

János Dávid**USING COMPOSTING TO TEACH WASTE REDUCTION
AND THE MATERIAL CYCLE****Introduction and problem statement**

By the 20th century, the mode of management of the consumer society had become dominant on Earth. The main characteristic of this mode of production is the ever-increasing production and, in connection with it, the ever-increasing consumption. The production of goods generates large quantities of waste, which, according to the initial habits, was deposited mainly in landfills and not recycled. In the 21st century, more and more people have realised that there is a significant amount of recyclable material in waste. If they are dumped and piled up, they are lost in the cycle. Today, economic actors are increasingly exploring waste as a source of raw materials. Inorganic and organic components are extracted and recycled back into the production process. One of the fundamental ideas of a waste-free lifestyle is the recycling and processing of waste.¹

The importance of composting is increased by the depletion of soil micro- and macrobiomes.² In intensive crop production, permanent ploughing is a regular feature, which causes a high degree of soil life disturbance. The organic matter structures that develop are then disrupted and broken down. A significant part of the mycobiome is destroyed or seriously damaged. To develop soil fertility, the living organisms that live in the soil are essential.³ A large amount of living and functional organic matter is necessary to maintain the physical and chemical properties of soils. The depletion of the soil biome is facilitated by both fertilisers and pesticides. Artificially produced chemicals kill or limit the activity of soil-dwelling organisms. The application of compost greatly aids the regeneration and maintenance of soil life. Fertilisers could be replaced by compost, albeit to a lesser extent on a field scale, but can be used on backyard farms and especially in small gardens.⁴ Compost also has a positive effect on soil structure, making compacted soils looser and facilitating the formation of aggregates in sandy soils that help water management.⁵

¹ DÁVID János: *A fenntarthatóságra nevelés hatékonyságának növelése a zero waste gondolkodás-mód alapelveinek gyakorlati alkalmazásával*. In: K. NAGY EMESE (edit.) *Hatékonyság és koherencia a pedagógiában, gyógypedagógiában és tanárképzésben*. Tanulmánykötet a XIV. Országos Tanítási Konferenciáról Miskolci Egyetem Bölcsész- és Társadalomtudományi Kar Tanárképző Intézet Miskolc, 2023. 193–209. (Later: DÁVID, 2023)

² PAYN, Valerie–FORSYTH, Jane: *An Ecological Gardeners Handbook: How to Create a Garden With a Healthy Eco-System and Garden Sustainably*. Kindle Edition, New York, 2015. (Later: PAYN–FORSYTH, 2023)

³ STEFANOVITS Pál–FILEP György–FÜLEKY György: *Talajtan*. Mezőgazda Kiadó, Budapest, 1999. (Later: STEFANOVITS–FILEP–FÜLEKY, 2023)

⁴ BIERMAIER, Monika–WRBKA-FUCHSIG, Ilse: *Kompost und Düngung im naturnahen Garten*. Cadmos Verlag, München, 2006. (Later: BIERMAIER–WRBKA-FUCHSIG, 2006)

⁵ SULZBERGER, Robert: *Kompost, Erde, Düngung*. BLV Buchverlag GmbH & Co. KG., München, 2003. (Later: SULZBERGER, 2003)

Our soils are depleted of humus as a result of intensive agricultural activity, reducing their productivity and deteriorating their physical structure, leading to increased erosion. Humus replenishment is very important in our soils, but the reduced organic manure supply due to the declining livestock population after the change of regime does not cover the needs. In horticultural crops, the use of compost alleviates the humus deficit in soils, maintaining their fertility and improving their structure.

In this study, we will focus on methods for the management of organic matter. We aim to present composting techniques that can be used in nursery and school gardens. There are also important pedagogical implications of this activity, which will also be discussed.

The perception of natural processes is not easy for today's children, most of whom live in an almost artificial environment and spend most of their time in virtual space. Unlimited access to consumer goods is natural for them. They do not see the process of production and the amount of by-products and waste generated. Education must show them the quantity of recyclable materials in waste and the means and procedures for processing them. Lastly, it is very important to explain the results of the work, how the finished compost is tested and how it can be used.

New methods of waste management

The human environment generates a very large amount of waste, mainly organic matter, much of which is suitable for composting. It is very important to make children see and understand the following:

- the best waste is the waste that is not produced,
- the waste that is produced should be collected and sorted into groups according to its recyclability,
- those that can be recycled should be managed.

By following these basic principles, the amount of material going to landfill can be greatly reduced. Sorting and processing compostable materials is easy for children to do, gives relatively quick results, and they can see the results of their work.

Pupils can also learn about the amount of waste in their immediate environment, with food waste being one of the most visible types of compostable waste. According to research by the Hungarian Food Safety Agency in 2022, we produce 60 kg of food waste per person.⁶ 40% of this could be avoided, so we produce 24 kg of food waste per person per year. Bakery products, fresh fruit and vegetables and dairy products account for 80% of food waste. Researchers' surveys show that food waste has decreased by 27% in the last 7 years, but still, an average of 24 kg of food waste is generated.⁷ The main causes of food waste are

⁶ NÉBIH: *Háztartási élelmiszerhulladék felmérés 2022 kutatási összefoglalója*. Nemzeti Élelmiszerbiztonsági Hivatal, Budapest, 2023. (Later: NÉBIH, 2023)

⁷ NÉBIH: *Maradék nélkül az élelmiszerpazarlás ellen*. Tanári változat. Maradék nélkül program. Nemzeti Élelmiszerbiztonsági Hivatal, Budapest, 2019. (Later: NÉBIH, 2019)

inattention and inadequate food planning and habits.⁸ Households often forget about stored ingredients or ready meals. Much of the food that remains is due to the abundant choice and almost unlimited availability.⁹

