Food Waste Processing Relationships with Environment Protection

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The aim of the present study was to analyze food waste generation and processing relationships with environment all around the world and, especially, in Romania. We are really facing a lack of information regarding the food waste generation in Romania. Thus, we further aimed the food waste characterization in two independent areas of Iaşi city as the starting point for the management development of such wastage. The clear conclusion is that of a generalized lack of education concerning the selective source-sorting. The population might be mobilized and we'll obtain quick and accurate responses, especially in the areas with medium-high income.

Keywords: food waste, processing, environment, selective source-sorting

The United Nations' Food and Agriculture Organisation (FAO) determined that around 1.3 billion tons represent annually the food wastage across the world (one-third of generated food). Meanwhile, 870 million people go hungry every day. But FAO says this vast waste not only generates extremely high economic losses but damages climate, water, land and biodiversity [1].

Food waste has important economic, social, and environmental implications. Thus, it is the largest source of global greenhouse gas emissions after China and the USA. The carbon footprint of food produced and not eaten is estimated at 3.3 Gts [billion tones] of CO_2 equivalent [1]. At the European level, the overall environmental impact is at least 170 Mt of CO_2 equivalent released per year. This corresponds to the generation of food waste in the EU estimated at around 89 million tons or 179 kg per capita per year. An average of at least 1.9t CO_2 equivalent t of food wasted is estimated to be released in Europe during the whole life cycle of food waste. Households produce the largest fraction, at 43% of the total. Estimate of annual food waste related emissions in 2020 might be 240 Mts. Thus, by 2020 estimates suggest that the food waste will increase to 126 million tons. European Union (EU) household sector is really responsible for around 45% of estimated annual greenhouse gas (GHG) emissions due to food wastage [2].

Food waste is generated at large quantities at all levels of the food production and consumption chain, in both developed and developing countries, throughout the year [3].

Landfill disposal has been traditionally used for food wastes. But, finally, there is the problem of landfills availability. That's why alternative ways to divert food wastes from landfills have been introduced i.e., composting, anaerobic digestion to generate biogas (due to the high organic carbon content), use of food waste disposers. The supply to livestock market as raw materials for animal feeding production, or for direct animal feeding, or for free donation to non-profit organizations could be a more effective way to manage such products under the economic environmental and social standpoint [4].

In Romania, the food waste is estimated to be around 2.5 mil tones, meaning 1/3 of food generation. The aim of the present study was the food waste characterization in two independent areas of Iaşi city as the starting point for the management development of such wastage. Moreover, detailed food waste characterization is indispensable for food waste management [5].

Experimental part

The experimental plan was developed in two areas of Iaşi city: one with medium-high income where are almost no livestock and poultry (area A) and one with medium-low income with livestock and poultry (area B).

The experimental basis was adapted to a previous one [6]. There were selected a number of 50 houses in each case-study area, representing 20% of all households. The solely selection criteria was the acceptance of the residents to collect selectively the food waste for 12 weeks in strong garbage bags. 20% of the bins used for the whole disposal waste were randomly selected for analysis each time. The analysis was performed on the day of normal, weekly waste collection in both areas (Tuesday and Thursday). All waste in each selected bin was analyzed. A total of almost 7.3 t of waste was analyzed over the study period. All weights were recorded as wet waste. Visible contaminations of food waste or similar were removed during the analysis, but the method did not correct for moisture content and minor contaminations of dry waste materials. Residents were generally unaware of the waste composition analyses. The same waste composition analysis method and analysis team were used on all occasions [6]. The composition analysis usually lack information about the criteria for the definition of food waste categories and the classification of food items [5].

Four indicators were used in the evaluation: the specific generation of separately collected food waste (kg/household, week) was determined based on weighting of separately collected food waste; the source-separation ratio (mass%), defined as the mass of collected source-separated recyclable material in relation to the sum of the same material-sorted, mis-sorted and unsorted-in disposed waste; ratio of impurities (mass%), defined as the mass of mis-sorted (i.e. incorrectly source-separated) materials in relation to all disposed waste in the particular fraction (correctly sorted and mis-sorted); and the specific food waste generation (kg/household, week) was determined based on results from waste composition analyses, adding

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amount of food waste found in residual waste to the amount of food waste separated by households, excluding the weight of mis-sorting [6, 7].

