METHODS OF PROCESSING RESIDUAL AND BIODEGRADABLE WASTE IN TIMIS COUNTY THROUGH THE GHIZELA LANDFILL AND BIOCOMPOSTERS IN THE TERRITORY

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Abstract: *The aim of the research undertaken is rooted in scientific and practical research on the acquisition of knowledge on how to process residual and biodegradable waste in waste management and possible pressures on the quality of the environment. The importance of the topic is derived from the fact that the soil is required by man for more and more different uses and the quantities of residues that can be introduced into the economic circuit in the form of useful substances extracted, represent relatively small volumes in relation to the total volume of residues, having a share of less than 2%, but through various technological and organizational measures it is possible to reduce the area to be occupied with residues by 30%. Around 77,000 tonnes of residual waste enter the Ghizela landfill every year. This waste is composed of several types of waste such as: fruit and vegetable scraps, meat, bakery products, eggs, prepared food, coffee grounds, coffee filters, tea bags, toilet paper, wet tissues, paper and cardboard packaging impregnated with oil or other liquids, etc., but also plastic, glass, foil, metal packaging, etc. are accidentally found. The best way to recover organic waste of all kinds is composting, with the possibility that the material obtained can be used in agriculture. In view of these considerations, the paper presents the data accumulated through the topic "Research on the problems and management of biodegradable waste - their implications on soil quality in Timis County", carried out during the doctoral school, respectively 18.11.2015 and until the present, a series of elements related to the current situation of waste management in Timis County and to the ways of processing residual and biodegradable waste through the Ghizela landfill and through the 35468 bio-composters distributed to the rural population through the SIMD program.*

Keywords: *biodegradable, characteristics, compost, waste, space, values*

INTODUCTION

The use of land, with the ever-increasing population, has become increasingly complex, transforming it from an object of labour and a means of production in agriculture and forestry into a source of raw materials for manufacturing industry and the physical-geographical space for the location of all the objectives necessary for the development of human society.

Under these circumstances, the soil-human relationship is of particular significance for the development of world agriculture and forestry.

In addition to food, clothing and timber requirements, soils will be called upon for more and more different requirements. They will increasingly be used as sites for many different human activities, for various constructions (buildings, roads, water reservoirs, dams, etc.), for recreational areas, platforms and disposal sites for many wastes and residues.

Pollution prevention, as a major factor in the protection and conservation of renewable natural resources and other components of the environment such as flora and fauna, can only be achieved by using the most appropriate materials, techniques, technologies and practices that lead to the elimination or at least the reduction of the accumulation of wastes or other pollutants or the limitation of the transfer of pollutants from one environment to another.

In this context, the issue of waste management appears as a priority need and the correct understanding of the problem leads to the choice of optimal solutions to solve it and ultimately to the environmentally sound and rational management of waste and to save precious natural resources both now and especially for future generations.

Numerous studies and research at national level have shown that there are interdependent relationships between agricultural technological systems of plant cultivation, the state of the environment, the level of economic development and the quality of life (Coste et al., 1997, Dumitru et al., 2000, Rogobete et al., 1994, Țărău et al., 1998, 2014).

In view of these considerations, the paper presents some aspects concerning the processing of residual and biodegradable waste through the Ghizela landfill and the 35468 biocomposters purchased and distributed to the rural population through the SIMD programme, representing only 23.30% of the rural population in Timis county.

MATERIAL AND METHOD

The material used is 77,000 tonnes which enters the Ghizela landfill annually as residual waste. This waste is composed of several types of waste such as: fruit and vegetable scraps, meat, bakery products, eggs, prepared food, coffee grounds, coffee filters, tea bags, toilet paper, wet tissues, paper and cardboard packaging impregnated with oil or other liquids, etc., but also accidentally plastic, glass, foil, metal, etc. packaging.

Analyses and other determinations have been performed in the physical-chemical analysis laboratory "O.S.P.A-U.S.V.T", Faculty of Agriculture, USVT Timisoara, Calea Aradului, no. 119, RENAR accredited according to STAS SR EN ISO/CEI 17025, by accreditation certificate no. LI 1001/2013.

