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Legal Regulations and Methods Neutralising Expired Food Products

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ABSTRACT

In retail chains, an expired product is withdrawn from sales and becomes waste which should be managed properly. Expired products cannot be placed back on the market for sale, sold at a reduced price or in promotion. The losses in the food trade result mainly from an inefficient organisation and excessive stocks that cause food expiration and perishability. In this chain, the expired food products, which in majority go to landfill sites, constitute a significant part. This article presents the legal regulations regarding neutralisation of expired food products together with their utilisation possibilities. One of the basic documents is the Directive 2009/28/EC of the European Parliament and the Council of 23 April 2009 on the promotion of the use of energy from renewable sources. The second important document is the Directive of the Council 1999/31/EC on the landfill of waste. According to the Regulation No 852/2004 of 29 April 2004 on the hygiene of foodstuffs, every facility should have elaborated procedures describing the manner of handling foodstuffs not meeting the requirements of health quality as well as food waste. One of the most often applied methods to manage waste is its thermal treatment. Incineration is problematic in environmental and social aspects. It includes numerous requirements and legal restrictions. Pyrolysis is an alternative to incineration. Composting in aerated bed is a widely known utilisation method of biological waste from agriculture and agri-food industry. Mineralisation of organic substances in biogas plants is a method for controlled course of processes aiming at the production of greenhouse gases, the negative effect on meteorological conditions of which is unquestionable in many social circles. Biomass fermentation in biogas plants is prospective because it enables to limit the emission of methane during uncontrolled biochemical processes accompanying landfill of waste.

Keywords: expired food products, neutralising organic waste, legal regulations, methods neutralising

INTRODUCTION

According to the EU report (European Commission 2010), the average food losses in the EU countries amount to 11.7%. According to the FAO Report (Gustavsson et al. 2011) they are at least 30% and according to the Natural Resources Defence Council they are up to 50% in the case of easily perishable products (Gunders 2012). Currently, expired food, thrown away by the processing industry – trade and gastronomy, constitutes the biggest part of the waste. In Poland, about 500 thousand tons of food a year is wasted in this way (Byczyński 2012). The same material, energy and financial outlays are incurred to manufacture damped food as in the case of consumed products. Wasting and then throwing food away increases the use of mineral fertilizers which contributes to the environmental pollution.

LEGAL REGULATIONS

In order to ensure energy security and withstand the climate change, European Union conducts the policy oriented towards limiting energy requirements. One of the basic documents is the Directive 2009/28/EC of the European Parliament and the Council of 23 April 2009 on the promotion of the use of energy from renewable sources (O.J. EU L 09.140.16). This Directive presumes that the share of renewable energy in the total energy use in Poland till 2020 should be on the level of 15%. The second important document is the Directive of the Council 1999/31/EC on the landfill of waste (O.J. EU L 182 of 16 July 1999, page 1). According to the binding law, in 2020 the amount of biodegradable waste which will be allowed on landfill sites is to be reduced by 65% in relation to the base year 1995.

State Sanitary Inspection is obliged to control the facilities under its supervision, according to the binding regulations, including the Act of 14 March 1985 on State Sanitary Inspection (J of Laws 2006 No 122, item 851, later amended) and the Act of 25 August 2006 on food safety and nutrition (J of Laws of 2010, No 136, item 914, later amended). The agencies of the State Sanitary Inspection supervise the food waste management in controlled facilities and check documentation, including the documents identifying the food producers and receivers as well as the agreements with the companies obliged to collect waste. This guarantees that the food which does not fulfil requirements will be utilised. Depending on the type of waste and its purpose, proper agreement should be made between the entrepreneur and the recipient of the waste operating on the basis of the Act of 14 December 2012 on waste (J of Laws of 2013, item 21, later amended) or on the Regulation (EC) No 1096/2009 of the European Parliament and the Council of 21 October 2009 laying down health rules as regarded animal by-products and derived products not intended for human consumption. Additionally, in the Regulation of the Minister of Environment of 10 November 2015 on the list of types of waste that natural persons or non-business entities may recover for their own needs and acceptable recovery methods (J of Laws 2015, item 93) changing the Regulation of 21 April 2006, 12 items were crossed out, including the waste with the code 16 03 80, i.e. expired food products or unsuitable for consumption.

