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Comparison of Municipal Solid Waste in the Hashemite Jordanian Kingdom and Poland - A Case Study

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Abstract: The determination of the quantity of produced municipal solid waste in a given area, as well as its characterizations in terms of composition and physico-chemical properties are the basis of any work related to planning, logistics and design of technological solutions in the management of this waste. The aim of the current study was to analyze the morphological composition of solid waste in Jordan and Poland. Amman 'the capital of Jordan' was selected because it has the highest population (65% of about 7 million populations) in Jordan. However, in the case of Poland, the data was collected from all over the country (45 million populations).

Key words: Municipal Solid waste Jordan · Poland · Biodegradable waste

INTRODUCTION

One essential step for the successful planning of a Municipal Solid waste (MSW) management program is the availability of reliable information about the quantity and the type of the MSW materials being generated which could be useful for the MSW management developers. Effective MSW management through MSW composition studies is important for numerous reasons, including the need to estimate material recovery potential, identify sources of component generation, facilitate the design of processing equipment, estimate the physical, chemical and thermal properties of the MSW and maintain compliance with national law and international directives.

MSW constitutes a heterogeneous mixture of materials with diversified and variable parameters such as unitary and total quantity, granulation, chemical composition and physical properties. The quantity and composition of MSW depends on the season of the year, types of residential buildings, availability of infrastructural facilities within a given area, standard of living of the inhabitants and a number of other factors of a social and economic nature. This variability makes defining and measuring the composition of MSW more essential for long-term urban development planning. The detailed material composition of the MSW is unique in different cities and districts of the country; one cannot talk about the typical composition of MSW either [1].

Characteristics of Municipal Solid Waste in Jordan: With regard to protecting the environment, the legislative system in Jordan has evolved over the past decades. It has changed from a number of various incoherent texts occurring in different sectorial legislations to a system of coherent and integrated legislation. These legislations were marked by the issuance of the Jordanian environmental law as an interim law in 2003, which was later approved by the House of Representatives in 2006. It should be noted that such a law provides the appropriate legislative umbrella for acts regarding the protection of the environment include: the general framework of law for the management of MSW which is aimed at providing the legal basic conditions to prevent and reduce MSW, to recycle and extract secondary raw materials to produce energy and the safe disposal of MSW with a view to protecting man as well as the environment [2, 3]. It should be mentioned that there are laws specifically dealing with the issue of the environment such as:

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- The Act on Solid MSW Management was issued under clause (8) of paragraph (a) of Article 23 of the Environment Protection Act No. 1 for the year 2003 [2, 3]. The disposal of solid MSW has recently become one of the most prominent environmental problems in Jordan. The amount of solid MSW is increasing rapidly for the following reasons: an increase in population, industrial and agricultural progress, failure to follow the proper procedures of collection, transportation and processing of the solid MSW, an increase in the consumption behavior of individuals, individuals' lack of awareness in the environment and the scarce environmental legislation regarding the management of solid MSW. As a result, the tremendously increased amount of solid MSW gave rise to the pollution of environmental elements of the land, air and water and to the exhaustion of natural resources in many parts of the world. These reasons prompted the Ministry of Environment to take a special interest in the management of solid MSW, for the sake of public health and safety [2].

According to the definitions of Ministry of Environment in Jordan:

Solid Waste: Is solid and semi-solid material resulting from any activities. It should be processed or disposed of.

Solid Waste Management: Are the activities regarding solid waste. This includes the stages of collecting, sorting, processing and disposing of solid waste.

Solid Waste Treatment: Is any environmentally acceptable process, whether natural or biological, that is conducted on the solid waste before disposal.

Landfill: Is a site adopted by the Ministry of Environment to dispose of solid waste; Ruseifa Landfill is the oldest and most important in Jordan. It receives waste from Amman and Zarqa. This landfill was transferred to the Ghabawi area. However the old site still receives tons of solid waste.

Solid Waste Sources: Solid waste has many sources including: industrial, domestic, commercial, agricultural and medical solid waste.It also includes waste from construction and demolition.