The interpretation of the results has been made in accordance with the "Methodology for the Elaboration of Soil Studies" (vol I, II, III) elaborated by ICPA Bucharest in 1987, completed with specific elements from the Romanian Soil Taxonomy System (SRTS-2003/2012), as well as other normative acts such as the Code of Good Farm Practices elaborated by ICPA Bucharest.

RESULTS AND DISCUSSIONS

The issue addressed refers to a quantity of 77,000 tons that enters annually from the Ghizela Non-Perishable Waste Landfill (Ghizela NLD) as residual waste and is treated in the mechanical-biological treatment plant and whether the currently collected municipal biodegradable waste is possible to be used in agriculture as fertilizer after processing.

Residual waste is composed of several types of waste such as: fruit and vegetable scraps, meat, bakery products, eggs, prepared food, coffee grounds, coffee filters, tea bags, toilet paper, wet napkins, paper and cardboard packaging impregnated with oil or other liquids, etc., but plastic packaging, glass, foil, metal, etc. are also accidentally found. Unfortunately, the percentage of non-biodegradable waste in the residual waste is currently quite high because the population does not respect the selective collection method.

Because this category of waste includes waste other than biodegradable waste, it requires mechanical treatment (sorting) before it can undergo the biocontainer biotreatment process. Mechanical treatment removes all types of waste that cannot be processed biologically.

Once they are sorted, the process of biocomposition in biocontainers begins, a process that is carefully supervised by the system computer and the computer program related to the process.

In the material resulting from mechano-biological treatment, there might be a possibility to be used in agriculture as a fertiliser, but due to the existence of other types of waste than biodegradable waste, it makes the resulting material not classifiable as composted waste and suitable for use in agriculture.

The Bureau de standardisation du Québec defines compost as follows: a solid mature product resulting from composting, which is a controlled process of bio-oxidation of solid heterogeneous organic substrate, including a thermophilic phase.

Compost means a product obtained by an aerobic, thermophilic process of microbial decomposition and synthesis of organic matter from waste products, containing more than 25% relatively stable humus consisting predominantly of microbial biomass and which is further subject to a low degree of decomposition, is sufficiently stable so as not to reheat or cause odour or insect breeding problems and has a C:N ratio = 10-15.

Composting can therefore be defined as a method of managing the biological oxidation process that converts heterogeneous organic materials into more homogeneous, fine-particle humus-like materials.

But composting waste presents a problem due to the higher technical costs essential to produce chemically and cosmetically acceptable compost. Even with advanced separation techniques, it is not possible to produce the same quality compost as that obtained from collected, source-separated material (biowaste or green waste).

Most composts obtained from mixed waste are not suitable for the production of agricultural food products because of possible high contamination (Table 1). These types of composts are more suitable for use in landscaping or for the remediation of degraded soils.

Table 1

The heavy metal content of mixed waste compost and of separately collected waste in Germany (mg/Kg)

Chemical element	Compost obtained	
	from mixed waste	after separate collection
Zinc	1570	222
Plumb	513	68
Copper	274	50
Chrom	71	34
Nickel	45	21
Cadmium	5,5	0,7
Mercury	2,4	0,2

Regarding the chemical characteristics of the waste entering the composting process, they show different values from case to case (Table 2-8).

The waste from Colterm C1 outlet (table 2), which entered the biocontainers, has a moisture content of 54.3% and a nutrient content of nitrogen - 1.29%, phosphorus - 2,431 mg/kg and potassium - 6,246 mg/kg. Heavy metals are also present in the juice, with a content of: copper - 35.6 mg/kg, zinc - 192 mg/kg, nickel - 138 mg/kg, lead - 110 mg/kg, chromium - 237 mg/kg, cadmium - 0.26 mg/kg. Mercury, cobalt and arsenic are below the detection limit of the analytical method (which are the interpretation limits for these values in case of waste).

