University of Zagreb
FACULTY OF GEOTECHNICS

Carbon footprint of food waste in hospitality sector

Varaždin, October 2022.

FACULTY OF GEOTECHNICAL ENGINEERING, Hallerova aleja 7, HR - 42000 Varaždin Tel.: + 385 (0)42 408 900, Fax: + 385 (0)42 313 587 OIB: 16146181375 E-mail: ured.dekana@gfv.unizg.hr www .gfv.unizg.hr

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IZRAĐIVAČ	SVEUČILIŠTE U ZAGREBU, GEOTEHNIČKI FAKULTET Hallerova aleja 7, 42 000 Varaždin
VRSTA DOKUMENTA	Ugljični otisak otpada od hrane u ugostiteljskom sektoru
BROJ DOKUMENTA	Klasa: 602-04/22-16/04 Urbroj: 2186-73-12-22-1 Datum: 03.10.2022.

VODITELJ IZRADE	Prof.dr.sc. Aleksandra Anić Vučinić Ustanova: Sveučilište u Zagrebu, Geotehnički fakultet
SURADNICI	Stjepan Matić, mag.ing.amb. Ustanova: Sveučilište u Zagrebu, Geotehnički fakultet
	Studenti diplomskog studija Inženjerstva okoliša: Matej Ambrozić, univ. bacc. ing. amb. Eleonora Brcković, univ. bacc. ing. amb. Liza Gajski, univ. bacc. ing. amb. Antun Imbrišić, univ. bacc. ing. amb. Martina Leskovar, univ. bacc. ing. amb. Mihaela Mrazović, univ. bacc. ing. amb.

Dekan

Izv.prof.dr.sc. Hrvoje Meaški

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1. INTRODUCTION

Population growth and rapid urbanization along with industrial development and lifestyle changes life and the economic system are the results of the creation of huge amounts of food waste. Waste food is one of the most common global challenges. (1) The infrastructure for food supply and the practice of food consumption changed, which turned out to be global a problem in food systems. Food waste has become one of the prevalent and unsolved problems that the world is still paying full attention to and looking for better ways to resolution. According to reports, about 1.3 billion tons of food is wasted annually. Such a waste of food has potential environmental, social, economic and economic consequences the area that needs to be solved. (2)

Food losses refer to the reduction in the mass of edible food throughout the supply chain. They they arise in the production phase, after harvesting and processing in the food supply chain. Losses that arise at the end of the food chain (retail and final consumption) are called "waste food", which refers to the behavior of traders and consumers. Food waste or loss is only measured for products intended for human consumption, excluding animal feed. (3)

The aim of this document is to show the flow of food waste and to show the method of management food waste. Current bio-waste management options applied in the EU include, in addition to the prevention of biowaste, collection (separate or mixed), anaerobic digestion and composting, incineration, energy recovery and waste disposal. Also, present measures and objectives for reducing food waste. Show carbon footprint values of food waste in the catering sector with different methods of waste management and for different types of food.

2. FOOD WASTE

The Waste Management Act (Official Gazette 84/2021) states the meanings of certain terms as follows:

- *biodegradable waste* is any waste or part of waste that is subject to anaerobic or aerobic decomposition decomposition, such as garden waste, food waste and paper and cardboard;
- *biowaste* is biodegradable waste from gardens and parks, food and kitchen waste from households, restaurants, catering and retail establishments and similar waste from food industry. (4)

It is important to emphasize that biowaste is not the same as biodegradable waste.

Biodegradable waste is a much broader term and refers to all waste that is subject to anaerobic and aerobic decomposition, and refers to garden waste, kitchen waste, biodegradable textiles and paper cardboard.

According to the Ordinance on the catalog of waste (Official Gazette 90/2015), municipal biowaste includes four key ones number of waste (KBO): 20 01 08 (biodegradable waste from kitchens and canteens); 20 01 25 (edible oils you have); 20 02 01 (biodegradable waste from gardens and parks); 20 03 02 (waste from markets). (5)

According to the revised Directive 2008/98/EC of the European Parliament and the Council on waste and disposal certain directives (OJ L 312, 22 November 2008) biodegradable waste is defined as: "wood, waste from food and garden waste, paper and cardboard and all waste that can undergo anaerobic or aerobic decomposition". Biowaste is defined as biodegradable waste from gardens and parks, food and kitchen waste from households, restaurants, catering and retail establishments and similar waste from the production of food products. The origin can be communal, but also production waste. It does not include residues from forestry and agriculture, including manure, sludge from equipment for treatment or other biodegradable waste such as natural textiles, paper or processed wood.
Those by-products from food production that have the status of non-waste are also excluded. (6)

2.1 Amounts of food waste

2.1.1 European Union

The latest estimates show that around 88 million tons of food waste is generated in the EU annually. Therefore, it is equal to 174 kg per person, i.e. a total of 170 million tons of CO2 per year, and from an economic point of view, a total of 143 billion euros that end up in waste. It is estimated that at the level EU households generate 53% of food waste, which is more than half of the total waste. For shops and catering sectors, that share is 70%, and 30% is for the food production and processing sector. Likewise estimates indicate that up to 10% of the 88 million tons of food waste is related to by marking the date because:

- 53% of consumers do not know the meaning of the label "best before",
- 60% of consumers do not know the meaning of the label "use by". (7)

The "use by" date is used for food that is rapidly perishable from a microbiological point of view and therefore, it is likely that after a short period of time it will pose a direct threat to human health. After the "use by" date, food is considered unsafe and must not be placed on the market. This date is indicated by the words: "use by" followed by the date, or the information where to the packaging has a date. The date stamp is made up of the day, month and, if possible, year, in that order and in uncoded form. Examples of foods marked with a date "use by" include, but are not limited to, fresh meat, perishable cakes, sliced meats products, fresh fish, etc. (8)

"Best before" indicates the date until which the food retains its special properties (color, taste, texture and smell) if stored properly. After the expiry of the "Best before until" date, the food is still safe for some time and can be placed on the market and consumed in in certain cases without any risk to health. (9)

2.1.2 Republic of Croatia

According to the Municipal Waste Report for 2020 (HAOP), the total in 2020 generated 488,850 tons of biowaste from municipal waste. In 2020, it was collected separately

118,692 tons of biowaste from municipal waste, which is an increase of almost 22% compared to 2019. year. Thus, the share of separately collected biowaste is 24%. Separate collection biowaste was implemented in 192 LGUs. (10)

In the separately collected quantities of municipal biowaste, 52% is biodegradable waste from kitchen and canteen (KBO 20 01 08), about 47% biodegradable waste from gardens and parks (KBO 20 02 01), and about 1% of edible oils and fats (KBO 20 01 05) and market waste (KBO 20 03 02). (10)

At the beginning of 2022, statistical research data on food waste were presented in Republic of Croatia, and the research was conducted by the Ministry of Economy and Sustainable Development, guided by the new European Union methodology for monitoring food waste. The survey covered 1000 households by about 2,000 units of the business sector, and OPG was included in all of them.