- The Act on management, transfer and circulation of the hazardous materials was issued under clause (7) of paragraph (a) of article 213 of the Environment Protection Act No. 1 for the year 2003 [2,3]. Harmful and hazardous materials are any simple compound, or mixed substances or any waste resulting from them, whether natural or manufactured which could be dangerous to the environment and to the safety of living beings. These include any substances that can be disposed of in landfills or sewage networks due to their dangerous properties and harmful effects on the living beings.

In the Hashemite Kingdom of Jordan, a 15-month project for the purpose of identifying MSW composition was conducted in present work this included the chemical and physical characterization of 16 street samples that were distributed in 8 regions of Amman city and represented 5 different categories. The analysis was conducted during all the four seasons (summer, autumn, winter and spring) from August 2010 to May 2011 [2]. The equipment that was used in the sampling procedure included: a collection truck, a weighing bridge, manual shovels, 232 liter and 116 liter bins and scales of (0-800) kg and (0-30) kg [2]. The equipment that was used in the sorting procedure included a weighing bridge, manual shovels, 232 liter, 116 liter and 20 liter bins and scales of (0-800) kg and (0 – 30) kg [2]. The dumped MSW was sorted for the summer season according to the American Standard Test Method for the Determination of the Composition of Unprocessed MSW (ASTM D 5231 – 92 (Reapproved 2008). The method describes the procedures of the determination of the mean composition of the unprocessed MSW based on the collection and manual sorting of a number of samples of MSW over a selected time period [2]. The materials were sorted into 13 categories (Table 1) (as shown in Table (1)) where each category was placed in a separate labeled bin [2].

The test covered the measurement of the residual moisture content in the MSW sample released by drying in open air for 24 hours. The weight loss before and after drying represents the moisture content in the sample. This test was carried out for each collected sample per size distribution (large, medium and fine) for each category and for the four seasons. The density, caloric value and volatile matter in each sample were also measured.

Table 1: Waste composition, physical and chemical characteristics of the sorted samples according to ????????

Season	Density (kg/m^3)		Organic waste	Paper	cardboard	Complex waste	Plastics	Textiles	Metals	Aluminium	Glass	Special waste	Hygienic textiles	Combustible waste	Non-com bustible waste
Summer	133.9	Weight (%)	52.5	8.3	6.8	1.4	16.9	2.9	1	0.5	22	0.5	3.6	2.5	0.7
(Average)		Moisture content (%)	56.32	20.97	13.34	13.55	13.95	0	3.13	10.13	0.61	0	30.04	19.5	0
		Calorific value	8645	11084	13495	12850	25992	0	0	0	0	0	21741	18015	0
		Volatile matter (%)	34.88	64.23	73.05	55.43	85.67	0	0	0	0	0	60.66	64.05	0
Autumn	111.2	Weight (%)	47.5	5.4	7.9	1.3	16.5	2.5	1	0.4	2.7	1.1	5.7	7.6	0.8
(Average)		Moisture content (%)	46.47	26.28	17.87	13.09	9.89	0	1.36	3.34	1.35	0	29.11	17.02	0
		Calorific value	71	10373	12917	19666	29992	0	0	0	0	0	14324	15385	0
		Volatile matter (%)	36.84	47.12	56.25	75.64	92.97	0	0	0	0	0	46.44	63.51	0
Winter	149.8	Weight (%)	47.7	6.9	9.5	0.7	14.5	1.1	1	0.4	3.5	0.4	6.7	5.7	2
(Average)		Moisture content (%)	61.52	45.65	45.32	22.81	11035	0	3.11	13.51	1.37	0	30.48	22.89	9.46
		Calorific value	1405	9087	10129	16294	23790	0	0	0	0	0	2754	15322	0
		Volatile matter (%)	20.92	50.13	44.25	61.58	75.18	0	0	0	0	0	41.45	57.71	0
Spring	128.7	Weight (%)	51	5.6	8.2	0.5	15.1	2.7	0.5	0.5	22	0.8	6.3	5.4	1.4
(Average)		Moisture content (%)	73.14	11.99	17.17	9.6	2.44	0	1.74	9.05	0.07	0	36.95	21.04	1.7
		Calorific value	1310	14954	13227	17765	33674	0	0	0	0	0	11082	12514	0
		Volatile matter (%)	15.02	73.84	69.15	66.47	89.22	0	0	0	0	0	5497	70.77	0
Average	130.9	Weight (%)	49.7	6.6	8.1	1	15.7	2.3	0.9	0.5	2.6	0.7	5.6	5.3	1.2
		Moisture content (%)	63.86	26.47	23.43	14.76	9.41	(a)	2.34	9.01	0.85	(D)	31.65	20.11	5.58
		Calorific value	2858	11374	12442	16644	28362	(a)	(c)	(c)	(c)	(D)	12475	15309	(c)
		Volatile matter (%)	27.16	58.83	60.68	65.03	(a)	(c)	(c)	(c)	(c)	(D)	50.88	64.01	(c)