Table 2

Waste entering biocontainers - Colterm exit C1 and C-M11-C1 C1 entry

No. Crt.	**Parameter determined**	**U.M.**	**Values determined Colterm exit C1**	**Values determined** C-M11-C1 C1 entry
1	Humidity	%	54,3	48,9
2	Azot	% s.u.	1,29	1,31
3	Loss calcination	% s.u.	33,35	47,59
4	pH	unit. pH	7,3	7.6 (22.5°C)
5	Total phosphorus	mg/kg s.u.	2.431	2.489
6	P_2O_5	mg/kg s.u.	5.567	5.700
7	Potassium	mg/kg s.u.	6.246	1.540
8	K_2O	mg/kg s.u.	7.495	1.848
9	Copper	mg/kg s.u.	35,6	194
10	Mangan	mg/kg s.u.	285	181
11	Zinc	mg/kg s.u.	192	197
12	Nickel	mg/kg s.u.	138	67,3
13	Cadmium	mg/kg s.u.	0,26	0,16
14	Iron	mg/kg s.u.	9.967	6.165
15	Plumb	mg/kg s.u.	110	11,8
16	Crom	mg/kg s.u.	237	107
17	Mercury	mg/kg s.u.	< 0,05	< 0,05
18	Cobalt	mg/kg s.u.	< 0,02	4,74
19	Arsen	mg/kg s.u.	< 0,15	2,36

Table 3

Waste entering biocontainers - P-M11-C3 entry C2 and C-M11-C7, output C3

No. Crt.	**Parameter determined**	**U.M.**	**Values determined P-M11-C3 entry C2**	**Values determined C-M11-C7, output C3**
1	Humidity	%	37,5	45.5
2	Azot	% s.u.	0,6	0.92
3	Loss calcination	% s.u.	46,39	45.47
4	pH	unit. pH	7,00 22.5°C	7,35 22.5°C
5	Total phosphorus	mg/kg s.u.	2.719	2.925
6	P_2O_5	mg/kg s.u.	6.227	6.35
7	Potassium	mg/kg s.u.	4.539	3.341
8	K_2O	mg/kg s.u.	5.447	5.02
9	Copper	mg/kg s.u.	270	37.6
10	Mangan	mg/kg s.u.	462	20.4
11	Zinc	mg/kg s.u.	248	272
12	Nickel	mg/kg s.u.	81,5	28.2
13	Cadmium	mg/kg s.u.	0,29	0.49
14	Iron	mg/kg s.u.	5.598	5.47
15	Plumb	mg/kg s.u.	261	220
16	Chrom	mg/kg s.u.	123	157
17	Mercury	mg/kg s.u.	< 0,05	< 0,05
18	Cobalt	mg/kg s.u.	4,41	4.07
19	Arsen	mg/kg s.u.	2,1	1.66

The waste in biocontainers C-M11-C1, input C1 (tab.2), has a moisture content of 48.9%, and a nutrient content of nitrogen - 1.31%, phosphorus - 2,489 mg/kg and potassium - 1,540 mg/kg. Heavy metals are also present in the soil, with a content of: copper - 194 mg/Kg, zinc - 197 mg/Kg, nickel - 67,3 mg/Kg, lead - 11,8 mg/Kg, chromium - 107 mg/Kg, cadmium - 0,16 mg/Kg, cobalt - 4,74 and arsenic - 2,36.

The waste in biocontainers C-M11-C3 (tab.3), input C2, has a moisture content of 37.5%, and a nutrient content of nitrogen - 0.6%, phosphorus - 2,719 mg/kg and potassium - 4,539 mg/kg. Heavy metals are also present in the soil, with a content of: copper - 270 mg/Kg, zinc - 248 mg/Kg, nickel - 81,5 mg/Kg, lead - 261 mg/Kg, chromium - 123 mg/Kg, cadmium - 0,29 mg/Kg, cobalt - 4,41 and arsenic - 2,1. Mercury is below the detection limit of the analytical method.

The waste entering the biocontainers C-M11-C7, output C3 (tab3), has a moisture content of 45.5.5%, and a nutrient content of nitrogen - 0.92%, phosphorus - 2,925 mg/Kg and potassium - 3,341 mg/Kg. Heavy metals are also present in the juice, with a content of: copper - 37,6 mg/Kg, zinc - 272 mg/Kg, nickel - 98,2 mg/Kg, lead - 20,4 mg/Kg, chromium - 157 mg/Kg, cadmium - 0,49 mg/Kg, cobalt - 4,07 and arsenic - 1,66. Mercury is below the detection limit of the analytical method.