According to research, the total amount of wasted food annually in the Republic of Croatia amounts to 286,379 tons, or 71 kg per inhabitant. Out of the total amount, the total is thrown away in the household 216,345 tons (76%), of which even 86,726 tons is the edible part of the waste. In the business sector that the amount is smaller, a total of 70,034 tons (24%), of which 19,311 tons is the edible part of food. (11) Graphically the amount of food waste is shown in Figure 1.

The largest part of food waste in the business sector is generated in primary production, including OPGs (58%), then in restaurants and catering facilities (22%), followed by processing and production (14%), while the smallest amounts (6%) are generated in retail and other distribution food. (11)

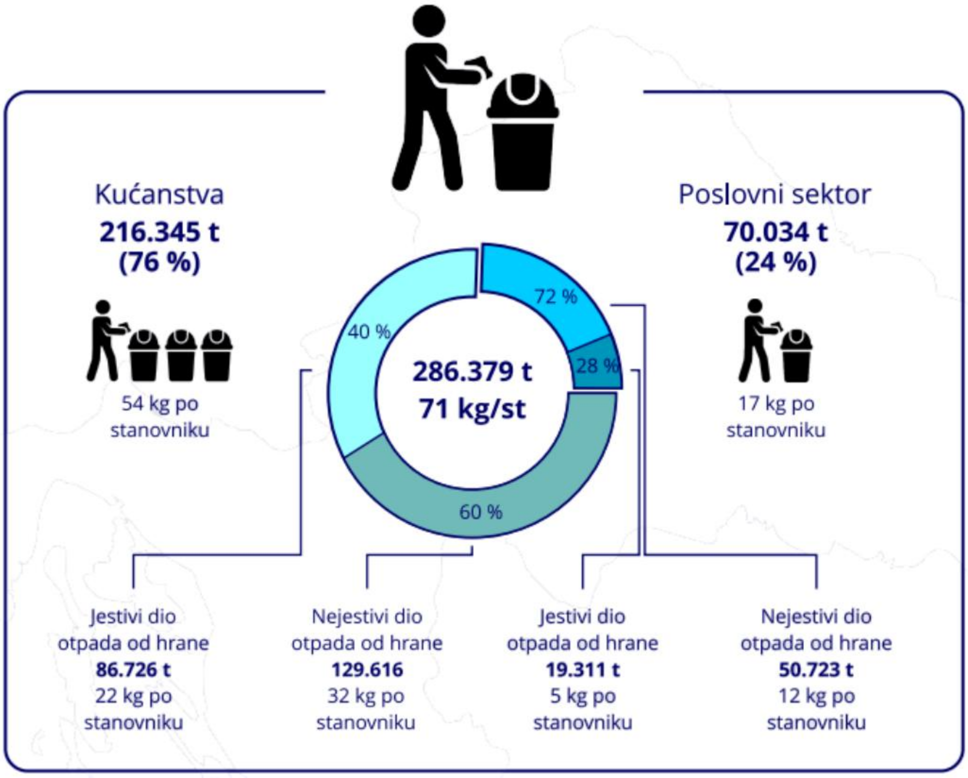

Figure 1 Annual amount of food waste in the Republic of Croatia (12)

2.2 Treatment of food waste

According to the statistical survey on food waste in the Republic of Croatia, and the survey was conducted by the Ministry economy and sustainable development, the most common reason for household food waste in the Republic of Croatia is too much the amount of purchased/prepared food, which is why more than half of households (52%) throw away food. The second most common reason is the expiry of the shelf life, which is why 37% of households throw away food, and the third in the second place in terms of frequency of throwing is food that is destroyed/inedible, which is thrown away by 30% of households. Other causes of food waste are forgetting about food, improper food storage, which leads to food spoilage, not the mood for food consumption. (11)

Also, according to the same research, it was determined that half of the households set aside excess food for animal nutrition. The next most common procedure is disposal in mixed municipal waste (43%), followed by composting (31%) and separation into a container for biowaste (26%). (11)

2.3 Measures and objectives for reducing food waste

It is necessary to work together on the problem of reducing the generation of food waste, but everyone has to start from yourself personally. The sector of food production and processing can influence in several ways reduction of food waste generation, and this goal can be achieved through improvement and adaptation work procedures and management systems of own processes and through the influences that the sector has on consumers of their products. (13)

As a responsible producer, implementing and promoting activities to reduce food waste it will benefit companies and consumers. So, for example, on the packaging of their products, manufacturers food products can include appropriate messages and advice that contribute to strengthening customer awareness on the problem and importance of reducing food waste:

- Proper preservation and storage of food;
  - o read the declaration in order to be informed about the food storage conditions,
  - o freeze food before the expiration date in order to extend the shelf life.
- Do not throw away leftover food;
  - o Put leftovers from lunch or dinner in the fridge and take them to work the next day or use for tomorrow's lunch or dinner,
  - o always use previously purchased products or products closer to expiration first validity,
  - o food that you will not use to share with the needy.
- Take care of the temperature of the refrigerator and freezer;
  - o the temperature of the refrigerator should be between 1-4ºC,
  - o the temperature in the freezer must be below -18 ºC.
- Find out about *the use by* date and best use by date labels . (13)

Every subject in the food business has the goal of successful business and positive business the result. The above is achieved through smart rationalization of costs. Under rationalization costs means reducing costs that can be achieved through better organization business process and motivation of employees in all processes of providing catering services. When rationalizing, it is necessary to look at costs in relation to income. Every expense can be reduced if the quality of the provided service will not be reduced. Especially in catering business, in no case should those costs be lowered, the lowering of which would be necessary, even in to the smallest extent, impaired the quality of the given service. The reasons why the entities dealing with catering companies should implement a food waste reduction strategy in their business:

- better management of all processes in catering (from procurement to serving the guest) which results in financial savings,
- donating food, as one of the effective tools for reducing food surpluses redistribution of surplus food to the needy includes favorable tax treatment and at the same time, it helps the needy, which can be an important marketing tool,
- improves your reputation among guests because it highlights your business as social responsible and socially sensitive business,
- contributes to the care of the environment and the sustainability of the food chain and business in general. (14)

According to the Waste Management Plan (WMP) of the Republic of Croatia for the period from 2017 to 2022. (Official Gazette 1/2022), the goal is to separately collect 40% of biowaste from municipal waste by 31 December 2023, and separate and recycle bio-waste at separately collected places or at the very source of the waste. In order to achieve the goal, the PGO set measures that are implemented in period from 2017 to 2022;

- development of quality criteria and labeling of compost and digestate,
- procurement of equipment and vehicles for the separate collection of biowaste,
- construction of a facility for biological treatment of separately collected biowaste. (15)