In recent years, a growing number of programmes have been launched to reduce food waste^{10,11}). The European Union has set a target to halve consumer food waste by 2030, in line with the UN's SDG 12.3 on sustainable development¹²). Globally, household waste is highest in economically developed countries¹³). However, in economically less developed countries, significant losses occur through production, processing and logistics, due to technological underdevelopment in production and economic organisation problems¹⁴). European surveys indicate that 53% of food waste in EU Member States is generated in households¹⁵). Research in Hungary shows that better-off families in Hungary waste more than poor families, but the food waste of families with young children also exceeds the national average.¹⁶ In this area, educational institutions have a major role to play in raising awareness among young children. A national survey indicates a change in consumer habits, according to which a group has emerged among university students and young people who have just graduated from higher education that can significantly shape the thinking of their peers through their opinions.¹⁷ The various forms of social media provide ample space for publishing their thoughts, and vloggers, especially YouTubers and TikTokers, are now considered to be a dominant factor in shaping thinking and opinions. These

⁸ KASZA Gyula–DORKÓ Annamária–SZAKOS Dávid: *Az élelmiszerpazarlás és megelőzése. Vidékfejlesztési kézikönyv 5. – Helyi termék kézikönyv* (Szerkesztő: Szomi Edina), Nemzeti Agrárgazdasági Kamara, Budapest, 2022. (Later: KASZA–Dorkó–Szakos, 2022)

⁹ KASZA Gyula–DORKÓ Annamária–KUNSZABÓ Attila–SZAKOS Dávid: *Quantification of Household Food Waste in Hungary: A Replication Study Using the FUSIONS Methodology Sustainability* 12, 2020/8 3069. (Later: Kasza et al. 2020)

¹⁰ KASZA Gyula–KUNSZABÓ Attila–MIKULÁS Viktória–DORKÓ Annamária–SZAKOS Dávid: *Fogyasztói élelmiszerhulladék-csökkentési programok Európában. Élelmiszervizsgálati Közlemények*, 2023/2. (69), 4435–4450. (Later: KASZA et al. 2023)

¹¹ CANDEAL, T.–BRÜGGEMANN, N.–BRUNS, H. –CASONATO, C. –DIERCXSENS, C.–GARCÍA-HERRERO, L.–GIL, J. M.–HAGLUND, Y.–KAPTAN, G.–KASZA, G. MIKKELSEN, B.E.,–OBERSTEINER, G.–PIRES, I.M.–SWANNELL, R.–VAINIORANTA, J.–VAN HERPEN, E., VITTUARI, M.–WATANABE, K.–SALA, S.: *Tools, best practices, and recommendations to reduce consumer food waste – A compendium*, Publications Office of the European Union, Luxembourg, 2023. (Later: CANDEAL et al., 2023)

¹² UNITED NATIONS (2015). *Sustainable Development Goals*. United Nations, 2015. <https://sdgs.un.org/goals> [14. 03. 2024.] (Later: UNITED NATIONS, 2015)

¹³ OVCA, Andrej–JEVŠNIK, Mojca–RASPOR, Peter: *Food safety practices of future food handlers and their teachers, observed during practical lessons*. *British Food Journal*, 2018/3. (120), 531–548. (Later: OVCA–JEVŠNIK–RASPOR, 2018)

¹⁴ PARFITT, Julian–BARTHEL, Mark–MACNAUGHTON, Sarah: *Food waste within food supply chains: quantification and potential for change to 2050*. *Philosophical transactions of the royal society B: biological sciences*, 2010/365. (1554) 3065–3081. (Later: PARFITT–BARTHEL–MACNAUGHTON, 2010)

¹⁵ FUSIONS: *Estimates of European Food Waste Levels* <http://eu-fusions.org/phocadownload/Publications/Estimates%20of%20European%20food%20waste%20levels.pdf> [31. 08. 2023.] (Later: USIONS, 2016)

¹⁶ SZABÓ-BÓDI Barbara–KASZA Gyula–SZAKOS Dávid: *Assessment of household food waste in Hungary*. *British Food Journal*, 2018/3. (120), 625–638.

¹⁷ BÓDI Barbara–KASZA Gyula: *Demográfiai tényezők hatása a fogyasztói élelmiszer-pazarlásra (Effect of demographic factors on consumer food waste)*. *Élelmiszervizsgálati Közlemények*, 2015/3. (61), 756–764. (Later: BÓDI–KASZA, 2015)

young people, committed to the idea of sustainability, are providing a wealth of ideas for zero-waste and low-waste lifestyles and for developing everyday habits that reduce environmental impact. These ideas include reducing food waste.

The management of food waste is exemplified by the bio-waste collection systems now in place in several cities in Hungary. In the cities involved (not yet covering all households in the country, but currently in 14 municipalities in the condominium zone), food waste is collected in brown bins. An EU decision in 2018 requires Member States to start the separate collection and processing of household bio-waste from January 2024.¹⁸

By demonstrating and practising composting, children can be shown how to process the waste material to produce material (compost and compost tea) that can be used in crop production.

Composting in schools and kindergartens is not only a way of processing organic waste from households but also green waste from the surroundings of institutions, kindergartens and school gardens. The key is to make children understand the possibility and importance of waste reduction and to actively participate in the composting process.

Community composting is spreading in major European cities. In Budapest, community spaces have been set up where residents can deposit their household waste^{19,20} Under the guidance of community compost masters, residents of apartment buildings collect and treat compostable organic kitchen waste and use the resulting compost in family or community gardens. In this way, they can process large quantities of organic matter and save it from being disposed of in landfills, unused and diverted from the natural cycle. Learning about community composters and participating in the composting process here is educational for children. They can see that there are many different types of composting, but they all have the same basic idea: by separating naturally degradable materials, collecting them and processing them, we can create fertile material. Whether small or large, in households or in factories, the process can be used to turn unusable, environmentally burdening organic matter produced by humans into compost that improves soil fertility.