(a)Textile waste was not included in the combustible waste in all the measurements

(b)Special waste was not included in all the measurements

(c)Metals, aluminium, glass and non-combustible waste was not included in the calorific value and volatile matter measurements

(d)not measured in the summer season

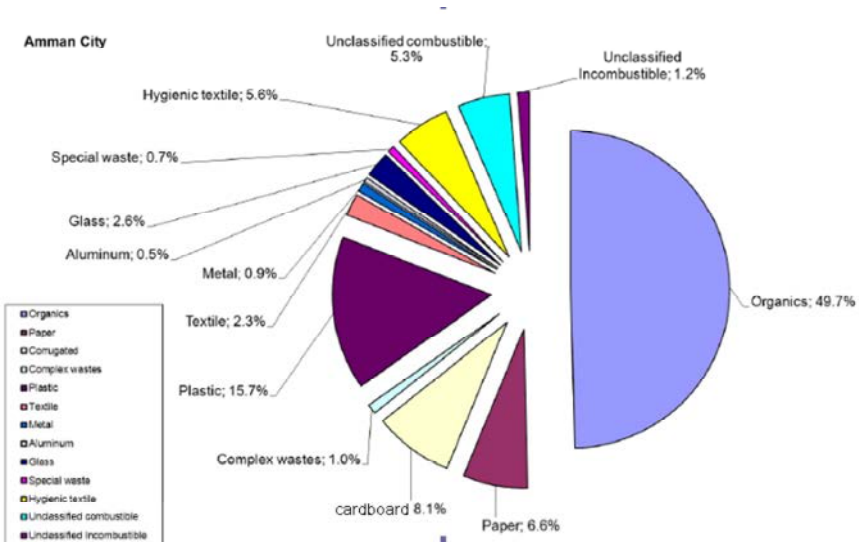

Fig. 1: Mean weight percentage (%) of waste composition of Amman city.

A- Residential - High lifestyle B- Residential - Medium lifestyle
C- Residential - Public lifestyle D- Commercial
E- Industrial

The results of the MSW composition analysis of the selected MSW for each street sample in Amman city that were sorted during the four seasons as well as the mean values of the MSW density and the percentage composition of the MSW categories of all selected streets are shown in Table 1 [2].

Fig. 1 shows the composition of the MSW of Amman City according to the 13 different categories [2]. Organic, plastic, cardboard, paper, hygienic textiles and combustible MSW constitute an average of 91.0% of the total MSW (49.7% organic, 15.7% plastic, 8.1% corrugated, 6.6% paper, 5.6% hygienic textiles and 5.3

Table 2: Mean weight percentage of different waste categories in waste samples of Amman City for the whole year according to different life styles.