The waste in biocontainers C-M11-C9, entry C3 (tab.4), has a moisture content of 45.4% and a nutrient content of nitrogen - 1.18%, phosphorus - 1,522 mg/kg and potassium - 3,527 mg/kg. Heavy metals are also present in the juice, with a content of: copper - 544 mg/Kg, zinc - 202 mg/Kg, nickel - 147 mg/Kg, lead - 31,8 mg/Kg, chromium - 230 mg/Kg, cadmium - 0,28 mg/Kg, cobalt - 6,81 and arsenic - 1,87. Mercury is below the detection limit of the analytical method.

Table 4

Waste entering biocontainers - Polaris C2 output and biocontainers - R-M11-C9 entry C3

No. Crt.	Parameter determined	U.M.	Values determined biocontainers - Polaris C2 output	Values determined biocontainers - R-M11-C9 entry C3
1	Humidity	%	45,5	45,4
2	Azot	% s.u.	0,98	1,18
3	Loss calcination	% s.u.	26,33	42,5
4	pH	unit. pH	8.2 -22.5°C	7.7 22.5°C
5	Total phosphorus	mg/kg s.u.	3.521	1.522
6	P_2O_5	mg/kg s.u.	8.063	3.485
7	Potassium	mg/kg s.u.	8.435	3.527
8	K_2O	mg/kg s.u.	10.122	4.232
9	Copper	mg/kg s.u.	61,3	544
10	Mangan	mg/kg s.u.	762	568
11	Zinc	mg/kg s.u.	312	202
12	Nickel	mg/kg s.u.	119	147
13	Cadmium	mg/kg s.u.	0,72	0,28
14	Iron	mg/kg s.u.	9.188	10.074
15	Plumb	mg/kg s.u.	1.209	31,8
16	Chrom	mg/kg s.u.	214	230
17	Mercury	mg/kg s.u.	< 0,05	< 0,05
18	Cobalt	mg/kg s.u.	< 0,02	6,81
19	Arsen	mg/kg s.u.	< 0,15	1,87

The wastes entering the Polaris biocontainers, output C2 (tab.4), have a moisture content of 52.5%, and a nutrient content: nitrogen - 0.98%, phosphorus - 3,521 mg/Kg and potassium - 8,435 mg/Kg. Heavy metals are also present in the waste, with a content of: copper - 61.3 mg/kg, zinc - 312 mg/kg, nickel - 119 mg/kg, lead - 1,209 mg/kg, chromium - 214 mg/kg, cadmium - 0.72 mg/kg. Mercury, cobalt and arsenic are below the detection limit of the analytical method.

Table 5

Waste entering biocontainers – Urban Zone 0 exit C4 and biocontainers - Rural Zone 0 entry C4

No. Crt.	Parameter determined	U.M.	Values determined biocontainers – Urban Zone 0 exit C4	Values determined biocontainers - Rural Zone 0 entry C4
1	Humidity	%	53,1	50,7
2	Azot	% s.u.	1,39	1,07
3	Loss calcination	% s.u.	34,11	37,62
4	pH	unit. pH	7.8 - 22.5°C	7.8 22.5°C
5	Total phosphorus	mg/kg s.u.	2.916	2.904
6	P_2O_5	mg/kg s.u.	6.678	6.650
7	Potassium	mg/kg s.u.	7.495	10.254
8	K_2O	mg/kg s.u.	8.994	12.305
9	Copper	mg/kg s.u.	30,6	62,9
10	Mangan	mg/kg s.u.	614	958
11	Zinc	mg/kg s.u.	327	313
12	Nickel	mg/kg s.u.	99,5	80,4
13	Cadmium	mg/kg s.u.	0,56	0,95
14	Iron	mg/kg s.u.	6.341	10.974
15	Plumb	mg/kg s.u.	45,6	47,7
16	Chrom	mg/kg s.u.	183,8	133
17	Mercury	mg/kg s.u.	< 0,05	< 0,05
18	Cobalt	mg/kg s.u.	< 0,02	< 0,02
19	Arsen	mg/kg s.u.	< 0,15	< 0,15

The wastes entering the biocontainers in rural area 0, entry C4 (tab 5), have a moisture content of 50.7% and a nutrient content of nitrogen - 1.07%, phosphorus - 2,904 mg/kg and potassium - 10,254 mg/kg. Heavy metals are also present in the soil, with a content of: copper - 62.9 mg/kg, zinc - 313 mg/kg, nickel - 80.4 mg/kg, lead - 47.7 mg/kg, chromium - 133 mg/kg, cadmium - 0.95 mg/kg. Mercury, cobalt and arsenic are below the detection limit of the analytical method.