The use of composting in small-scale gardening

After the intensive arable farming of the 20th and 21st centuries, more and more people are nowadays realising the negative consequences of constant soil rotation and the use of chemicals.²¹ The systematic use of large-scale machinery for soil rotation disturbs the soil structure and damages the organisms living in it. Modern farming practices have made soil erosion and soil degradation a problem

¹⁸ DIÁN Dóra: *A barna kuka: minden, amit tudnod kell a biohulladék szelektív gyűjtéséről*. wmn.hu 2024. <https://wmn.hu/ugy/61793-a-barna-kuka-minden-amit-tudnod-kell-a-biohulladek-szelektiv-gyujteserol> [25. 03. 2024.] (Later: DIÁN, 2024)

¹⁹ URL1: *Komposztálás a városban 1*. ReCity Magazin. 2018. <https://recity.hu/komposztalas-a-varosban-1/> [07. 09. 2023.] (Later: URL1, 2018)

²⁰ URL2: *Komposztálás a városban 2*. ReCity Magazin. 2018. <https://recity.hu/komposztalas-varosban-2/> [07. 09. 2023.] (Later: URL2, 2018)

²¹ KOCSIS István: *Komposztálás*. Szaktudás Kiadó Ház, Budapest, 2005. (Later: KOCSIS, 2005)

worldwide.²² More and more farmers are turning to no-till farming (no-dig technology). Charles Dowding (<https://www.charlesdowding.co.uk/>) is an internationally recognised expert on small gardens and a no-dig gardener. He offers a wealth of advice on his website and YouTube channel.

Digging-free gardening is all about imitating nature. A thick blanket of organic matter is created on the surface of the soil, which naturally degrades and decomposes. The compost is already a very good basis for growing plants because it is structurally favourable and has an excellent nutrient content. Regardless of the size of the garden, the finished compost can be used everywhere - it can be used in vegetable gardens, flower beds and under fruit trees. It increases the nutrient content of the soil and improves its structure, loosening bound soils.

Permaculture is also rapidly gaining ground in Hungary. Iván Gyulai, who heads the Ecological Institute for Sustainable Development Foundation (<https://www.ecolinst.hu/>), can be considered its apostle in Hungary. At the Foundation's Gömöri Training Centre in Gömörszőlős, the operation of nature copying farming has been observed for decades. Permaculture involves the accumulation of a thick layer of organic matter on the soil, which, as it decomposes, often has a similar effect to composting, not surprisingly, as the deep mulch material also composts and decomposes in a short time (a few months), forming a thick, loose layer rich in organic matter and nutrients. The mulch and then compost accumulated on the surface of the soil has a beneficial effect on soil water management, allowing water to flow downwards while at the same time covering the soil surface and preventing evaporation.

In the nursery and school gardens of educational establishments, these modern methods of growing plants can be introduced to children. Together with them, they can make simple mulches, for example, from grass clippings and branch cuttings, and put together a deep mulch cover. A third method is to make compost from organic materials found in gardens and households and use it to improve the soil or directly as a growing medium.

Theoretical background to composting

Composting is essentially based on natural processes. The accumulation and transformation of fallen leaves and branches and undergrowth on the soil is well observed in native decomposing forests. Compost formation is most clearly illustrated by the decomposition of fallen tree trunks, which is also understandable to children. Natural composting is a recycling process independent of people. Organic matter that is deposited on the soil is transformed and decomposed after accumulation. After a certain period, the components of the organic matter, mainly of plant origin and to a lesser extent of animal origin, which decompose during humification, are no longer recognisable.

²² NARDOZZI, Charlie: *The Complete Guide to NO-DIG GARDENING. Grow beautiful vegetables, herbs, and flowers – the easy way!* Quarto Publishing Group, Dover, 2021. (Later: NARDOZZI, 2021)

Micro-organisms (mainly bacteria), worms and arthropods, and fungi are involved in the decomposition and humus formation.²³ In humification, the more complex organic matter is decomposed into simple organic compounds, sulphate, nitrate, water and carbon dioxide.²⁴ Compost formation is a thermogenic (exothermic) process, which can be very well observed in winter when examining a compost heap. This heat helps decomposition, but also plays a role in killing pathogens (e.g. fungi and insect eggs) that colonise decaying plant parts. It also helps to sterilise the compost produced, and later, as the heat is reduced, living organisms (such as worms and ants) reappear. The large amounts of heat produced during composting can be used to build composting boilers.²⁵

The process of compost maturation can be divided into four stages based on the temperature of the compost heap.²⁶

In the introductory stage, microorganisms proliferate rapidly, and intensive heat production begins. In 1-2 days, the temperature of the compost heap can reach nearly 70 °C.

In the decomposition phase, the temperature is lower, and bacteria proliferates and decomposes rapidly at an optimum temperature of around 55 °C.

In the transformation phase, the temperature drops over several weeks, at which point the lignin that makes up the plant cell walls begins to break down. The process produces mono-, di- and triphenol compounds, which are then combined to form humic substances.

During the build-up phase, the temperature drops further and the humification of the organic matter takes place, resulting in the dark brown, blackish colour of the humus. Maturation of the compost is mainly caused by psychrophilic bacteria and moulds. Radiolarians proliferate in compost heaps at 15-20 °C.²⁷

Soils formed by life activity have two main components: 1. animals and their remains, and 2. high molecular organic humic substances formed from dead plants. The latter are acidic organic colloids with an amorphous structure.²⁸

During composting, dead organic matter is transformed by the activity of aerobic microorganisms. A part of them is humified to form compost, which consists of stabilised organic matter, mineral nutrients and microbial ferments. During qualitative changes, the compost is transformed into a material that improves the physical and chemical properties of soils. This is one of the most important purposes of its use. The other main property of humic colloids is that they help plants to take up nutrient molecules.