Category	Density (kg/m^3)	Organic waste	Paper	cardboard	Complex waste	Plastics	Textiles	Metals	Aluminium	Glass	Special waste	Hygienic textiles	Combustible waste	Non-combustible waste
A	115.9	51.6	9.5	7.9	1.2	15.8	0.7	0.9	0.6	3.7	0.3	5.8	1.6	0.8
B	136	55.5	5.9	6.4	1	15	1.8	0.9	0.5	2.3	1	6.4	2.5	1.1
C	154.3	53.1	4.6	6.8	0.7	13.9	4.6	1	0.3	1.9	0.3	7.1	4.4	1.6
D	95.9	43.1	7.7	14.9	0.7	55.5	0.7	0.8	0.7	1.9	0.2	4.4	2.1	0.8
E	139	32.2	5.7	8.1	2	14.1	3.3	0.8	0.3	4.4	1.6	2.4	23.3	2.2

A- Residential - High lifestyle B- Residential - Medium lifestyle C- Residential - Public lifestyle D- Commercial E- Industrial

combustible MSW). Glass MSW constitutes 2.6% and textile MSW constitutes 2.3% of the MSW. Incombustible MSW constitutes 1.2%, while complex MSW constitutes 1.0%. Metals and special and aluminum MSW are considered low, with a weight percentage of less than 1% for each (Fig. 1).

By comparing the average weight percentages of different MSW categories in the different seasons, it can be seen that in general the weight percentages are similar during the whole year except for some cases, such as: the complex MSW weight percentage is higher in Summer and Autumn than in Winter and Spring, which could be due to the fact that more drinks are consumed during Summer and Autumn because of the higher weather temperatures. Also, the hygienic textile weight percentage in summer is lower than during the other seasons, which could be due to the fact that cold and influenza are less prevalent during summer as opposed to winter. The weight percentage of textile MSW in winter is smaller than in other seasons, which could be related to the fact that people throw out less old clothes in the cold winter season than in the other seasons. A fourth example of a different weight percentage of MSW in different seasons is the higher weight percentage of combustible MSW in autumn than in other seasons, which could be due to the higher amount of old vehicle tires, since a lot of people change the tires of their vehicles before the beginning of the Winter season.

The mean density of the solid MSW - without compaction - for each season, ranges from 111.2 kg/m^3 in autumn to 149.8 kg/m^3 in winter with an average of 130.9 kg/m^3 for the whole year. In general, the organic and incombustible MSWs increase the density of the MSW samples, in addition to the glass MSW [2]. The mean values of the weight percentage of the categories and sub-categories for each of the plastic, metal and aluminum MSWs that were sorted in all the sample streets during the four seasons are shown in Table 2 [2].

The Characteristics of Municipal Solid Waste in Poland: In Poland, on 23 January 2013, the Waste Act of 14 December, 2012, which superseded the Waste Act of 27 April, 2001 came into force [4]. The new regulations specified measures which serve to protect the environment as well as human life and health and to prevent any negative impact on the environment and human health resulting from the production of waste and its management, decreased the said impact, limited the general effects of the use of resources and improved the effectiveness of such use. The Act precisely stipulates that everyone who takes actions which cause or which could cause the occurrence of waste, should plan, design and conduct these actions using such methods of production or forms of services as well as raw materials and materials which, as a priority, prevent the occurrence of waste or limit its quantity and negative impact on human life and health and on the environment.

On 1st January, 2011, an Act on *amending the Act on Maintaining the Cleanliness and Order in the Municipalities and certain other acts* (Journal of Laws from 2011, No. 152, item 897) came into force and this was an important step in the process of the adaptation of the Polish law to the directives of the European Union [5]. The amended act requires municipalities to thoroughly change the existing waste management system and above all, to take over the ownership of waste (power over the waste) and reduce the quantity of waste reaching the landfills. Within the set time limits, the municipalities are obliged to accomplish the appropriate levels of reduction in the quantities of biodegradable waste and increase the recycling of other waste fractions. The amended act imposes numerous obligations and tasks on the municipalities, the performance of which will allow the appropriate municipal waste management system to be implemented.

The new waste act introduces significant changes in the existing, hardly effective legal solutions. Above all, it clearly specifies the rules of waste handling, which may be characterized as follows:

- The prevention and minimization of waste production,
- The recovery of waste, the production of which cannot be avoided in the given technical-economic conditions,
- Waste treatment,

Table 3: Average morphological composition of waste in Poland in the years 2007-2012.

