Agricultural Research & Technology
Open Access Journal
ISSN: 2471-6774

Juniper Publishers
key to the Researchers

Mini Review
Volume 24 Issue 1 - April 2020
DOI: 10.19080/ARTOAJ.2020.24.556260

Agri Res & Tech: Open Access J

Reusing Sewage Sludge in Agriculture: A Mini-Review

Ugo De Corato*

Department of Bioenergy, Biorefinery and Green Chemistry (DTE-BBC-BIC), Italy

Submission: April 08, 2020; **Published:** April 13, 2020

***Corresponding author:** Ugo De Corato, Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) – Department of Bioenergy, Biorefinery and Green Chemistry (DTE-BBC-BIC), Bari, Italy

Abstract

Sewage sludge production in European countries has widely raised in the last decade and its fate is currently landfilling, incinerators, composting, land application, or anaerobic digestion. To explore its agronomic potential, the main target of this mini review is to understand the effects of anaerobic digestates from sewage sludge in agriculture as soil improver.

Keywords: Agriculture; Digestate; Organic fertilizer; Soil amendment

Introduction

Sewage sludge (SS) are a category of solid residues from different bio-wastes (mainly industrial, commercial, and residential sectors) as well as from urban wastewaters (UWWs). The treatment of UWWs is a process dealing with different issues, such as the engineering of innovative purification techniques, the environmental impact assessment, and the effects on society and the economy [1]. In the last thirty years in Europe, many governmental institutions and authorities lead particular attention on this aspect that has been sustained by European Union through the adoption of directives [2] which have been then receipted into national laws by the different member states, such as Italy [3,4]. As a result, the quality of treated UWWs received by groundwater bodies has improved substantially by applying the cogent guidelines. However, this implied the dramatic increase of SS, that is the principal waste coming from UWWs treatment process. The global production of SS reveals faster growing trend [5]. SS production in European countries accounted from 5.5 Mtonnes [6] to nearly 10 Mtonnes of dry solid matter of sludge per year [7] grouped in 8.7 Mtonnes from EU-15 countries and 1.2 Mtonnes from EU-12 [8]. According to the reports of European Commission [9], these values correspond to a mean production of 17 kg per capita of dry sludge per year, but in some countries, including Italy, this ratio is below to 10 kg per inhabitant, suggesting an insufficient level of collection and treatment of wastewaters.

Reusing Sewage Sludge by Composting

Since SS is currently classified as a putrescible waste which requires a proper stabilisation before its disposal or reuse as soil amendment in agriculture, many works in literature focused on its virtuous reuse to propose different kinds of solutions both in terms of treatment and application. First, contaminants removal has been seen to be a possible way through heavy metal leaching using physical, chemical, and biological techniques [10]. However, these procedures are often expensive in terms of cost, time, and economic sustainability. On the other hand, recovery of valuable compounds such as nitrogen (e.g. ammonia stripping) [11,12] and phosphorus (e.g. recovery from ashes) [13] seems to be quite promising, especially for what concerns the preservation of natural resources and the support of the circular economy perspective [14,15]. Other technological approaches are based on pyrolysis for producing syngas, bio-oil, and biochar sometime used in agriculture [16]. Second, many further studies on SS application as soil amendment [17] and its derivatives [18,19] in organic agriculture have been published. In general, the main studies have been focused on the evaluation of bio-fertilisers with amendment effect on the different doses, species, and types of soil for the soil depending, with experiments scaling up from pots in greenhouse [20,21] or in outdoor [22,23] until open field applications [24,25]. In addition, many works investigated the phytotoxic effects of SS related to the excess of heavy metals [26,27], organic pollutants [28], and ammonia nitrogen [29]. In order to avoid or minimize such relevant limiting risks, SS should be pre-treated by bio-oxidative process by composting process before to yield it as soil conditioner [20,30]. During composting heavy metals content decreases significantly [31], as well as the leaching of nitrates [32], and the pathogens are not detected [33]. In addition, humification of the biodegradable organic matter in the composted SS, that is transformed into more stable and mature forms of organic compounds (humus-like), is reached during composting process [34].