According to the Regulation No 852/2004 of 29 April 2004 on the hygiene of foodstuffs (O.J. EU L 139 of 30.04.2004, p. 1, later amended) every facility should have elaborated procedures describing the manner of handling foodstuffs not meeting the requirements of health quality as well as food waste, having regard to eliminate potential contamination of other raw materials and finished products. In accordance with this Regulation, the food waste and non-edible by-products in production and food trading facilities are to be stored in closed containers which need to be properly constructed and maintained in good condition, easy to clean and disinfect. This is a basic way for a hygienic and environmentally-friendly removal of food waste from such facilities.

The position of the Ministry of Environment clearly determines that the use of colloidal grinders is contrary to the binding regulations from the environmental protection. According to the Act of 18 July 2001 Water law (J of Laws of 2005, No 239, item 2019, later amended) it is prohibited to dispose of waste– within the meaning of the Act on waste – as well as liquid animal excrement, into water. The provisions of the Act of 7 June 2001 on collective water supply and sewage removal (J of Laws of 2006, No 123, item 858, later amended) implemented the prohibition of waste input into sewage. According to this Act, it is forbidden to input solid waste into the sewage system, which could decrease the sewage pipes capacity, especially including gravel, sand, ash, glass, pomace, yeast, bristles, cuttings of furskin, textiles, fibres, even if shredded. The food waste should be neutralised or recycled with the use of different methods.

Expired food of animal origin or containing products of animal origin which are not hazardous is regarded as raw material category 3 (Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009). In a disposal plant, the expired food products are subjected to the thermal processing and combustion is the most often used method. Products may also be processed in composting plants or in digestion installation where pasteurisation and hygienization processes need to be included.

METHODS NEUTRALISING EXPIRED FOOD PRODUCTS

One of the most often applied methods of waste management is its thermal treatment. Thermal waste utilisation means a set of consistent technological segments realising waste combustion, recovery and use of heat generated by burning, treatment of exhaust gases and other combustion products as well as preparation of combustion products and exhaust gases for economic use or storage. Such set of installation technological segments fulfils the legal requirements (Skowron 2003). Thermal combustion may take place in waste incineration as well as in utility boilers. Implementation of the projects aiming at the construction of waste thermal treatment units requires applying reliable and tested technologies.

Currently, the only such technology is grate combustion. This technology, created in the first half of the 20th century, is systematically developed and updated and is applied to both lower calorific value waste (4–6 MJ/kg) as well as to high calorific value waste (12–18 MJ/kg). In the case of lower calorific value waste, air-cooled grates are used with special system of mixing remains subjected to burning, whereas in the case of high calorific waste, grates are water-cooled. Such grates operate in a few hundred installations worldwide. No other technological solution allows to combust such lower calorific value waste as grate incineration. Rotary kiln incinerators to autothermal work require waste with calorific values of minimum 15–18 JM/kg and chamber incineration plants – of minimum 16–19 MJ/kg (Marchwińska and Budka 2014). Regarding technical parameters, universality and reliability, the only type of incineration plant which may be compared to grate incineration plant is fluidized bed incineration. However, it requires initial waste shredding which decreases the amount of generated net useful electric power. The application of these technologies is limited by high costs which are generated by the most technologically advanced incineration plants as well as the difficulties connected with achieving complete combustion.