²³ ALEXA László–DÉR Sándor: *Szakoszerű komposztálás. Elmélet és gyakorlat*. Profikom Kft., Gödöllő, 2001. (Later: ALEXA–DÉR, 2001)

²⁴ COOPERBAND, Leslie: *The Art and Science of Composting. A resource for farmers and compost producers*. University of Wisconsin-Madison Center for Integrated Agricultural Systems, Madison, 2002. (Later: COOPERBAND, 2002)

²⁵ ORSZÁGH József: *Komposztkezés kísérletek*. Komposztkezés Magyarországon, 2014. <http://komposztkezesmagyarorszag.hupont.hu/tovabb> [07. 04. 2024.] (Later: ORSZÁGH, 2014)

²⁶ ALEXA László–DÉR Sándor: *Szakoszerű komposztálás. Elmélet és gyakorlat*. Profikom Kft., Gödöllő, 2001. (Later: ALEXA–DÉR, 2001)

²⁷ SULZBERGER, Robert: *Kompost, Erde, Düngung*. BLV Buchverlag GmbH & Co. KG., München, 2003. (Later: SULZBERGER, 2003)

²⁸ STEFANOVITS Pál–FILEP György–FÜLEKY György: *Talajtan*. Mezőgazda Kiadó, Budapest, 1999. (Later: STEFANOVITS–FILEP–FÜLEKY, 2023)

Materials suitable for composting:

- Kitchen waste: fruit, vegetables, broken eggshells, coffee grounds, tea bags.
- Yard waste: plant remains (dead blossoms, fallen fruit, vegetables and their parts, shredded branches, leaves of trees and bushes, grass clippings, non-tarragonizing weeds).
- Other wastes: non-coloured paper, cardboard, shredded wood not treated with chemicals, sawdust, and wood shavings.

Not to be put in the composter:

- glass, metal and plastic,
- cooked food scraps, bread and bones,
- colourful and glossy newspapers,
- chemical wood waste,
- pesticides and chemicals,
- diseased plant parts,
- peel of Mediterranean and tropical fruits treated with chemicals,
- cooking and motor oil,
- paints,
- batteries and accumulators.

Types of composters best used in educational institutions

Compost heaps

The simplest composting process. Pile organic materials on the surface of the soil or in a small pit. It is ideal if the composter is in a shady place and does not dry out very much. The materials that can be placed in it are very varied, including garden waste, tree trimmings, grass clippings and household by-products. This simple composter is best suited to introducing compost-making to children in kindergartens and schools.

Grid composting frame

Similar in construction and content to the compost heap, but here, a frame is made from fencing wire mesh, slats or logs. This gives a nicer, more gilded impression. It is worth putting together a removable side wall to make it easier to handle the composting material and show the transformation process.

Indoor composter with closed lid

Especially suitable for the treatment of kitchen vegetable and food waste. In this device, the decomposition takes place under anaerobic conditions and does not give off an unpleasant odour due to its enclosure. A starter material containing a rich bacterial flora of fermented cereal bran and molasses is required to initiate the decomposition. In a warm kitchen environment, the bacteria will break down the inserted materials relatively quickly, over a period of a few weeks.

Experience has shown that the most suitable waste materials are:

- vegetables, fruits, grains in raw or roasted/cooked form,
- cheese, dairy products,
- raw or prepared meat, bones,
- coffee grounds, even with filter paper.²⁹

This type of composting can be a great help in households, especially for the quick and hygienic presentation of kitchen waste. Its advantage over the worm composter is that it can also be used for food waste.

The organic matter placed in the composting bin must be slightly compacted to remove air. During the decomposition process, compost tea collects at the bottom of the container and can be used for irrigation or foliar spraying. As this system contains little micro-organisms, the composting process is not complete, and the end result is pre-treated compost that has started to decompose. This material should be placed in an outdoor composter or turned into the soil. If you put it in a larger balcony box, even on a balcony, and layer soil on top, it will eventually turn into potting soil.

Electric kitchen composting machine

Also, for indoor use, even in the kitchen. An electric kitchen composter is a machine similar in size and construction to a breadmaker. It transforms the kitchen waste placed in the composting bin in three phases over a period of 4-8 hours: first it de-hydrates, then it shreds the dry material and finally it cools it.³⁰ The machine produces a chip-like material from the organic waste that is added, which shrinks to almost 20% and is not compost, but is a good compost base material that can be further broken down in compost heaps or soil, increasing its organic matter content.³¹ Electric kitchen composters are an excellent way to introduce and train children to manage organic food waste from kitchens in a way that is suitable for their skills in every household and thus significantly reduce the amount of material going to landfill.

Electric kitchen composter with microorganisms

A very similar machine to the previous one, except that bacteria here carry out significant decomposition. The machine heats a dispersion of the Bacillus ReecleMicrobe starter bacteria mixture in its tank to body temperature. After the bacteria have multiplied, after 18 to 24 hours, the kitchen waste can be added. De-

²⁹ BOKASHI Organko: *What is organic waste in your household?* In: *Collect organic waste*. Bokashi Academy <https://bokashiorganko.com/bokashi-academy/collect-organic-waste> [07. 04. 2024.] (Leter: BOKASHI n.d.)

³⁰ NATURPROJEKT: *Konyhai komposztáló*. Sage FoodCycler elektromos komposztáló leírása. Naturprojekt, n.d. <https://www.naturprojekt.hu/termekeink/konyhai-komposztalo-44>. [30. 04. 2024.] (Leter: NATURPROJEKT, n.d.)

³¹ HAJAS Gyula: *Elektromos konyhai komposztológépet teszteltünk – ez lehet a jövő?* Greendex. 2022. <https://greendex.hu/elektromos-konyhai-komposztalogepet-teszteltunk-vajon-ez-a-jovo/> [02. 04. 2024.] (Leter: HAJAS, 2022)

pending on the quality of the raw materials, the bacteria will complete the decomposition in 2 to 24 hours.³² The end result is almost finished compost. The device performs the waste transformation quietly, odourlessly and is very suitable for use in confined spaces.