The pilot project called *Reduce food waste, cook for your guests* is aimed at reduction of the amount of biowaste, the largest part of which is food waste, and properly separated collection and disposal of waste generated in the hotel sector, respecting the goals from of the Waste Management Act and the Waste Management Plan of the Republic of Croatia for the period 2017-2022. years. The project is implemented by the Fund for Environmental Protection and Energy Efficiency in cooperation with Ministry of Economy and Sustainable Development, Ministry of Tourism and Sports and Geotechnical Faculty of the University of Zagreb. (16)

As part of the project, a manual was created as a valuable tool for hotels in their efforts to reduce quantities of biowaste, especially food waste, because its activities are proposed in a concise manner reduction with successful measures, the methodology for measuring the amount of waste and the calculation is explained financial cost associated with food waste. It is intended for employees of all hotels in Republic of Croatia, regardless of size, location or type, taking into account the fact that it is performed in all of them the activity of preparing and serving food and drinks. (16)

The project is currently being implemented in two hotels - in the hotel "Park plaza Histria" in Pula and the hotel "Osijek" in Osijek. In the framework of various activities and educations, information is collected and posted appropriate methods, in order to ultimately apply the project to the level of the whole of Croatia and also included kitchens from other hotels. Workshops for employees were held in the hotels involved, where they were introduced to examples of hotels that are already operating according to the principle of planned management food, proper storage of food and assessments of realistic amounts of meals. In cooperation with hotel staff conducted measurements in the Osijek hotel, which showed how the reducing the amount of waste by 11%, based on recommendations and consultations carried out with the staff hotel. It started from measuring the total amount of food waste, in ten categories, which are included meat, eggs, bread, milk and dairy products. From the initial measurements, up to 50% the amount of bread decreased, partly because smaller plates were served in addition to large plates, how guests would have a choice and take the amount of food they can eat on their plate. (17)

3. FOOD WASTE MANAGEMENT

Current biowaste management options applied in the EU include, in addition to prevention generation of biowaste, collection (separate or mixed), anaerobic digestion and composting, incineration, energy recovery, waste disposal and processing with food waste processing devices. The ecological and economic benefits of different management methods depend significantly on the local ones conditions such as population density, infrastructure and climate, as well as the market for related products with this type of waste (energy, compost). (18)

At the EU level, about 45% of what is produced annually ends up in composting and anaerobic digestion of municipal biowaste, and about 25% of the amount of municipal biowaste is disposed of. Remaining the quantity is processed by mechanical - biological procedures and incineration. (18)

At the level of the Republic of Croatia, it is estimated that in 2020 it will end up in landfills 326,668 tons of biowaste from municipal waste (separately collected and as an integral part mixed municipal waste), i.e. about 67% of the generated amount. For recovery (composting, anaerobic digestion, etc.) about 21% of the generated biowaste (102,265 tons) was sent, which is an increase of 7 percentage points compared to the previous year. The remaining quantities are mostly ended up as part of mixed municipal waste in management centers waste on mechanical - biological treatment. (10)

3.1 Waste disposal sites

According to the Waste Management Act (Official Gazette 84/2021), the maximum allowed mass of biodegradable material municipal waste, the disposal of which can be allowed in a calendar year with all permits for waste management in the Republic of Croatia is 264,661 tons, which is 35% of the mass of biodegradable of municipal waste produced in 1997, which in 2020 we exceeded by 62,027 tons. The amount of municipal waste deposited in landfills can be the most 10% of the mass of the total produced municipal waste by 2035. (4)(10)

Increased amounts of biowaste in municipal waste put an additional burden on landfills because all the organic part of the waste also contains a certain amount of moisture, which reacts with the other part over time disposed waste. Waste is decomposed and neutralized over time, and due to chemical, physical and microbiological processes, mineralization occurs with the release of heat, water vapor and gases. It is important to point out that the speed of decomposition of these processes within the landfill depends on the composition of the waste, moisture content, type and proportion of organic matter, method of disposal, etc. By disposal of biowaste there are also harmful effects on the environment because the filtrate, i.e. highly polluted, seeps liquid, landfills have to be treated because it contains bacteria and cyanides and could contaminate drinking water underground. (19)

Chemical properties and temperatures within the body of the landfill change through four phases, and they are formed gases such as methane, carbon dioxide, nitrogen and others that tend to leave the body landfills, so they also need to be taken care of. Larger amounts of methane require additional costs due to the obligation to set up a system for collecting landfill gas and energy recovery. Carbon dioxide as a secondary gas also has a negative impact because contributes to the "greenhouse effect". Of course, there is also the problem of unpleasant odors with gases occur, and their intensity depends largely on weather conditions and wind direction. So, less organic components means less harmful impact and shortening the time of all active processes. (19)

Unfortunately, biowaste as a source of food also attracts various animal species such as birds, rodents, reptiles and insects, and if there is no prescribed fence and daily covering with inert material material, larger animals enter the landfill, which increases the possibility of spreading infectious diseases. (19)

From 2005 to 2020, a total of 317 locations of official landfills, of which municipal waste was disposed of at 306 locations. At the end of 2020 a total of 228 closed waste disposal locations were recorded (86 locations have the status closed ex-situ), i.e. 93 active landfills that are obliged to submit data for 2020. year, of which 84 landfills were used for municipal waste disposal, and 9 for disposal production waste. (20)

3.2 Composting

Composting is a natural process in which organic waste (kitchen waste, garden waste, etc.) while creating a rich nutrient fertilizer or soil improver. It's about aerobic biological decomposition of organic matter into a stabilized material, which no longer consumes oxygen creates toxic material. It is a simple and inexpensive process that is not time-consuming. (18)

Compostable fractions of waste are: raw (uncooked) food, organic waste from gardens (no includes soil), most paper and cardboard and other organic materials such as straw, hay, wood wood chips, sawdust and feathers. Cooked food is biodegradable, but not considered compostable. Earth, plasticized and waxed paper are not biodegradable or are biodegradable to a very small extent, and are therefore considered non-compostable fractions. (18) In Table 1 there is a presentation non-compostable and compostable categories of biodegradable waste.