As a result of thermal disposal and utilisation of organic waste, the problem of air pollution produced by incineration plants arises. The exhaust fumes contain highly toxic chemical compounds such as polychorinated dibenzo-para-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), commonly called dioxins and furans, which – if they infiltrate into the environment – pose a serious threat (Grochowalski et al. 1993, Sokołowski 1994, Yoshimura and Masuda 1994 and 1996). Dangerous pollution comprises nitrogen oxides which, together with exhaust fumes, connect with ozone and then transform into nitric acid (V). It reacts with metals and drops with rain in the form of salt. As a result of reaction with hydrocarbons toxic organic nitrate, perioxides are created. Significant and common exhaust gases pollution is sulphur dioxide. If the commonness of organic waste combustion is assumed, the problem of excessive air pollution with sulphur dioxide and carbon dioxide (increases the existing greenhouse effect) as well as carbon monoxide (a very toxic gas created by incomplete combustion) will return. In the exhaust gases after thermal disposal of waste the hydrogen chloride appears as well, which is water-soluble and forming hydrochloric acid and hydrogen fluoride – corrosive gas that is also easily soluble in water. Exhaust fumes may also contain heavy metals. Removal of those substances from waste gases is usually difficult and expensive (Marchwińska and Budka 2014). Every company building incineration plants has their own checked grates and heat-recovery systems together with boiler configuration. There is no preferred type of grate (besides currently unadvisable – cylindrical-shaped grate) as well as structural form of the boiler or required parameters of produced steam. The only but significant limitation is achieving the required energy efficiency index above 0.65. Then, the combustion process is regarded as a recovery operation (Wielgosiński 2012).

Incineration is problematic in the environmental and social aspects. It includes numerous requirements and legal restrictions (Gawłowski 2011, Piecuch 2006, 1999). There is a need to select such combustion technology which will be accepted in economic and ecological aspect and will not have social resistance (Nowak 2013, Mokrzycki and Uliasz-Bocheńczyk 2005, Piecuch 2006, Poskrobko B. and Poskrobko T. 2012).

Pyrolysis is an alternative to incineration. It is a set of physicochemical processes which need to be initiated and conducted to obtain effects in the form of thermal decomposition of solid, liquid or gas fuel of different types of hydrocarbon making organic substance in waste without oxygen. In the process of pyrolysis, due to the lack of oxygen, no toxic compounds such as PCDDs and PCDFs are created (Piecuch 2006). This method is used for particular groups of waste which must be selected from the whole mass of waste delivered to the processing plant. The group of waste whose utilisation by pyrolysis is effective includes mainly organic chemical products such as: plastics, tires, paints, varnishes, cosmetics and other plastics. The biggest merit of this process and its main advantage over combustion is the fact that it is safe for air cleanness. However, the process of bonding post-pyrolytic secondary waste and secondary waste after combustion (slags) is similar (Piecuch 2006).

Composting in aerated bed is widely known as a utilisation method of biological waste from agriculture and agri-food industry (Błaszczyk 2007, Matcalf and Eddy Inc. 2003). It is based on the biochemical processes consisting in decomposition of organic substances. Composting is generally conducted in two stages (Manczarski 2007):

I. intensive composting (thermophilic stage) – in this stage fresh compost is obtained from organic waste. The material is hygienised, easily degradable substances are decomposed, potential odour emission is decreased;
II. maturing stage (mesophilic stage) – during this stage mature compost is obtained from fresh compost. Hard degradable substances are decomposed and stable humus structures are created, resistant to the external factors and rich in nutrients.

The time of each phase depends on the composition of the composted biomass and the applied technology. Aerobic mineralisation is an exothermal process and the intensity of decomposition depends on the compounds susceptibility to it. Fats, majority of proteins and sugars including starch are easily decomposed, whereas hemicellulose and cellulose are harder to decompose. Lignin and proteins from scleroproteins group such as keratin are very resistant to decomposition (Manczarski 2007). The most significant parameter of composting is temperature which may even exceed 70°C (Yamada and Kawase 2005). Such high temperature is detrimental to the majority of thermophilic microorganisms taking part in the decomposition of organic matter in the thermophilic phase of composting. A temperature decrease in the composting bed may be achieved by increasing the degree of aeration; however, the results are not always as expected. It is also important to maintain moisture in the composted material between 50 and 70% through the whole period of microorganisms' activity. On the other hand, excessive aeration may cause drying of pile which may result in decreasing the activity of microorganisms or even hinder the whole process (Sołowiej et al. 2010).