Worm composting (vermicomposting)

The most spectacular is composting with different worm species.³³ Most worm composts are made with one of four species of earthworms: *Eisenia fetida* (Savigny 1826), *Eisenia andrei* (Bouché 1972), *Perionyx excavatus* (Perrier 1872) or *Eudrilus eugeniae* (Kinberg 1867).³⁴ The compost does not need to be turned or aerated during the worm composting process because the worms aerate the plant remains by their burrowing and movement.³⁵ Worm compost generally contains more nutrients than other composts, especially those that are easily taken up by plants³⁶. In some experiments, the use of worm compost in horticultural crops increased shoot biomass by 78% and root development by 57%.³⁷ The higher temperatures of the compost heap kill microorganisms that are not thermophilic and cannot tolerate environments that often heat up to 60-70 °C. Worm compost contains plant growth-promoting hormones (e.g. auxin, gibberellin and cytokinin) produced by bacteria.³⁸ Worm composts can be made both outdoors and indoors. In the first method, the organic material is piled up in a prism or a box. It is beneficial for the worms to cover it, because dung worms do not like light. This can also be demonstrated to children by disturbing the compost to show the worms. Shining a light on them will quickly make them retreat into the dark interior of the pile. Indoor worm farming can be quite spectacular because the animals can be reared in containers that are closed on all sides, with a hinged top or one side

³² GAMMO: *REENCLE elektromos komposztáló termékleírása*. GAMMO, n.d. https://gammo.hu/re-encle-elektromos-otthoni-komposztalo-14-literes-106?gad_source=1&gclid=CjwKCAjwrcKxBhBM EiwAIVF8rNeUh7Goi8M6q346VO6r_aAenznczBYDr5dCbMnWpznhCiwLooWonxoCT_UQAvD_BwE [02. 04. 2024.] (Leter: GAMMO, n.d.)

³³ CHANU, L. J.–HAZARIKA, S.–CHOUDHURY, B. U.–RAMESH, T.–BALUSAMY, A.–MOIRANGTHEM, P.–YUMNAM, A.–SINHA, P. K.: *A Guide to vermicomposting-production process and socio economic aspects*. Extension Bulletin 2018/81. ICAR Research Complex for NEH Region, Umiam 793 103, Meghalaya. [02. 05. 2024.] (Leter: CHANU et al. 2018)

³⁴ EDWARDS, Clive–ARANCON, Norman–SHERMAN, Rhonda: *Discovery and Development of New Species for Vermiculture*. In: Edwards, Clive A., Arancon, Norman Q., Sherman, Rhonda L. (eds.) *Vermiculture Technology*. CRC Press, Boca Raton, USA, 2010. [02. 03. 2024.] (Leter: EDWARDS–ARANCON–SHERMAN, 2010)

³⁵ GRAND, Abraham: *Gilisztakomposzt*. Best4Soil, 2021. <https://best4soil.eu/videos/5/hu> [10. 04. 2024.] (Leter: GRAND, 2021)

³⁶ STEWART, Amy–LOWENFELS, Jeff: *The Complete Guide to vermicomposting*. Nature's Footprint, Inc. Bellingham, 2013. <https://naturesfootprint.com> [10. 02. 2024.] (Leter: STEWART–LOWENFELS, 2021)

³⁷ BLOUIN, Manuel.–BARRERE, Julien.–MEYER, Nicolas–LARTIGUE, Silène–BAROT, Sébastien–MATHIEU, Jérôme: *Vermicompost significantly affects plant growth*. A meta-analysis. *Agron. Sustain. Dev.* 2019/39. (34). [10. 04. 2024.] (Leter: BLOUIN et al., 2019)

³⁸ VIJAYABHARATHI, Rajendran–SATHYA, Arumugam–GOPALAKRISHNAN, Subramaniam: *Plant growth-promoting microbes from herbal vermicompost*. In: Egamberdieva, D., Shrivastava S. & Varma, A. (eds.): *Plant-growth-promoting rhizobacteria and medicinal plants*. Springer, Cham, Switzerland, 2015. [10. 09. 2022.] (Leter: VIJAYABHARATHI–ARUMUGAM–GOPALAKRISHNAN, 2015)

of glass. In this way, children can directly observe the movements and feeding of the worms.

Use of compost in educational institutions

We can use the compost we make with the children for the following purposes:

- In their immediate environment (kindergartens and schools) we can demonstrate the decomposition of organic matter in nature.^{39,40} They will be able to see how the organic waste they put in the compost is transformed and the end product will be similar to soil. In this way, we can model soil formation that is continuous in nature.
- Composting can be used to reduce the amount of waste. Organic waste collected by children can be processed by composting to produce valuable nutrient soils.
- The resulting compost can be used in school or kindergarten gardens to improve soil fertility or to grow houseplants. The compost will increase the nutrient content of the soil, allowing more organisms to live in it, and thus produce bigger and more beautiful crops. Children can directly see the benefits of their work and eat the plants they produce.⁴¹
- Alternatively, the compost tea produced as a by-product or from soaking the compost can also be used as a supplement to irrigation water. Regular irrigation with compost tea significantly enhances plant growth. Similar results can be obtained by spraying the diluted tea on the leaves.⁴²

Activities used in composting

- Choice of composting method. Not applicable for kindergartners, but we can discuss the types of composters with primary school students. The teacher can show them the advantages and disadvantages of each device and process and provide them with information about the possibilities of the educational institution. The simplest are compost heaps and grid composters. Worm composters can also be set up for a small budget. Both methods can be used to demonstrate the composting process and to do it together with children. Composting machines are spectacular and fast, but due to their price most kindergartens and schools cannot afford them. However, by regularly monitoring and applying for tenders, institutions with smaller budgets can get access to these modern machines. Compost heaps, grid composting frames and composting with worms are considered the best options because of their ease

³⁹ HUMUSZ1 (n.d.). *Így légy aktív! Programötletek óvodáknak, óvodásoknak.*

<https://humusz.hu/komposztalj/ovodaknak> [15. 03. 2024.] (Leter: HUMUSZ1, n.d.).