Excel software was used to conduct Student T-test, completed with Mann Whitney Rank Sum test, to assess the significance of statistical differences. The significance was determined with probability (p) values i.e., $p < 0.05$ corresponding to a 95% confidence level.

Results and discussions

Results from weightings of separately collected food waste over the 12 weeks of experiment in both areas are shown in figure 1.

As it is evident from figure 1, there is an average difference of 37.5% between the amounts segregated-collected food in A and B case-study areas. This difference might be induced by the use of food wastage for feeding livestock and poultry in B area.

Results from waste composition analyses performed in both areas are presented in figure 2.

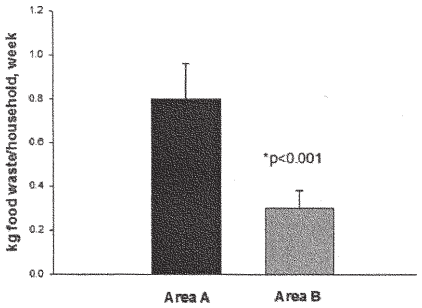

Fig. 1. Average amount of separately collected food waste in A and B areas per household and week (12 weeks experiment). *Values of $p < 0.05$ were considered statistically significant.

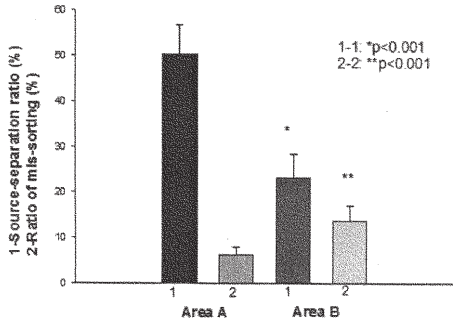

Fig. 2. Waste composition analysis in A and B areas: source-separation ratio (%mass) and ratio of mis-sorting (%mass) household and week (12 weeks experiment). *.**Values of $p < 0.05$ were considered statistically significant.

The differences between A and B areas are very clear. There exists an average difference of 46.29% for the source-separation ratio (%mass). The higher value in the case of A area is due to the increased care and responsibility. This conclusion is highlighted also by the average difference of 45.98% for the ratio of mis-sorting, higher this time in the case of B area.

Another important conclusion is that the amounts of food discarded differed between households, ranging from 5% to 27% (data not shown). The lowest value might be well correlated with livestock and poultry feeding, especially in B area.

Estimation of municipal solid waste composition generated in A and B Iaşi city areas is shown in figure 3.

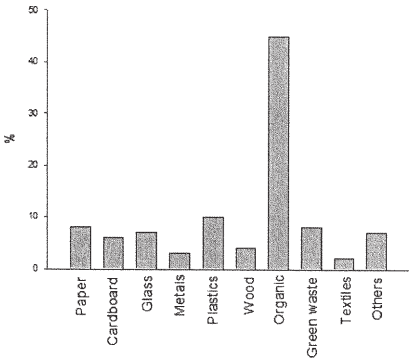

Fig. 3. Average composition of municipal solid waste generated in A and B Iaşi city areas for 12 weeks experiment.

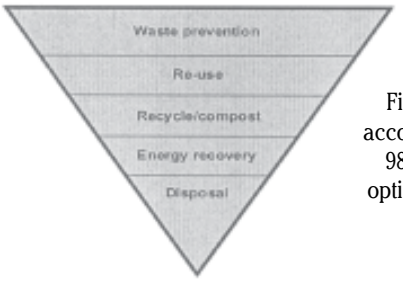

Fig. 4. Waste hierarchy according to Directive 2008/98/EC: waste treatment options for each packaging material [8]

There is a major difficulty to define the term "food waste". That's why in literature there exists avoidable, possible avoidable and non-avoidable food waste. Waste prevention measurements aim at the reduction of the former [5].

The EU's Waste Framework Directive (2008/98/EC) sets out a 'waste hierarchy' (fig. 4), from prevention through to disposal via minimisation, reuse, recycling and recovery. As applied to food, it has been argued that the waste hierarchy translates into a 'food use hierarchy' from prevention to landfill via redistribution to humans, feeding to animals and energy or nutrient recovery [8].