Table 1 Non-compostable and compostable categories of biodegradable waste

Kategorija biorazgradivog otpada	Vrsta otpada	Kompostabilna / nekompostabilna
Kuhinjski otpad	Kora povrća, komadići voća	Kompostabilna
	Vrećice od čaja, čaj u rinfuzi, kava, ljuske jaja, kruh	Kompostabilna
	Kuhana hrana, meso, mliječni proizvodi, riba, kosti i kolači	Nekompostabilna
Vrtni otpad	Komadići grana	Kompostabilna
	Drvenasti vrtni otpad promjera većeg od 5 mm	Kompostabilna
	Zemlja	Nekompostabilna
	Ostali organski otpad npr. biljke, cvijeće, lišće	Kompostabilna
Papir i karton	Kompostabilne, ne-reciklabilne: kuhinjske role, maramice, kutije za jaja, tuljci od wc papira, masni papir	Kompostabilna
	Reciklabilne: novine i časopisi, uredski papir, papirnate vrećice, sjajan papir, omotnice, sjajni karton npr. kutije od žitarica	Kompostabilna
	Nekompostabilna, ne-reciklabilne: plastificirani i slojeviti papir i karton, ukrasna folija za zamatanje poklona, navošteni papir i karton	Nekompostabilna
Ostale kućne kompostabilne vrste	Slama, sijeno, drvna sječka, piljevina i perje	Kompostabilna
Sitni materijal	Ne uključuje komadiće grana	50:50 Kompostabilna / Nekompostabilna

According to the output results of the project Improvements of the data collection system on biowaste and food waste by HAOP (Croatian Environment and Nature Agency) in 2017. 37,626 tons of biowaste were composted in 9 Croatian composting plants. Of that, 78% does biodegradable waste from gardens and parks, while 14% is biodegradable waste from kitchens and canteens. The total capacity for composting in 2017 was 107,689 tons. If taken into account that in 2017, a total of 39,389 tons of biodegradable waste were composted, including biowaste, it can be concluded that only 37% of the available capacity for composting was used. (18)

There are three reasons why organic matter is converted from biodegradable waste into compost:

- avoiding phytotoxicity (changes of different character (e.g. leaf damage, growth retardation) on plants caused by the application of plant protection agents, fertilizers and others chemical agents),
- removal/destruction of pathogenic microorganisms,
- production of fertilizers or means for soil improvement and/or recycling of organic waste i biomass. (21)

From the aspect of environmental protection, composting is a much more acceptable way of disposal biodegradable waste from waste disposal at non-hazardous waste disposal sites or others landfills. Unmanaged biodegradation of waste (decomposition of biowaste) is not considered composting. (21)

Article 22 of the framework directive on waste stipulates the obligation of the members to separate bio-waste and recycling at the source and encouraging home composting. Quantities of biowaste composted in households can also be counted when calculating the municipal waste recycling rate, which can raise the value of the municipal waste recycling rate in a certain proportion. (18)

The key to successful implementation of home composting (quantity and quality of composted waste) is not only in providing households with composters, but also in encouraging and implementing them education on how to properly compost. In contrast to the collection of household biowaste i taken to facilities for processing, home composting, except for using the material as fertilizer or soil improvers have additional benefits:

- the end user separately collects, processes and uses the material at the place of origin which avoids unnecessary pressure on the environment from traffic and the principle is satisfied proximity,
- home composting reduces the need to apply quality improvement products soil and products based on peat,

- home composting of compostable plastics will reduce the amount of mixed plastics that needs to be processed,
- can provide LGUs with potential savings in terms of separate costs collection and processing of biowaste, and thus savings for residents in terms of tax reduction for waste management,
- home composting contributes to reducing the amount of biodegradable waste that ends up on postponement. (18)

3.3 Biogas plant – anaerobic digestion

Since it is produced from biomass that stores solar energy, biogas produced anaerobic digestion is a permanently renewable source of energy. Anaerobic digestion is biochemical a process in which complex organic compounds are broken down by the action of various species bacteria in the absence of oxygen. As a result of this process, biogas and digestate, a fertilizer, are produced has significant advantages compared to raw manure (lack of unpleasant odors, higher nutritional value and better ratio of carbon and nitrogen). When in the process of anaerobic digestion uses a homogeneous mixture of several different substrates such as organic waste and manure, it is called co-digestion. Different types of biomass can be used for biogas production, but manure and slurry, residues and by-products from agricultural production are most often used, degradable organic waste from the agricultural and food industry, the organic part of municipal waste waste and catering waste, waste sludge and energy crops. Energy value biogas is chemically bound in methane. The average calorific value of biogas is around 21 MJ/mn^3. (22)

The amount of digested biowaste in the Republic of Croatia in 2017 was 46,546 tons. According to the types of waste, the amounts of digested biowaste are shown in Table 2. Listed the amount of biowaste was processed in 11 out of 25 biogas plants of total capacity 1,395,809 tons/year. According to data for 2021, there are 70 in the Republic of Croatia biogas plants, but only 21 of them have a permit for waste management, and of those 6 recovers biowaste from municipal waste. (18) (23)

Table 2 Amount of anaerobically digested biowaste in 2017, by types of waste (18)

Vrsta otpada	Naziv otpada	Anaerobna digestija
02 01 02	otpadna životinjska tkiva	13.260
02 01 03	otpadna biljna tkiva	1.395
02 02 01	muljevi od ispiranja i čišćenja	1.489
02 02 03	materijali neprikladni za potrošnju ili preradu	119
02 02 04	muljevi od obrade efluenata na mjestu njihova nastanka	1.315
02 03 01	muljevi od pranja, čišćenja, guljenja, centrifugiranja i separacije	649
02 03 04	materijali neprikladni za potrošnju ili preradu	3.463
02 03 05	muljevi od obrade efluenata na mjestu njihova nastanka	39
02 05 01	materijali neprikladni za potrošnju ili preradu	13.270
02 05 02	muljevi od obrade efluenata na mjestu njihova nastanka	455
02 06 01	materijali neprikladni za potrošnju ili preradu	1.179
02 06 03	muljevi od obrade efluenata na mjestu njihova nastanka	53
02 07 01	otpad od pranja, čišćenja i mehaničkog usitnjavanja sirovina	513
02 07 04	materijali neprikladni za potrošnju ili preradu	2.261
19 08 09	mješavine masti i ulja iz separatora ulje/voda, koje sadrže samo jestivo ulje i masnoće	3.434
Proizvodni biootpad:		**42.894**
20 01 08	biorazgradivi otpad iz kuhinja i kantina	3.150
20 01 25	jestiva ulja i masti	284
20 02 01	biorazgradivi otpad	207
20 03 02	otpad s tržnica	11
Komunalni biootpad:		**3.652**
Ukupno RH:		**46.546**

Biogas, as a product of anaerobic digestion, is used for heat and electricity production energy, while the resulting solid and liquid residues in the form of digestate are accepted after composting as a fertilizer for agricultural areas due to the high content of useful ingredients (nitrogen, phosphorus, potassium) necessary for growing plants. Some of the advantages of anaerobic digestion are:

- absence of smell - farms do not have to be dislocated,
- obtaining high-quality fertilizer - reduced use of artificial fertilizers,
- obtaining biogas - electricity, heating,
- clean water - returning to the digestion process. (24)

3.4 Mechanical-biological treatment of waste

Mechanical-biological waste treatment (MBO) represents a set of technological processing operations of waste resulting in products such as RDF/SRF and stable organic components which

it can be disposed of in a landfill and/or under certain conditions used as a soil improver.
(18)

As part of MBO, it is also possible to separate and recycle useful types of waste, but these materials are not nor approximate quality such as materials separated at the source of origin. Compost as output the product from MBO is usually used for soil recovery, remediation and as a cover in landfills waste, because it may contain a high concentration of metals, plastics and other undesirables material. (18)