There are many composting systems, depending on the adopted criteria (Staszczyk 2003). The simplest way involves the process conducted in piles with periodic waste mixing. It is conducive to the homogenisation of substrate mix subjected to composting and provides the oxygen necessary to the proper course of the process (Aniszewska 2007, Baeta-Hall et al. 2005). The advantages of this composting method are mainly low investments costs and simple technology (Puyuelo 2010). The greatest disadvantages include huge space requirements and susceptibility of piles to weather conditions, especially if there is no roofing (Czekała et al. 2013). The second group of composting methods constitute closed technologies. They are characterised by the fact that the processes take place in reactors, usually chambers or containers (Olszewski et al. 2005). During operation, they have a large energy demand. They require an installation with precise aeration and chamber leachates seizing systems (Boniecki et al. 2012). The construction and exploitation of such installations are connected with large financial outlays but are compensated by many advantages. The most significant ones include: precise process control, independence from the weather conditions and the possibility to recover and use heat from the installation (Czekała et al. 2013).

The greatest advantage due to which this method is popular in many countries is low financial expenditures. Maintenance of optimal process parameters such as proper temperature and moisture as well as access of oxygen necessary for microorganism development may be achieved with the use of specialised measuring equipment. Additionally, appropriate fraction of previously sorted waste is selected (Kucharczak et al. 2010). More and more problems are caused by the compost management – the main product of composting – due to the protection of agricultural products against soil pollution. Very strict restrictions have been implemented regarding the amount of harmful substances in all materials applied into the soil. This mainly concerns the amount of heavy metals and some organic pollutants as well as the sanitary-epidemiological safety (Manczarski 2012).

Mineralisation of organic substances in biogas plants is a method for controlled course of processes aiming at the production of greenhouse gases, the negative effect on meteorological conditions of which is unquestionable in many social circles (Węglarzy et al. 2011). The biomass fermentation in biogas plants is prospective because it enables to limit the emission of methane during uncontrolled biochemical processes accompanying a waste landfill (Szlachta 2008, Szlachta and Fugol 2009). Fermentation is a biochemical process occurring with the participation of microorganisms and their enzymes. As a result of organic matter conversion, methane and carbon dioxide are obtained (Pilarski and Adamski 2009). Fermentation fulfils three functions, it enables to (Ledakowicz and Krzystek 2005):

- convert the energy from waste into a useful fuel (biogas) which may be stored and transported,
- recycle organic waste into stable soil improvers, liquid fertilizer and energy,

- make the waste inert, aiming at decreasing the negative impact on the environment.

The organic waste from such industries as: agriculture, meat industry, dairies, distillers, breweries and fruit and vegetables processing may be successfully used in biogas plants (Curkowski et al. 2013).

The applied technological process as well as used substrates influence the composition of obtained biogas. Biogas mainly consists of methane, carbon dioxide and hydrogen oxide (Cebula 2012) and the amount of methane decides about biogas quality and usefulness. Table 1 presents the chemical composition of biogas according to different sources (Mollera et al. 2004, Arvanitoyannis and Kassaveti 2008, Luostarinen et al. 2009, Lansing et al. 2008). Table 2 (Lewandowski 2012, Rosik-Dulewska 2006, Romaniuk et al. 2010) presents content of biogas components and pollution as well as their effects. The potential of biogas production mainly depends on the availability of raw materials (Dinuccio et al. 2010).

Biogas is produced constantly and does not depend on weather conditions. Its application has the following advantages (Lewandowski 2012):

- it decreases the use of non-renewable resources and emission of compounds produced during their combustion as well as lowers the greenhouse gasses emission,
- it reduced odours by over 80%,
- it eliminates pathogens in the process of hygienisation,
- it enhances the conditions of soil fertilizers and eliminates synthetic fertilizers in agricultural crops,
- it decreases the risk of surface and ground waters contamination and enables to improve the water efficiency,
- it allows the developing countries to increase the level of civilisation by providing light, electricity and water.