In the case of rural waste, the potassium content is higher and the heavy metal content is lower. In the case of waste going into biocontainers the moisture content varies between 34 - 54 %. The concentration of nutrients varies as follows: nitrogen between 0.6 - 1.3 %, phosphorus between 1,500-3,500 mg/kg and potassium between 1,500 - 8,400 mg/kg.

The microelements have a variation in concentration as follows: copper between 36 - 540 mg/kg, zinc between 190 - 310 mg/kg, cobalt below 4.7 mg/kg. Along with these elements iron and manganese have the role of microelements.

Toxic heavy metals have a concentration as follows: cadmium between 0.16 - 0.72 mg/Kg, lead between 12 - 1,210 mg/Kg, arsenic between 1.7 - 2.4 mg/Kg, and the concentration of mercury is below the detection limit of the method.

In the research carried out to test the effect of compost, a cultivated soil from the Dinias area was used, which shows the following chemical characteristics (Table 6).

Table 6

Soil element values for the Dinias sample - relative to air-dry soil

Crt. no.	Parameter determined	UM	Value determined
1	pH in aqueous suspension (soil: water ratio = 1:2.5)	unit.pH	8.12 - 21.20 °C
2	Humidity	%	18.68
3	Organic matter	% of su	5.59
4	Total nitrogen	%	0.10
5	Mobile phosphorus in Al, recalculated by pH	ppm	141.2*
6	Mobile potassium in Al	ppm	407**
7	Copper (Cu), total form	ppm	28.97
8	Iron (Fe), total form	ppm	10,865
9	Zinc (Zn), total form	ppm	107.3
10	Manganese (Mn), total form	ppm	270
11	Chromium (Cr), total form	ppm	29.3
12	Cadmium (Cd), total form	ppm	0.059
13	Lead (Pb), total form	ppm	19.05

* Very high (above 72 ppm) ind,72 MESP , *** Very high (above 301 ppm) ind,73

Soil reaction is weakly alkaline (values between 7.9 and 8.2-in.63 MESP1987). Organic matter content is medium (values between 3.8-8.0-in.70 MESP 1987), total nitrogen content is low (values between 0.100 and 0.1400-in.71 MESP 1987) The content in mobile phosphorus and mobile potassium is very high, which indicates a strongly anthropically modified soil, either an older settlement, or through repeated fertilization with high doses of phosphorus and potassium, or a former space for the storage of chemical fertilizers with phosphorus and potassium, etc.

As far as the values of some elements are concerned, compared to the reference values considered normal (table 7), they are slightly above the threshold considered optimal for: copper - 28.97 ppm, zinc - 107.3 ppm and below the threshold considered optimal for: manganese 270 ppm, chromium 29.3 ppm, cadmium 0.059 ppm, lead 19.05 ppm.

Table 7

Reference values of various soil elements (extracts from Table 1, SRTS-2003, Annex 10)

Symbol element	Normal values (ppm)	Alert thresholds (ppm) Warning levels / Types of using		Action thresholds (ppm) Intervention levels / Types of using	
		sensitive	less sensitive	sensitive	less sensitive
Cobalt (Co)	15	30	100	50	250
Total chromium (Cr)	30	100	300	300	550
Copper (Cu)	20	100	250	200	500
Manganese (Mn)	900	1,500	2,000	2,500	4,000
Zinc (Zn)	100	300	700	600	1,500
Cadmium (Cd)	1	3	5	5	10
Nickel (Ni)	20	75	200	150	500
Lead (Pb)	20	50	250	100	1,000

The compost used was obtained by biocomposting of food waste in individual compost bins and has the following chemical characteristics (Table 8): is slightly alkaline, with a pH of 8.02., and the organic matter content is high, with a value of 62.68%.