The output materials from the MBO plant depend on the composition of the input material. Research is showed that the waste entering the mechanical-biological plant can be used (ensure separation during the process) 4-14% of recyclable waste (metals, plastics...), organic components 38-70%, RDF 0-75%. The proportion of the unusable part that is required set aside ranges from 10 to 25%. (18)

MBO is a technology that represents a tool for reducing the amount of disposed waste. Contributions reaching the goals prescribed by the Directive on landfills, but does not effectively ensure i sufficient recycling to achieve municipal waste recycling goals.
The mentioned technology is intended for processing the remaining waste after separating the useful ones fractions from municipal waste in a satisfactory proportion. (18)

Currently in the Republic of Croatia there are three plants for mechanical-biological treatment of total capacity 289,000 tons/year. One plant is privately owned, while the remaining two are facilities are located within the county centers for waste management (CGO Marišÿina i CGO Kaštijun). During 2017, two MBO plants were active in the Republic of Croatia, which received for processing 92,055 tons of waste, of which 58,440 tons were waste that in a certain part may contain biowaste and food waste. If we take into account the approach according to which in mixed municipal waste (KB 20 03 01) and municipal waste that is not specified in another way (KB 20 03 99) biowaste appears with a share of 37.06%, the total amount of bio-waste that ended in 2017 at MBT facilities amounted to 21,705 tons. (18)

As part of the established centers for waste management (CGO Marišÿina and CGO Kaštijun) the same waste processing technology is applied, which consists of waste shredding, biodrying, allocations: fuel from waste, metal, non-composted fractions of municipal and similar waste and the rest is waste from mechanical processing, after which the non-composted fraction of communal and disposes of similar waste at the bioreactor landfill, and forwards the remaining separated fractions companies authorized for waste management. (18)

3.5 Devices for processing food waste

3.5.1 Device for aerobic treatment of food waste

The Griffon food waste processing device uses technology that simply mimics nature digestion process. It works using the same principles that govern our body and other living things organisms by creating a perfect thermophilic biological environment for microorganisms to they digest food waste into liquid. The devices are installed at the place of origin of waste from food, restaurants, hotels, kitchens of hospitals, schools, etc. thus avoiding the costs incurred the traditional system of transport and waste collection using trucks and bins, and at the same time the amount of waste that ends up in landfills and the emission of carbon dioxide are reduced and of methane that would be generated by its decomposition. (25) (26) Display of the device in Figure 2.

Figure 2 Griffon device for processing food waste (26)

The device works by putting food waste into it, and then adding a certain amount the amount of a mixture of microorganisms which, in the presence of water and oxygen from the air, start process of aerobic digestion of waste. Food waste is digested into smaller pieces, which eventually they turn into a liquid as the only processing product. The liquid is safely filtered through a sieve 0.5 mm in size into the sewerage infrastructure from where the water goes to purification devices wastewater and which can be reused after treatment. The device is easy to use

use and there are different device capacities (149 kg/day, HRK 249/day, HRK 499/day and 999 kg/day). (25) (26) In addition to the Griffon device, there are also devices with the same working principle on the Croatian market Orca devices. (25)

3.5.2 Dehydrators

The ECOVIM device uses technology that turns biowaste and food scraps into organic substrate, reducing the total mass of food waste by 83% - 93%, and the resulting substrate is sent to further processing procedure. Most often to the composting process, and then it is used as fertilizer, i.e. organic supplement to the soil. The device works on the principle of dehydrating waste, and it is possible to can be used for all types of food residues - thermally processed and preparation residues, including fruits, vegetables, carbohydrates (potatoes, dough, bread and rice) and proteins (meat, fish and smaller animal bones). What should be avoided are large animal bones, and plastic, coated paper, glass, cans, metal and chemicals are by no means suitable for processing. (27)

The device is easy to use and there are different device capacities (30 kg/day, HRK 100/day, 300 kg/day, 500 kg/day and 1300 kg/day). For their use, it is necessary to provide a drain process water into the sewage system. The processing time depends on the size of the device: from 6 hours on the smallest Eco's device until 11 p.m. on the largest. With its use, waste processing is carried out on its place of origin, thereby avoiding CO_2 emissions that would be caused by transport, but not completely because the substrate created by processing needs to be transferred to further processing. (27) Display of the device in Figure 3.

Figure 3 ECOVIM device for processing food waste with a capacity of 100 kg/ day (27)

4. CARBON FOOTPRINT OF FOOD WASTE

4.1 Carbon footprint of food waste - general amounts

In the research of Jeswani and associates (2021) it was established that in the territory of the United The Kingdom annually produces 13.1 million tons of food waste throughout the supply chain, which leads to greenhouse gas emissions in the amount of 27 million tons of CO2 eq. per year. Largest the volume of waste is generated in the sub-sectors of cereals (31%) and vegetables (28%). However, meat and fish they have the greatest impact of the total life cycle impact on the environment, although they make up only 10% of the total food waste. Although the generated food waste has the largest contribution, both in terms of the amount of waste and in terms of impact on the environment, the contribution of other phases (primary production, processing, etc.) is also significant food distribution). These data emphasize the need to consider the impact of food waste on environment and engaging all participants in the supply chain in formulating reduction strategies food wastage. In their work, they presented a comparative table of the carbon footprint of food waste which are presented in different literature for different regions, according to which amount of carbon food footprint ranging from 1.9 to 2.9 t CO2 eq. / ton of food waste, shown in Table 3. (28)

Table 3 Carbon footprint of food waste (28)

Research	Region	Carbon footprint of food waste (t CO2 eq. / ton of food waste)
Jeswani et al. (2021) (28)	United Kingdom	2.06
Monier et al. (2010) (29)	Europe	1.9
FAO (2013) (30)	Globally	2.5
Scherhaufer et al. (2015) (31)	Europe	2.9
Scherhaufer et al. (2018) (32)	Europe	2,13

4.2 Carbon footprint of food waste by type of food and processing method

Research by Eriksson et al. (2015) compared the carbon footprint of food waste for different ways of managing food waste in the waste hierarchy in the city of Uppsala, Sweden. A life cycle assessment was carried out for six different management methods food waste, if it ends up in a landfill, incineration, composting, anaerobic digestion, if it is used as animal feed or ends up as a donation. They used for assessment five food products; bananas, grilled chicken, lettuce, beef and bread. Established are that for all five streams of food waste, a waste management hierarchy has been established proved to be useful, but also as an approximate tool for prioritizing different options waste management. (33)

According to the research of Eriksson et al. (2015), the management of where food waste ends up in the landfill it turned out to be the worst option. The greatest potential for emission reduction of greenhouse gases was found in anaerobic digestion (-0.67 to -0.047 kg CO_2 eq. / kg waste food) and donations (-0.61 to -0.013 kg kg CO_2 eq. / kg waste food). Including all modes management, the biggest difference between disposal and donation is for chicken (3.5 kg CO_2 eq. / kg of food waste), while the biggest difference between disposal and anaerobic digestion was for beef (2.8 kg CO_2 eq. / kg food waste), banana (1.8 kg CO_2 eq. / kg of food waste) and green salad (0.30 kg CO_2 eq. / kg food waste), and the biggest difference between disposal and incineration was for bread (2.6 kg CO_2 eq / kg food waste). (33) Presentation of the results of different management methods of food waste can be found in Table 4.