Reusing Sewage Sludge by Anaerobic Digestion

Anaerobic digestion (AD) is one of the most exploited techniques in next-generation wastewater treatment plants (WWTPs) to yield biogas and sewage sludge anaerobic digestate (SSAD) at the same time. This is a better way by which a waste can show the interesting agronomic features due to its appreciable macronutrients content versus the presence of organic and inorganic contaminants [35]. Land and agronomic application of SSAD as soil improver/conditioner/amendment is currently regulated in Europe [36], and it was mostly diffused in countries, e.g. Portugal and Spain, which adopted more stringent legislation for exploitation of SSAD in agriculture [22]. However, according to Eurostat data updated on 2015, SSAD is still poorly reused in other states where it is mostly disposed of a solid waste through incineration (e.g. Netherlands and Switzerland) or landfilling (e.g. Italy, Serbia, and Croatia) [37]. This solution, in particular, should be strictly limited whenever possible and exploited only as last chance [38]. SSAD usually contains only organic compounds, macro- and micronutrients, trace metals, organic xenobiotics, and microorganisms [39] so resulting a new by-product in agriculture for soil amendment [14]. But, unfortunately, SSAD often contains harmful compounds that poses serious hazards for the environment and human health depending on the treated wastes quality and processing type to improve their safer use. So, different approaches of disposal, including dumping seawater, landfilling, and incineration have been explored as suitable options [40-42], but really, they are still very limited for the practical use due to serious pollution drawbacks and beneficial constituent losses. Since the major components of SSAD are represented by organic matter and beneficial plant nutrients involved in the main biogeochemical cycles (especially phosphorus and nitrogen), their use may combine the amelioration of the soil physicochemical and biochemical properties with the need to dispose the huge amounts of SS [43]. Aggregate stability, bulk density, porosity, and water retention of the soil may be improved by such practices that may have positively affected plant nutrient balance, crop production, and food quality [40,44]. Land application of SSAD has led to increase soil pH [45] or decrease pH values [46,47], to increase electrical conductivity [48], soil organic carbon accumulation [49], and macronutrients (nitrogen, phosphorous, potassium) [50]. Besides the effects on soil physicochemical parameters, the SSAD amendment improves some biological properties as total microbial biomass, enzyme activity, and basal respiration, where all soil parameters are strictly related to soil quality, fertility, and crop production [51-53]. Despite the reported positive effects, the use of SSAD may have affected negatively soil fertility and crop production due either to the unbalanced content of nutrients in the amendment [54] or input of high amount of toxic compounds in soil, as heavy metals [55,56], pharmaceutics [57], hormones [58], aromatic hydrocarbons [59], and pathogen microorganisms [60]. The practical use of SSAD as soil improver is already known in literature [22] where the main targets of the published works focussed on applicability of SSAD for exploiting different nitrogen dosages in field practices, evaluating their effects on sandy and poor soils, and studying their phytotoxic effects to assess the correct dose range for its application in pot experiments in a cucumber cropping system under greenhouse [61].

References

1. EEA (2016) European water policies and human health - Combining reported environmental information. European Environment Agency, Report n° 32 of 2016.
2. https://eur-lex.europa.eu
3. http://www.gazzettaufficiale.it
4. http://www.gazzettaufficiale.it
5. doi: 10.1016/j.wasman.2017.03.002
6. http://ec.europa.eu/environment/waste/sludge/index.htm
7. Milieu Ltd., 2008. Report to European Commission's DG Environment: Environmental, economic and social impacts of the use of sewage sludge on land. Part II: Report on Options and Impacts (DG ENV.G.4/ETU/2008/0076r) pp. 158.
8. https://doi.org/10.1504/ijewm.2016.080795
9. European Commission (2017) Ninth Report on the implementation status and the programmes for implementation (as required by Article 17) of Council Directive 91/271/EEC concerning urban waste-water treatment.
10. https://doi.org/10.1007/s11270-016-3141-3
11. https://doi.org/10.1080/17597269.2017.1336348
12. https://doi.org/10.14672/ida.v4i2.1198
13. https://doi.org/10.1007/978-981-10-8031-9
14. https://doi.org/10.1016/j.rser.2018.02.041
15. https://doi.org/10.1007/s10705-016-9774-1
16. https://doi.org/10.1002/jpln.201100143
17. https://doi.org/10.1007/BF01569890
18. https://doi.org/10.1016/j.apsoil.2011.03.001
19. https://doi.org/10.1016/j.biortech.2006.12.023
20. https://doi.org/10.1016/j.biortech.2005.02.005
21. https://doi.org/10.1016/S0960-8524(96)00121-6
22. https://doi.org/10.1007/s12649-016-9519-z