⁴⁰ HUMUSZ2 (n.d.). *Így légy aktív! Programötletek iskoláknak, iskolásoknak.*

<https://humusz.hu/komposztalj/iskolaknak#levelkomposztalo> [15. 03. 2024.] (Leter: HUMUSZ2, n.d.).

⁴¹ URL2 <https://www.iskolakertprogram.hu> [15. 03. 2024.] (Leter: URL2, n.d.).

⁴² HALLER Gábor: *Komposzttea talajkondicionáló készítmény forgalomba hozatali és felhasználási engedélye.* Földművelésügyi És Vidékfejlesztési Minisztérium Növény- és Talajvédelmi Főosztály, Bp., 2004. (Leter: HALLER, 2004).

of implementation and the best visualisation of the process, as well as their usability in domestic educational institutions.

- Compost bin assembly. To prepare the compost heap, it is sufficient to dig a pit in a corner of the nursery or school garden, preferably in a shady place. This activity can also be done by children. Using their small spades and shovels and their buckets, they should dig a hole 2 metres by 2 metres and 0.5 metres deep. Pile the excavated material on the edge of the pit so that less soil needs to be moved. Due to the dangerous nature of the composting frame, young children should be restricted in its assembly. They should be observers, and the teacher should constantly explain to them the process and why the implementor is using it. It is not necessary to dig a pit when assembling the composting frame. A frame of bricks or concrete formwork can be used instead of slats. These can be assembled by stronger children, but care must always be taken to avoid injuries. Dry-assembled frames are unsafe and can be broken by children, so it is advisable to glue the individual elements together with a bonding agent (mortar or tile adhesive). The worm composter can be made in several ways: the simplest is to use a wooden or plastic crate, but you need to drill a hole in the bottom of the crate to allow the compost tea to flow out. The other method is to stack at least two large buckets or crates on top of each other, with a spacer in the bottom to allow a few centimetres of space between the two containers. Holes are drilled in the bottom of the upper pot, and the compost tea that drains out of the bottom collects in the bottom crate. If you fit a removable plug or openable tap, the liquid can be easily extracted. Children are restricted in assembling the frame of the worm composter because of the risk of accidents, but they should carry out the filling themselves. They shall put pieces of less treated cardboard paper, some grass and dry leaves in a box. Then, they shall place the worms on these and cover them with leaves or a thin layer of potting soil. After piling, they shall moisten (water) and then cover with damp cloths.
- Waste collection. Children should be shown where the composting material can be collected. Green plant waste from kindergarten and school gardens, non-tarred plant parts, leaves and grass clippings can be used. They can also collect them in their yards and gardens and place them in the composter themselves.
- Waste sorting. It is very important for children to learn about compostable materials. In particular, plant parts can be used to make compost, but they can also put in small amounts of paper. Bones, stone fruit peels, stones, metals and chemicals should not be put in the composter. Layer the landfill materials, alternating between so-called green and brown waste. Sorting the contents of the bins can be a spectacular experience for children. When monitoring the bins, participants should use protective gloves, and the teacher should take care to avoid infectious and disgusting materials. Dumpster monitoring is a very good way of examining the composition of household waste and separating materials that can be recycled by composting from those that cannot.
- Operation of the composter. The composting bins should be filled with selectively collected compostable material. This process can be carried out by

children. Even kindergarten children can collect the "fuel" for the composting bins. Naturally, their actions should be constantly monitored by teachers, who should constantly encourage them and explain the purpose of the work: what we are doing and why. The composters under discussion can be fed continuously. After the initial start-up, the organic waste generated can be put into the composter immediately after sorting. Feeding the composter can be an individual task, but group work is recommended in kindergartens and small schools. Compost bins should be moistened by watering during dry periods. This can be done using small watering cans or hoses. The compost heap should be aerated seasonally, either by turning it over or by moving it to another location. Draining the compost tea from the worm composter is a spectacular event, so prepare it properly, let the children see the liquid, help them to tap and understand it. Running the composter is not a daily task, but it should be tended to often. Children should see the meaning and benefits of working continuously. The teacher should explain to them the meaning of their activity at each phase.

- Examine the composition of the compost. In well-assembled compost bins, not only organisms that are not visible, but also organisms that can be observed with the naked eye or a small magnifying glass, multiply rapidly. These are of great interest to children. They like to see moving animals in the compost, and the sight is accompanied by lively and sometimes loud reactions. Take a sample of the inside of the compost heap and spread it out on a sheet of white paper on a table. Use tweezers or a pair of scoopers to spread out the compost material with small wooden spoons (ice-cream sticks). With the help of the teacher, separate the materials found at different stages of the transformation process. Let them see if the raw materials can be identified. Let them look for living organisms in the compost material. First with the naked eye, then with the use of magnifying glasses. The kindergarten teacher and the teacher show them how to use a magnifying glass correctly. As the children grow, they can hold larger magnifying glasses in their hands. They can observe organisms that are difficult to see with a magnifying glass using a stereo microscope. Young children have difficulty using microscopes, especially binocular tools. Digital microscopes that provide a projected image of the object being examined on a small screen are best for young children. The children can watch this together, while the teacher can explain the characteristics of the organism they are looking at. Worms in a worm composter are relatively easier to study because they are larger and less mobile. One observation may be the feeding of the worms. By providing suitable conditions, the feeding of worms can be studied. To achieve this, it is advisable to place the worm composter in a box with a glass plate on one side so that the worms can be examined without disturbing them. Care should be taken that dung worms do not like light and will retreat into the compost heap under stronger light. Another main area of observation of worms is to understand the worm-like movement. If the worm is not disturbed, it will soon move. Study the forward progress, observing how the animal can move by observing the contractions of different parts. The third observation is to study their body structure. The most important thing for this is the teacher's attention and explanation.