Table 4 Carbon footprint of food according to the method of food waste management and type of food (33)

Way waste management / type of food	Banana (kg CO_2 eq. / kg food waste)	Chicken with embers (kg CO_2 eq. /kg waste food)	Green salad (kg CO_2 eq. / kg food waste)	Beef (kg CO_2 eq. / kg food waste)	Bread (kg CO_2 eq. / kg food waste)
Disposal site	1.40	3.10	0.21	2.10	1.90
Burning	0.10	-0.31	0.25	0.003	-0.67
Composting	0.043	0.043	0.043	0.043	0.043
Anaerobic digestion	-0.38	-0.26	-0.047	-0.67	-0.55
Food for animals	-0.011	-0.038	0.005	-0.030	-0.13
Donation	-0.12	-0.35	-0.013	-0.31	-0.61

In the research of Moult et al. (2018), the carbon footprint of food waste was calculated for different ways of managing food waste for five different foods using a lifetime assessment century, and taking into account emissions from the process of processing waste into useful products, disposal

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food waste and waste transport. The emissions generated in the conversion processes were also taken into account waste food into animal feed, anaerobic digestion, composting and the resulting emissions by dumping food waste at a landfill with 70% gas collection and at a landfill without collection system. In their research, they also calculated the average emissions caused by transport of waste expressed in the unit kg CO2 eq. per kilometer traveled for one ton of food waste.

In addition to the resulting emissions, in their research they calculated the amount of emissions prevented if: donated food waste, became a substitute for grain-based animal feed, produced electricity energy through the process of anaerobic digestion, by burning food waste with energy recovery and energy recovery of the collected gas at the landfill and if it were to be used as a substitute for mineral fertilizers by anaerobic digestion and composting. Amounts the calculated emissions of research by Moult and colleagues (2018) are shown in Table 5. (34)

Table 5 Carbon footprint for different ways of handling food waste for five types food (34)

	Treatment of food waste	**Carbon footprint (kg CO2 eq. / ton of food waste)**					
		Bread	**Cheese**	**Fruit and vegetables**	**Fish Meat**		**By weight average**
–	The process of converting it into animal feed	7	7	7	7	7	7
	Anaerobic digestion process	163	159	43	67	89	89
	Composting process	44	44	44	44	44	44
	Methane emission, landfill with 70% gas collection	848	1.339	408	980	1.333	791
	Methane emission, landfill without system collection	3.181	5.021	1.531	3,676	4,999	2,965
	Emissions from the transport of food waste to processing sites (kg CO2 eq / km t of waste from food)	0.20					
–	Consumption of donated food	1,400 13	700 2,500		2,700 13,	800	5,590
	Substitute for grain-based animal feed	364	1.005	36	1.121	735	369
	Electricity exchange, anaerobic digestion	340	537	164	393	535	317
	Replacement of mineral fertilizers, anaerobic digestion	103	222	17	187	147	85

	Replacement of mineral fertilizers, composting	97	210	16	176	139	80
	Replacement of electricity, incineration with energy recovery	177	283	-36	47	130	74
	Electric replacement. energy, landfill. with collection. gas and energy recovery	238	376	115	275	375	222

According to the obtained results, disposal of food waste in a landfill is the worst way waste management for all foodstuffs, especially for foodstuffs with high energy content value, therefore the diversion of such food from landfills is particularly important. If the food is not suitable for human consumption, the best available option is to convert it into animal feed, after followed by anaerobic digestion, for all five foods except fruits and vegetables, for which it is anaerobic digestion is preferable to conversion into animal feed. However, the reduction of emissions contained in to waste food is never higher than 41% if food waste is converted into animal feed i 20% for anaerobic digestion waste treatment, compared to a 99% reduction in emissions if the food is donated. According to research, the option of incineration of food waste with return of energy is preferable to composting bread, cheese and meat, but not fruit, vegetables or fish. That's it respect, their hierarchy of food waste management differs from the hierarchy of waste from of food published by the EPA and the European Union, although the EU hierarchy is based on a range of environmental criteria, and not only on greenhouse gas emissions, while the hierarchy of the US EPA includes environmental, social and economic considerations. (34)

4.3 Carbon footprint of food waste - devices for processing food waste

With a device for aerobic processing of waste food, the waste could be processed on the spot of its creation, which would avoid the need for its transport and CO2 emissions that would caused by the transport of waste. Given that the device requires electricity to operate, and as the product is water that ends up in the sewage system, the carbon footprint of this method of processing of waste food was calculated according to the energy consumed by the Griffon brand aerobic device, shown in Table 6.

Table 6 Carbon footprint of food waste treatment with an aerobic Griffon device

Model	Max. capacity (kg / h)	Consumption (kWh)	Time to process 1 ton of food waste (h)	Spent electricity. energy for processing 1 ton of food waste (kWh / t)	CO2 emissions - electricity production. energy, - HR (kg CO2 eq. / kWh)	CO2 emissions - electricity consumption. of energy – HR (kg CO2 eq. / kWh)	Total CO2 emissions for processing 1 ton of food waste (kg CO2 eq. / t)
150	7	0.187	142.9	26.7	0.228	0.372	16.03
250	11	0.55	90.9	50.0			30.00
500	23	0.75	43.5	32.6			19.57
1000	45	1.5	22.2	33.3			20.00

For the purpose of calculation in Table 6, the values of CO_2 emissions generated during the event were used production and consumption of electricity in the territory of the Republic of Croatia, which is expressed in kg CO_2 eq. / kWh. For electricity production, it amounts to 0.228 kg CO_2 eq. / kWh, and for electricity consumption 0.372 kg CO_2 eq. / kWh, which is a total of 0.60 kg CO_2 eq. / kWh. (35) Total CO_2 emissions for processing one ton of food waste (kg CO_2 eq. / T) are different, depending on the model of the device, its capacity and the strength of the electric motor, i.e. its consumption. If the average value for all four devices is taken, for processing one ton of food waste with an aerobic device produces a total of 21.40 kg of CO_2 eq.. Additional research the amount of waste water generated during the processing of food waste should be determined aerobic device, in order to be able to calculate CO_2 emissions eq. which arise during the operation of the device for wastewater treatment for the amount of wastewater generated by the operation of an aerobic device. Therefore, by processing waste food with an aerobic device, the emissions that would be generated are prevented if the waste ended up in a landfill without a gas collection system in the amount of 2,943.6 t CO_2 eq. / t of food waste and emissions caused by transport in the amount of 0.20 kg CO_2 eq / km t food waste.