EU's long-term objective is to become a recycling and resource effective society, where waste is utilized as a resource and waste generation is prevented. The 7th Environment Action Programme (EAP) reviewed the Directive 2008/98/EC in 2014 and proposed new recycling and other waste-related targets by 2025/2030 (table 1). Another really important target is phasing out landfilling by 2025 for recyclable (including plastics, paper, metals, glass and bio-waste) waste in non hazardous waste landfills-corresponding to a maximum landfilling rate of 25%.

A rotten apple or cup of spoiled yogurt does not seem like much wasted food. But collectively, global consumers spend around $400 billion a year on produce and snacks that ultimately get trashed. Cutting food waste levels in half would save the world up to $300 billion by 2030. In the USA alone, an average family could save around $1,600 a year by eating leftovers and shopping smartly. Moreover, European Commission recommended in its Roadmap to a Resource Efficient Europe, in 2011, that disposal of edible food waste should be halved by 2020. It is to be mentioned that there is no great difference between the food loss rates by mass and by monetary value, except i.e. for bread and pastry, as compared to fruit and vegetables, and dairy products [9].

In EU top, Romania occupies the 10th honorable place in EU27 club concerning the food waste generation. But there is a general trend for increasing amount till 2020.

In terms of environmental impact the effects are also very serious. Food waste is biodegradable, being the biggest

Paper and cardboard	Glass	Metals	Plastics	Wood	Food waste
90%	90%	90%	60%	80%	75.5%

Table 1
SELECTIVE EU COLLECTION TARGETS BY 2025/2030

sources of methane, a greenhouse gas much more powerful than carbon dioxide that contributes to a large extent to the problem of global warming [1, 8].

People seem to be aware of the economic consequences of food waste but unaware of the environmental ones. The percentage of people who believe that food waste has no environmental impact because it is biodegradable is very high, 39% of consumers holding this belief. Moreover, 73% of people consider that packaging waste is a bigger environmental problem than food waste. Overall, it seems that people do not link food waste to environmental damage [1, 8].

Surplus food management plays a key role in food waste reduction [10]. Moreover, it is important to reveal the generalizable importance of understanding householders lifestyles, attitudes, habits, and institutional contexts [11].

Food waste selective treatment using new methods as anaerobic digestion to generate biogas, bio-drying or composting are to be applied on large extent in the next future.

The anaerobe fermentation process (40 and 65 days) has an important impact on all the studied materials (corn 75%-corn cob 25%; wheat bran; two raw Barley; mix; potato peel; and rye), having the real potential to be used for different sorts and recipes in order to obtain good quality biogas [12].

Collagen hydrolysates obtained by associated enzymatic and chemical processes for high-yield extraction of collagen from leather waste, under mild reaction conditions, are fit for application in agriculture [13].

The addition of the collagen hydrolysates to synthetic polymers represents a suitable solution for improving the biodegradability of plastic materials used for packing up. As raw materials, to transform into collagen hydrolysates, untanned leathers' wastes are used [14].

Selective waste collection was efficiently increased in mostly member states. The beginning separation of food waste has an important impact on the suitability of bio-drying [15]. Nevertheless, it is hard to say that waste bio-drying and thermal treatments are the most beneficial solution, even though it is an attractive one. This fact has to be established following a more complex environmental and financial analysis [16].

Packaging can have a positive role in preventing food waste. The whole waste management is based on Romanian National Strategy for Waste Management and National Plan for Waste Management [17].

New antimicrobial material based on bacterial cellulose-polyvinyl alcohol and benzoic acid was developed [18].

In certain circumstances and favored by out of the ordinary conditions a number of interactions may take place between the food additives and the food or packaging materials [19]. The use of reactive polyurethane adhesives has in some cases been found to lead to contamination of the packaged food with un-reacted isocyanates and carcinogenic aromatic amines, formed by the reaction of adhesives components with moisture from the food [20].

There are new technologies proposed to remove, at an acceptable rate, the mercury contents in the exhaust flue gases, released by the waste incineration [21].

Conclusions

Food waste represents a growing problem for the whole world, taking into account the economic, social, and environmental consequences. The awareness for the economical consequences is very high, in contrast to that for environmental and social ones.

The reduction of amounts of food waste might represent a very important target for all the countries. Energy and nutrient recovery will remain essential components of food waste management, as preferred options to disposal. Food waste selective treatment using new methods as anaerobic digestion to generate biogas, bio-drying or composting are to be applied on large extent in the next future.

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