600,00	910,00	250,00	350,00
Vitamin A (IU/kg)	< 2000	< 2000	< 1000	< 1000
Vitamin D (IU/kg)	< 2000	< 2000	< 2000	< 2000
Vitamin E, α - tocopherol (mg/kg)	n.r.	n.r.	2,50	2,70
Vitamin E (mg/kg)	n.r.	n.r.	14,40	14,90
Vitamin B1 (mg/kg)	n.r.	n.r.	0,08	0,10
Vitamin B2 (mg/kg)	n.r.	n.r.	0,11	0,12
Vitamin B3 (mg/kg)	n.r.	n.r.	0,75	0,75
Vitamin B6 (mg/kg)	n.r	n.r.	0,10	0,15
Folate (µg/100g)	154,00	111,00	37,00	49,80
Vitamin C (mg/kg)	n.r.	n.r.	12,10	12,80
Vitamin B12 (µg)	n.r.	n.r.	n.r	n.r.

Comparative theses between soil with compost and without compost



Conclusions

- The investigation represented, in addition to taking on a role at a scientific level, acquires an importance regarding the circular economy because it represents the closing of the circle between waste management and real recovery and natural insertion of recycled material.
- The correct treatment through composting of the organic fraction and the consequent use of the product produced to an economic and environmental advantage allows us to respect the concept of waste generation - service management - recovery - use - recycling of a natural good - improvement of production - protection of resources .
- On this basis, the Republic of San Marino, through the Secretariat of State for Territory and Environment, has promoted this research to demonstrate the importance of correct management of the organic fraction of waste which represents a considerable quantity in the entire territory of the Republic.
- Out of a population of 36,000 inhabitants and a waste production of 16,000 tonnes of which 40 - 45% is represented by the biodegradable fraction.