Food waste processing devices - dehydrators, reduce the total mass of food waste by 83% - 93%, and the resulting substrate is sent for further processing, most often composting. Considering that the operation of the device requires electrical energy, and the product is a substrate that goes to further processing, the carbon footprint of this way of processing waste food is calculated according to to the energy consumed by the ECOVIM brand dehydrator, to the CO_2 emissions generated by the process composting and transport of the resulting substrate to its place of processing. (27) Display of calculations is in Table 7.

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Table 7 Carbon footprint of processing food waste with a dehydrator device of the ECOVIM brand

Model	Max. capacity t (kg / h)	Consumption (kWh)	Time for treatment of 1 ton of food waste (h)	Spent electricity. energy for processing 1 ton of food waste (kWh / t)	CO2 emissions - electricity production. energy, - HR (kg CO2 eq. / kWh)	CO2 emissions - electricity consumption. of energy – HR (kg CO2 eq. / kWh)	Total CO2 emissions for processing 1 ton of food waste (kg CO2 eq. / t)
EN-30	3.33	1.8	300	540	0.228	0.372	324
EN-100	6.67	3,2	150	480			288
EN-300	14,29	10	70	700			420
EN 500 LW	21.74	15	46	690			414
EN 1000/150 0	56,52	23	17.7	407.1			244.3
Composting process (kg CO2 eq. / ton of food waste)			44				
Emissions of transporting the resulting substrate to the processing site (kg CO2 eq / km t of food waste)			0.20				

For the purposes of calculation in Table 7, the same data on the value of the CO2 emission that is generated were used during the production and consumption of electricity in the territory of the Republic of Croatia, which is expressed in kg CO2 eq. / kWh as per the need of Table 6.. Also for the dehydrator device in total CO2 emissions for processing one ton of food waste (kg CO2 eq. / T) are different, depending on the model device, its capacity and the strength of the electric motor, i.e. its consumption. If take the average value, for all five devices, when working to process one ton of waste from the food dehydrator device produces a total of 338.05 kg CO2 eq / t of food waste. Additionally, more emissions are generated by the process of composting the resulting substrate, which amounts to 44 kg CO2 eq. / ton substrate and transport emissions of the resulting substrate to the place of processing in the amount of 0.20 (kg CO2 eq / km t of substrate), for which the data from Table 5 from the research of Moult and associates were used (2018). (27,34,35)

If it is taken into account that processing 1 ton of food waste with a dehydrator reduces its mass food waste by 85%, and that the remaining 15% represents the resulting substrate that needs further processing processing, i.e. 150 kg of substrate. It can be done with the help of emission values that arise during the event of the composting process and transport of the resulting substrate, calculate the total carbon footprint. On occasion of work for the processing of one ton of food waste with a dehydrator device results in a total of 338.05 kg CO2 eq., additionally another 6.6 kg CO2 eq. for the composting process, 150 kg of the resulting substrate and 0.03 kg CO2 eq / km for 150 kg of the resulting substrate, i.e. 1.8 kg CO2 eq for the transport of a maximum

60 km to the place of processing, all in total processing with a dehydrator device produces 346.45 kg of CO_2 eq / t food waste.

4.4 Carbon footprint of food waste - transportation of food waste

According to research by Moult and colleagues (2018), the carbon footprint of food waste transport amounts to a total of 0.20 kg CO_2 eq. per kilometer traveled for one ton of food waste. (34) Po according to the rules of the profession, the distance from the place of origin of the waste to the place of its disposal should be be within a radius of a maximum of 60 km, where during the transport of waste for that distance is generated emission of a total of 14 kg CO_2 eq. / tons of food waste. By aerobic processing of waste food devices at the place of waste generation, waste transport is not required, and thus they are prevented CO_2 emissions that would result from this.

4.5 Food waste streams and the carbon footprint of food waste

Food waste streams with emissions resulting from food waste disposal through each disposal options are shown in Figure 4. To show food waste flows for different ways of food waste management, the values from Table 5 were used, which were extracted from research by Moult et al. (2018) and calculated values of the carbon footprint of food waste created by devices for processing food waste from Table 6 and Table 7.

Figure 4 shows four main columns:

- **CO_2 emissions caused by different methods of food waste management:** aerobic devices, dehydrators, donation, processing into animal feed, process anaerobic digestion, burning, composting and disposal of food waste to a landfill with 70% gas collection and to a landfill without a collection system.
- **Prevented CO_2 emissions** represent the amount of CO_2 that has been prevented by a certain process. In the case of food waste processing devices, the prevented CO_2 emissions are shown in such a way that food waste did not end up in a landfill and no transport was required places of processing. For other methods of food waste management, values were used

from Table 5, which are the processes: consumption of donated food, use as food for animals, use of produced electricity, use as a substitute for mineral fertilizers, energy recovery of collected methane at the landfill i by burning the collected methane from the landfill on a flare.

- **Net CO2 emissions** are expressed as the difference *of CO2 emissions created in different ways food waste management* and prevented *CO2 emissions .*
- **The priority for the management method** represents the most desirable management option food waste in relation to the carbon footprint.

Donating food causes the smallest carbon footprint of all food waste disposal options regardless of the type of food, followed by the disposal of waste food with an aerobic device and dehydrator devices. Conversely, landfilling leads to the highest net carbon footprint footprint, increasing if the volume of released-uncaptured methane is greater.

Prevention of CO2 emissions is also achieved by converting waste food into animal feed and anaerobically by digestion. Composting and incineration are considered to have similar CO2 emission values, a both are preferable to landfills, for which CO2 emission values are very high even for modern landfill with efficient collection and use of gas. (34)

Figure 4 Food waste streams and the carbon footprint of food waste

4.6 Carbon footprint of food waste in the catering sector of the Republic of Croatia

According to the results of a statistical survey on food waste in the Republic of Croatia, which conducted by the Ministry of Economy and Sustainable Development in 2021 according to the new methodology of the European Union for monitoring food waste in restaurants and catering facilities ended up with a total of 15,072 tons of food, of which even 4,834 tons of the edible part of the food ended up in waste. (11)

Carbon footprint of food waste generated in restaurants and catering facilities in the area of the Republic of Croatia for 2021 was calculated in two ways. With the help of values that found in Table 4. average carbon dioxide emissions were calculated if the food ended up as waste. The values obtained by the mentioned calculation are in Table 8.