- Examining the use and effects of compost. Use the compost that have been created with the children together. In small gardens in educational institutions, you can turn it into the soil or simply spread it around plants. Make compost tea from the compost by wetting it. All this can be done by children, who can load their buckets with a small shovel and then dump it in a trench or scatter it around plants. In the latter case, watering is very important, so that the leachate from the compost is absorbed into the soil and the plants can feed on it. You and your children can also plant plants in flowerpots or balcony boxes. In this case, mix the compost with potting soil. To demonstrate the benefits of compost, always have plants that have not been treated with compost or compost tea. Constant monitoring and recording of plant measurements is very important. With the kindergarten children, record the measurements taken at different times with a stick or a paper tape. Mark the measurements well on the scale and compare the marks with the child during later measurements. The schoolchildren should be reading off the rulers and measuring sticks or tapes. They shall learn the methods of measurement and use the instruments. Record the measured data on paper or digitally, together with the date and the name of the organism measured. Later, these quantified data should be compared. In addition to recording quantitative attributes, it is important to assess qualitative attributes. These may include: plant colour, stem thickness, size and quantity of flowers and fruits, etc. Have pupils look for similarities and differences between compost-treated and untreated plants by observation.

Methods used in composting

- Fertilisation. During compost making and maintenance, children actively participate in the learning process and acquire knowledge and skills through hands-on activities. The method is based on active participation, hands-on experience, group work and cooperation, creativity and problem solving, as well as deeper understanding and long-term memory. In this way, activity-based learning helps students to develop deeper understanding, develop problem-solving and collaborative skills, and foster long-term memory.
- Observation. During composting, a variety of observation methods can be used to monitor the process itself and the quality of the compost. These observation methods can help to monitor the progress of the composting process and assess the quality of the compost. Regular monitoring and evaluation will enable the necessary interventions to be made and the composting process to be successfully completed.

Temperature measurement: during composting, the activity of micro-organisms causes the temperature of the compost to rise. Temperature measurement helps to monitor the composting process and to maintain the optimum temperature. This can be done by using a thermometer placed in the middle of the compost.

Smell: During composting, properly decomposed materials give off a pleasant, earthy smell. If the compost has an unpleasant smell, this may indicate that the process is not working properly or that the compost is too wet or too dry.

Checking water content. Checking the moisture content of the compost will help determine if water needs to be added or if the compost needs to be aerated. To do this, the compost should be squeezed with a hand tool and the moisture content checked.

Visual observations: During composting, visual changes can be observed, such as changes in the colour of the compost, decomposition of organic matter, the presence of earthworms, etc. These observations help to evaluate the composting process and results.

Compost quality testing. The compost can be inspected for the presence of visible materials, such as fragments, plastics, and by assessing the grain structure and colour of the compost.

Group work. The cooperative learning method is an excellent way to organise group work when teaching composting. The principles and forms of this method can help students to understand more efficient and community-based composting.

Cooperative group work. Unlike classical group work, cooperative group work involves students actively working together and solving tasks together. Groups are heterogeneous in composition and members take on different roles, which promotes effective division of labour and responsibility. Cooperative group work provides opportunities for communication between learners, helping each other and working towards a common goal.

Group task solving. Students work together to solve composting problems. In group problem solving, pupils think together, discuss problems and find solutions together. This method develops communication and problem-solving skills as well as the ability to work in groups.

Project-based group work. For example, in teaching composting, a composting project can be assigned to groups in which students research and document the composting process.⁴³ Project-based group work develops research, presentation and collaboration skills.

The cooperative learning method thus promotes not only the transfer of knowledge, but also collective collaboration, which is particularly important in the teaching of composting.

Direct experience. While making compost, children can experience the large amount of waste in their environment. These organic materials of different origins can be decomposed in relatively simple ways and do not pollute landfills, and the compost produced can be used in a wide range of ways in crop production. By following the process and being involved in each stage, students can see how waste is transformed. When the teacher shows them the sequence of changes, they can see for themselves the processes that take place in nature without human intervention. This is a great way to model the natural cycles of matter. They can also see for themselves the beneficial effects of the compost used in the institutional gardens, and consume the products produced.

⁴³ HUMUSZ3: *Így légy aktív! – Programötletek civil szervezeteknek és informális közösségeknek (klubok, társasházak, közösségi kertek)*. HUMUSZ, n.d. <https://humusz.hu/komposztalj/civil-szervezeteknek> [15. 03. 2024.] (Leter: HUMUSZ3, n.d.)

Seeing cause and effect relationships. The teaching of composting can demonstrate a number of cause-and-effect relationships that help students to understand and become more aware of sustainability and the balance of nature. The effect of micro-organism life activity on the temperature of compost. During composting, the temperature of the compost increases due to the activity of micro-organisms. High temperatures promote decomposition and the release of nutrients from the compost. The cause-and-effect relationship is intense life activity > temperature rises > rapid decomposition and nutrient release.

Organic matter decomposition and soil nutrition: during composting, organic nutrients decompose, decomposition products increase the nutrient content of the compost. By mixing the compost into the soil, we increase its fertility, which helps plants to grow.

Waste reduction and environmental protection: composting recycles organic waste, reducing the burden on landfills. By increasing soil fertility with the resulting compost, less fertiliser and pesticides are needed, which are often harmful to the environment. Composting therefore helps to protect our environment.