The production costs are similar to the costs of electric energy from the power grid and with higher interest rates, they may even be lower.

The production of energy from biogas has its weaknesses. The most significant ones include high investments connected with the construction of tanks, fermenters, acquisition of engine, generator, control-measurement instruments, but also the necessity to strictly comply with the re-

Table 1. Biogas chemical composition

Source	Biogas composition [%]					
	CH_4	CO_2	N_2	H_2	H_2S	O_2
Mollera et al. 2004	55–75	25–45	0–0.3	0.1–0.5	0–3	0.1–0.5
Arvanitoyannis and Kassaveti 2008, Luostarinen et al. 2009	50–75	25–50	0–2	0–1	0–2	0–1
Lansing et al. 2008	52–85	14–18	0.6–7.5	0–5	0.08–5.5	0.1–0.2

Table 2. The content of biogas components and pollution as well as their effects (Lewandowski 2012)

Component	Content	Effect
Methane	45–70%	• Determines calorific value. • With the content >45% biogas is combustible. • With the content 5–15% biogas and air mixture is highly explosive
Carbon dioxide	25–50%	• Decreases calorific value • Causes corrosion (low concentration carbonic acid) when the gas is moist. • Damages alkaline fuel cells
Hydrogen sulphide	0–0.5%	• Causes corrosion of appliances and pipes (many engine manufacturers defines maximal level of 0.05%) and with the content of 40 mgm^{-3} gas desulphurisation is conducted. • SO_2 emission behind burner, H_2S emission with incomplete combustion. • Decreases the effect of catalysts.
Ammonia	0–0.05%	• NO_x emission behind the burners.
Water vapour	1–5%	• Causes corrosion of appliances • Condensate may damage appliances and installations • Risk of freezing pipes and nozzles system
Dust	>5 pm	• Blocks nozzles and fuel cells
Nitrogen	0–5%	• Decreases biogas calorific value • With high temperature of burning it creates dioxides and trioxides (NO_2, NO_3)
Siloxanes	0–50 mgm^{-3}	• Are abrasive and damage engines

gimes of fermentation processes such as: temperature, pH, balanced hydraulic retention time and constant level of organic compounds wasteload, homogeneity of substrate mix and air-tightness (Lewandwski 2012).

The post-fermentation sludge, rich in nutrients, is a byproduct of anaerobic decomposition of organic matter. Although huge amounts of post-fermentation sludge require special utilisation method, it should not be treated as waste but rather as a valuable source of minerals and energy. It may be used in agriculture or in natural areas, thermally processed or ultimately deposited at a landfill site. Each of the described methods has both advantages and disadvantages and affects the environment in a different way. Therefore, the methods should be selected depending on the composition of digestate, characteristic features and geographical location of the area of its designation so that they are safe and cost-effective. In Poland, the post-fermentation sludge is usually thermally utilised or used in agriculture. Large part of sludge is landfilled; however, this method should not be used because it does not bring any benefits. Fertilisation or energy potential generated in the substance is lost. Application in agriculture, in contrast landfilling, is very beneficial due to appropriate fertilisation properties of the post-fermentation sludge. The thermal use enables producing additional energy as well as valuable ash, which may be used as fertiliser owing to high amount of minerals.

CONCLUSION

1. About 1 to 3% of food production includes perished or expired foods, i.e. thousands tons every year. Shops still rarely use the services of disposal companies which means that waste is dumped. Hypermarkets and supermarkets lower prices and make discounts; with huge turnover, they constantly have products requiring utilisation. Therefore, they sign agreements for collecting the expired food. Improperly managed waste poses a threat to human health and pollutes the environment.
2. Realisation of the sustainable development concept is achieved among others by proper waste management. The newest research indicates that food waste does not have to be deposited on landfill sites. They may be a valuable material in processing because microelements might be recycled from them (Galanakis 2012, Kazimierowicz 2014,2017, Śmiechowska 2015).
3. According to the author, the applicable legal regulations and methods for neutralizing this type of waste are sufficient.

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