Table 8 Average emissions t CO_2 eq. for food waste in the Republic of Croatia for 2021

Research	**Average values of the carbon footprint of food waste (t CO_2 eq. / ton of food waste)** 2.06	**CO_2 emissions sampled by food waste in the Republic of Croatia for 2021 (t CO_2 eq.)**
Jeswani et al. (2021) (28)		31,048.32
Monier et al. (2010) (29)	1.90	28,636.80
FAO (2013) (30)	2.50	37,680.00
Scherhaufer et al. (2015) (31)	2.90	43,708.80
Scherhaufer et al. (2018) (32)	2,13	32,103.36

According to the calculation from Table 8 of the average emission t CO_2 eq. for food waste in the Republic of Croatia for 2021 caused by throwing away 15,072 tons of food, are in the range from 28,636.80 to 43,708.80 t CO_2 eq. depending about the expressed average value of the carbon footprint of food waste (t CO_2 eq. / ton of food waste) in the conducted research. Which is equivalent to 6,170 to 9,418 passenger vehicles on petrol engine in trains for a year, an average of 18,540 km per car, or for neutralization of the generated emissions requires between 473,499 - 722,716 tree seedlings that will grow for 10 years. (36) In the event that the edible part of the food did not end up in the waste, average values emissions would be 32% less.

With the help of the weighted average values of the carbon footprint found in Table 5, calculated are average carbon dioxide emissions for different ways of waste management as an example amount of food waste generated in the Republic of Croatia in 2021. The obtained values, specified by calculation, they are in Table 8.

Table 9 Carbon dioxide emissions t CO_2 eq. for different ways of waste management on the example of quantity food waste in the Republic of Croatia in 2021

Management method	Carbon footprint (t CO_2 eq. / ton of food waste)	CO_2 emissions sampled by food waste in the Republic of Croatia for 2021 (t CO_2 eq.)
Donation	-5,590	-84,252.48
Food for animals	-0.362	-5,456.06
Anaerobic digestion	-0.313	-4,717.54
Burning	-0.074	-1,115.33
Composting	-0.036	-542.59
Landfill, 70% of captured CH_4 with energy recovery	0.569	8,575.97
Landfill, 70% of captured CH_4 burning at the torch	0.791	11,921.95
Landfill, 0% CH_4 captured	2,965	44,688.48

The calculated CO_2 emissions sampled by food waste in the Republic of Croatia for 2021 are additionally required increase for the emissions that occurred during the transportation of food waste to the place of disposal, in the value of 0.20 kg CO_2 eq. per kilometer traveled for one ton of food waste. According to according to the calculation from Table 9, the best way to manage food waste in the Republic of Croatia, as confirmed in the research of Moult et al. (2018), it is donating food that causes the lowest carbon footprint footprint from all food waste disposal options, which would prevent the emission of a total 84,252.48 t CO_2 eq., but given that the generation of food waste cannot be avoided this way food waste management cannot be fully realized. A good system of waste management, positive results could be achieved, which were obtained if the waste food is processed by processing it into animal feed, anaerobic digestion, burning or composting, i.e. the goal is to avoid food waste ending up in a landfill. If i ends up in a landfill, it would be desirable for the landfill to have a methane collection system that would then be used for energy recovery. This would make emissions t CO_2 eq. were almost five times less than if the waste ends up in a landfill without a waste gas collection system.

Calculation of carbon footprints of food waste processing with food waste processing devices that are created in restaurants and catering facilities in the Republic of Croatia in 2021 is in Table 10.

Table 10 Calculation of carbon footprints by food processing devices

Device type	Amount of food waste in the catering industry in the Republic of Croatia in 2021 (t)	Average CO_2 emissions for processing 1 ton food waste (t CO_2 eq. / t)	Carbon footprint of processing with an aerobic device (t CO_2 eq.)
Aerobic devices	15,072	0.0214	318.02
Waste dehydrator from food		0.34645	5,221.70

If the 15,072 tons of food waste that was created in restaurants and catering establishments in the territory of the Republic of Croatia in 2021, processed with the help of devices for aerobic processing of waste food, the carbon footprint would be 318.02 t CO_2 eq., or 5,221.70 t CO_2 eq. if would be processed with a dehydrator device. If we compare the obtained amount with the values from Table 8., we can determine that the treatment of food waste with an aerobic device would prevent emissions of CO_2 eq. in the amount of 28,381.63 to 43,453.63 t CO_2 eq., and the dehydrator with a device of 23,415.10 to 38,487.10 t CO_2 eq. on the territory of the Republic of Croatia.

5. CONCLUSION

The establishment of an effective food waste management system is necessary for the sake of environmental protection, more efficient use of resources, but also economic and social benefits. Even with strict preventive measures programs and policy changes that will encourage food redistribution, food waste from housing, institutional and commercial sectors will never be eliminated because certain waste from food is inevitable. The procedures involved in reducing food waste should be at the top hierarchies of food waste management. Food, even if it loses its commercial value, it often retains its nutritional properties and has economic and social value, which is why it is needed treat. (37)

By studying professional scientific literature, CO_2 eq emission values were calculated which generated by food waste from the hospitality sector in the Republic of Croatia in 2021. year for a total of 15,072 tons of food waste, of which as much as 4,834 tons is the edible part of food. (11) Therefore, average emissions t CO_2 eq. for food waste in the Republic of Croatia for 2021 is in the range from 28,636.80 to 43,708.80 t CO_2 eq. depending on the expressed average value of the carbon footprint of food waste (t CO_2 eq. / ton of food waste) in the conducted research. In case yes the edible part of the food did not end up in the waste, the average emission values would be lower by 32%.

Considering the way food waste is managed, the best way would be to donate food would prevent the emission of a total of 84,252.48 t CO_2 eq., but given that the generation of waste from food cannot avoid this method of food waste management is not possible to achieve, however emissions of t CO_2 eq would be significantly reduced . as much food as possible to donate, actually donates. The above would be achieved with a good waste management system and respecting the hierarchy of waste management.

Food that cannot be donated, it is preferable that food waste ends up being processed as food for animals, by anaerobic digestion, incineration or composting, i.e. in order to avoid it that food waste ends up in a landfill. If it ends up in a landfill, it would be desirable the landfill has a methane collection system that would then be used for energy recovery, thereby emissions t CO_2 eq. caused by food from waste at the level of the Republic of Croatia for the year 2021 amounted to 8,575.97 t CO_2 eq.. Calculated CO_2 emissions sampled by food waste required additionally increase for the emissions that occurred during the transportation of waste from food to the place disposal, in the value of 0.20 kg CO2 eq. per kilometer traveled for one ton of waste from food.

In order to reduce food waste, processing devices should receive additional attention waste food. After the option of donating food, the treatment of waste food with aerobic devices is the first the most desirable option for disposing of this type of waste. A device for processing waste food can be installed at the place of origin of food waste (restaurants, hotels, hospital kitchens, schools, etc.) which would avoid the costs incurred by the traditional system of transport and waste collection by using trucks and bins, and at the same time, the amount of waste that ends up in landfills is reduced and emissions of carbon dioxide and methane that would result from its decomposition. Average emissions CO2 for processing 1 ton of food waste with an aerobic device amounts to 21.40 kg CO2 eq. / t of waste from food, and dehydrator devices 346.45 kg CO2 eq. / t of food waste.

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