Sensitisation to environmental problems. The teaching of compost making can use sensemaking methods to help students understand and appreciate this important environmental practice more deeply. Sensitisation aims to develop awareness and empathy for environmental problems.

Visits to composting plants. The teacher should organise a visit to local composting sites, community composters or small gardens where students can see the composting process in action. This can help them understand the practical aspects and benefits of composting.

Discussions and debate. The teacher should ask the students about their own experiences of composting, why they think it is important and what they think the impact is on the environment. Talking through composting-related activities can help to raise awareness and sensitisation.

Environmental films and documents. Films showing the huge amount of waste produced by mankind will make children aware of the importance of waste reduction. Then films and documents on composting will show how and why waste reduction is possible. These can not only provide information but also develop an emotional connection with the subject.

Creative projects. School pupils can create posters, presentations or essays on composting. This can help to raise awareness and sensitisation.

Educational opportunities

Developing cognitive functions. Through active exploration of reality, children learn about the form, space, volume and colours of the environment. Their sense of orientation, their sense of time, the differences in size and quantity develop almost imperceptibly, while their vocabulary expands, and their expressive skills improve.

Learning to compost is an excellent way to develop cognitive functions for children of all ages. Composting is a complex process involving many scientific

- and engineering principles and offers an excellent opportunity to practice critical thinking, problem solving and decision-making.
- The educator will relate composting to scientific concepts, explain the biological and chemical processes involved in composting, and explain how composting is a process of thinking, thinking, thinking, thinking and thinking.
- The student should learn about the different organisms involved in composting (earthworms, micro-organisms, etc.) and investigate the properties of the materials used in composting.
- Use activities that require teacher decision-making. Ask students to choose between compostable and non-compostable materials. Discuss the possible advantages and disadvantages of composting. Help students to make decisions about composting.
- The teacher should make composting fun and interactive. Play games and activities related to composting. Read stories and books about composting. Keep a composting diary or draw pictures of composting.
- When teaching composting, it is important to be patient and support students according to their individual abilities. Encourage students to ask questions and explore. Teaching composting can provide a meaningful learning experience for both children and adults.
- Develop motor skills. Composting is an excellent way to develop children's motor skills. Composting involves children in a range of physical activities that help develop gross and fine motor skills, coordination and balance. In addition, composting can be used to develop hand-eye coordination and dexterity. Teachers can develop children's motor skills in the following ways:
- Ensure children actively participate in composting tasks. Ask children to collect compostable materials in the garden or kitchen. Help children to chop and mix compostable materials. Have children turn and wet the compost.
- Make composting fun and playful. Play composting-related games with children, such as compost searching or compost sorting. Make composting-related pictures and figures with children. Sing songs and sayings about plants and animals.
- Develop community relationships through group activities. Composting is a teamwork-based activity that allows children to work together, share responsibility and learn to build compromise. In addition, teaching composting can also serve to promote environmental awareness and a commitment to sustainability, which can strengthen children's sense of community and responsibility. Celebrate the finished compost together, with the active participation of the children. They should also emphasise the success of their joint work by harvesting and consuming the composted crops they have produced together.
- Physical (body) development through different movements and physical effort. During composting, there are many opportunities for physical activity: collecting and sorting compostable materials, turning the compost and spreading the compost are all activities that increase physical fitness.
- Developing environmental awareness. Teaching children to compost is an excellent way to develop environmental awareness. Composting is a sustainable practice that helps reduce waste and improve soil quality. Teaching com-

posting to children can help them understand the concept of a circular economy and encourage them to be more responsible stewards of the environment. Teachers can help pupils to develop environmentally aware behaviour by carrying out the following activities:

Explain the benefits of composting. Talk about composting as a way to reduce waste. Explain how compost improves soil quality. Discuss the environmental benefits of composting, such as reducing soil pollution.

Involve children in the composting process. Ask children to collect compostable materials from the garden or kitchen. Help children to chop and mix compostable materials. Have children turn and wet the compost.

Compost waste generated at school. Talk about the importance of composting as part of everyday life.

Organise field trips or excursions to learn about composting activities in other communities. Take children on field trips to community composting sites, composting events or to the municipal compost pile.

Education for sustainable farming. Composting is a great opportunity to develop the concept of sustainability. It helps children to understand how to reduce and recycle waste. They can be educated to understand that reusable materials are better for the environment than single-use materials. They should learn about the importance of waste selection and recycling. Composting is a simple, yet effective process for processing some of the waste by converting surplus organic matter into compost that increases soil fertility. Through composting, children can understand the cycles of matter in nature.

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Abstract

A KOMPOSZTÁLÁS FELHASZNÁLÁSA A HULLADÉKCSÖKKENTÉS ÉS AZ ANYAGKÖRFORGÁS TANÍTÁSÁBAN

A háztartásokból kikerülő hulladék jelentős mennyisége olyan szerves anyag, amely viszonylag egyszerű eszközökkel lebontható. A keletkezett komposzt felhasználható a kertekben a növénynevelés során.

A tanulmány bemutatja a komposztálás főbb alapelveit, valamint azokat az eszközöket és eljárásokat, amelyek az iskolákban is jól használhatók. A komposztálás során a gyermekek konkrét tevékenységsor elvégzésével megismerik a természetben végbemenő anyagkörforgást és a szerves hulladékok mennyiségcsökkentésének módjait. A saját munka révén közvetlenül tapasztalatokhoz jutnak. Az alkalmazott módszerek: a tevékenykedtetés, megfigyelés, közvetlen megtapasztalás, folyamatkövetés, az ok-okozati összefüggések felfedezése. A tanulói munka a fizikai munkavégzés megszerettetésén keresztül olyan készségek és tulajdonságok kialakulását segíti, amelyek pozitívan hatnak a gyermekek közösségi kapcsolatára és a kötelességeik teljesítésére.