The compost obtained has a high content of organic matter, total phosphorus and total potassium which recommends it for use in agriculture.

The values recorded for some elements (table 9) are below the maximum concentration of metals (table 13): 157.8 ppm for copper, 778.2 ppm for zinc, 106.7 ppm for chromium, 9.81 ppm for cadmium.

Table 8

Chemical characteristics for food biocompost - related to air-dried biocompost,sample 629

Crt. no.	Parameter determined	UM	Value determined
1	pH in aqueous suspension (soil:water ratio = 1:5)	unit.pH	8.03
2	Humidity	%	62.68
3	Total nitrogen	%	0.97
4	Organic matter	% of su	63.20
5	Total phosphorus	%	7.72
6	Total potassium	%	3.44
7	Copper (Cu), total form	ppm	157.8
8	Iron (Fe), total form	ppm	27,150
9	Zinc (Zn), total form	ppm	778.2
10	Manganese (Mn), total form	ppm	3,174
11	Chromium (Cr), total form	ppm	106.7
12	Cadmium (Cd), total form	ppm	9.81
13	Lead (Pb), total form	ppm	6.10

Table 9

Heavy metal loading limits for composts (in s.u.)

Metal	1. Maximum metal concentration (ppm)	3. Concentration of metals in "high quality" compost, (ppm monthly average)
Arsen	75	41
Cadmium	85	39
Chrom	3,000	1,200
Copper	4,300	1,500
Plumb	840	300
Mercury	57	17
Molybdenum	75	18
Nickel	420	420
Selenium	100	36
Zinc	7,500	2,800

1-The maximum amount of heavy metals in composts is considered safe for crops and animals, including humans.

3-The maximum concentration of metals allowed for composts applied to the meadow and home garden or sold or sold for the market

Referring to the soil in which the compost has been incorporated, it has the following characteristics:

Soil reaction is weakly alkaline (ind.63 MESP1987). Organic matter content is high (ind.70. MESP 1987), total nitrogen content is very low (ind.70. MESP 1987.

As regards the values of some elements compared with the reference values considered normal (table 10), they are above the threshold considered optimal for: copper - 66.8 ppm, values close to the alert threshold for sensitive uses, zinc - 173 ppm above the threshold considered optimal for: cadmium - 4 ppm, chromium - 31.2, cobalt - 47.0 and below the threshold considered optimal for nickel - 5.3 ppm, above the alert threshold for sensitive uses for: lead - 52.8 ppm.

Table 10

Chemical analysis of mixture P3 - soil + compost, from furrow, sample P4

No. Crt.	Incerwhich executed	U.M.	Values determined
1	pH in aqueous suspension (soil: water ratio = 1:2.5)	unit. pH	8.12
2	Humidity	%	27,7
3	Organic matter	% s.u.	5,73
4	Azot	% s.u.	0,1
5	Total phosphorus	mg/kg s.u.	333
6	P_2O_5	mg/kg s.u.	763
7	Potassium	mg/kg s.u.	492
8	K_2O	mg/kg s.u.	593
9	Copper	mg/kg s.u.	29
10	Iron	mg/kg s.u.	10.900
11	Zinc	mg/kg s.u.	109
12	Mangan	mg/kg s.u.	277
13	Chrom	mg/kg s.u.	29.5
14	Cadmium	mg/kg s.u.	0.08
15	Plumb	mg/kg s.u.	19

CONCLUSIONS

The paper presents aspects of biowaste treatment and composting techniques using aerobic processes.

In the case of home/yard composting, a number of aspects need to be taken into account: local conditions, composting technology, waste management, motivation and awareness and technical composting systems.

In the case of composting technologies, the following stages are presented: mechanical reception and processing, coarse treatment, intensive decomposition, fine treatment, maturation stage and storage.

The aim was also to obtain compost from municipal biodegradable waste currently collected as residual waste and treated in the mechanical-biological treatment plant at the Ghizela Non-Perishable Waste Landfill (Ghizela NLD) and to establish the possibility of using it in agriculture as a fertilizer.

From the comparison of the chemical characteristics of the soil used for composting (before and after incorporation), regarding the values of some heavy metals, a slight increase in some elements can be observed, which recommends a more careful preparation of the material for composting.

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