How to cite this article: Ugo De C. Reusing Sewage Sludge in Agriculture: A Mini-Review. Agri Res & Tech: Open Access J. 2020; 24(2): 556260.
DOI: 10.19080/ARTOAJ.2020.24.556260

23. https://doi.org/10.1504/ijewm.2009.024702

24. https://doi.org/10.3923/jas.2009.1401.1411

25. https://doi.org/10.1111/j.1365-2494.2010.00743.x

26. https://doi.org/10.1007/s11356-016-7193-0

27. https://doi.org/10.1016/j.chemosphere.2006.12.019

28. http://ec.europa.eu/environment/archives/waste/sludge/pdf/organics_in_sludge.pdf

29. https://doi.org/10.1556/aphyt.47.2012.2.4

30. https://doi.org/10.1016/S1002-0160(12)60067-8

31. https://doi.org/10.1007/s11356-008-0041-0

32. https://doi.org/10.1016/j.wasman.2005.09.008

33. https://doi.org/10.101610.1007/s11274-011-0704-8

34. https://doi.org/10.1016/j.biortech.2007.09.024

35. https://doi.org/10.12911/22998993/92889

36. https://eur-lex.europa.eu

37. https://ec.europa.eu

38. https://eur-lex.europa.eu

39. Kulling D, Stadelmann F, Herter U (2001) Sewage Sludge – Fertilizer or Waste? In: UKWIR Conference, Brussels.

40. Kominko H, Gorazda K, Wzorek Z (2017) The possibility of organic-mineral fertilizer production from sewage sludge. Waste & Biomass Valorization, 8: 1781-1791.

41. https://doi.org/10.1007/s11356-015-5618-9

42. https://doi.org/10.1016/j.wasman.2003.08.006

43. https://doi.org/10.1016/j.ecoleng.2014.03.066

44. https://doi.org/10.1016/j.jhazmat.2008.03.046

45. https://doi.org/10.1018/00103629509369471

46. https://doi.org/10.1016/j.ecoleng.2010.03.008

47. https://doi.org/10.1007/978-1-4614-0668-6-3

48. https://doi.org/10.1016/j.apsoil.2016.01.002

49. https://doi.org/10.1016/j.apsoil.2013.11.007

50. https://doi.org/10.1080/00380768.1991.10415030

51. https://doi.org/10.1515/sab-2017-0030

52. https://doi.org/10.1016/j.wasman.2017.03.002

53. https://doi.org/10.1007/s11157-016-9407-9

54. https://doi.org/10.1081/PLN-120038546

55. https://doi.org/10.1016/j.chemosphere.2012.05.092

56. https://doi.org/10.1016/j.chemosphere.2006.12.019

57. Redshaw CH, Cooke MP, Talbot HM, McGrath S, Rowland SJ (2008) Low biodegradability of fluoxetine HCl diazepam and their human metabolites in sewage sludge-amended soil. Journal of Soil Sediment 8: 217-230.

58. https://doi.org/10.1016/j.scitotenv.2006.12.025

59. https://doi.org/10.1016/j.jhazmat.2007.01.142

60. Gerba CP, Smith JE (2005) Sources of pathogenic microorganisms and their fate during land application of wastes. Journal of Environmental Quality 34: 42-48.

61. https://doi.org/10.1016/j.wasman.2019.08.018