	Rural municipalities		Urban-rural municipalities		Cities	
Components	Range of values	Average value	Range of values	Average value	Range of values	Average value
Fraction – 10 mm	0.0-53.1	20.7	4.1-37.0	20	6.9-37.0	14.7
Organic materials	7.2-311.5	21.1	2.9-40.4	21.2	12.2-33.9	25.9
Wood	0.0-9.3	1.1	0.0-1.8	0.5	0.0-1.2	0.5
Paper and cardboard	5.9-18.5	9.6	6.9-13.7	10.6	6.9-20.7	14.2
Plastics	7.2-26.9	16	5.5-43.6	19.9	5.5-27.2	18.2
Glass	5.2-26.2	12	4.2-14.9	9.5	7.3-13.9	10
Textiles	0.0-5.7	3.2	0.0-5.2	3.1	1.9-5.4	3.6
Metals	0.0-7.9	3.7	1.7-5.6	3.4	1.7-5.6	3
Hazardous materials	0.0-1.3	0.3	0.0-0.3	0.1	0.0-1.4	0.3
Multi-material	0.0-5.9	105	0.0-3.4	0.9	0.3-5.4	2.4
Inert	1.6-29.8	8.8	1.4-16.8	8.4	1.5-13.3	5.1
Other categories	0.0-9.3	2	0.0-9.5	2.4	0.3-5.4	2.2
Total	100	100	100	100	100	100

- Safety, from the point of view of human health and environment – the land filling of waste which cannot be subjected to recovery or treatment in view of the technical-economic conditions.

In accordance with article 3, section 4 of the *Waste Act,* the definition of municipal waste is as follows:

"*Household waste as well as waste that does not contain hazardous waste coming from other waste producers, which, due to their nature or composition, is similar to household waste".*

The waste can be classified in terms of: the source of its generation (place of generation), material composition, nuisance, risk to the environment and fitness for further use. According to the catalogue of waste which divides waste in terms of the source of its generation (Regulations of the Minister of Environment dated 27 April, 2001 on waste catalogue, Journal of Laws No. 112, item 1206) municipal waste constitutes group 20 [4]. Additionally, packaging waste, being municipal waste, if collected separately or occurring as mixed packaging waste is classified in sub-group 15 01.

The MSW in Poland is characterized by variable composition and properties and the variability depends on a number of factors. A particular impact on the quantity and quality of waste is exerted by the standard of living of the inhabitants who produce the waste, their dietary habits and variable traditions in different seasons of the year. In recent years, in Poland, the amount of packaging which becomes waste has increased significantly, which has influenced an increase in their volume as well as an increase in the secondary raw materials in MSW.

Different waste is produced by an inhabitant of a modern block of flats and different waste is generated by an owner of single-family house with a kitchen garden (more organic waste). The inhabitants of the countryside and peripheral areas of cities, whose houses are equipped with individual fireplaces, burn some of the MSW, which causes an increase in the quantity of the mineral fractions in MSW. In the city suburbs, where there are plenty of commercial-service facilities, the quantity and quality of MSW may differ significantly from that generated in areas which fulfill residential functions. In general much less MSW is produced in rural areas than in cities. According to the data reported by the Central Statistical Office, 2-2.5 times less MSW is produced by one rural dweller when compared to an urban dweller [6]

Table 3 presents the average morphological composition of MSW in Poland in the years 2007-2012. 391 MSW samples were analyzed during the research. The results of the analysis of 1 MSW sample, collected at a MSW landfill constituted a large majority of the data [4, 6]. Fig. 2 presents the average quantities of MSW received from households in rural areas in Poland during the respective seasons of the year.

The studies were started in autumn 2011 and conducted until December 2012 in four series corresponding to the four seasons of the year (spring, summer, autumn, winter). The analysis covered 72 households located in rural municipalities and urban-rural municipalities as well as 12 buildings of municipal infrastructure (commercial facilities, care and educational institutions, office buildings and facilities providing hotel-catering services) in rural areas. The research included households conducting various activities (conducting/and not conducting agricultural activities), a varied number of persons (2-8 persons - in total almost

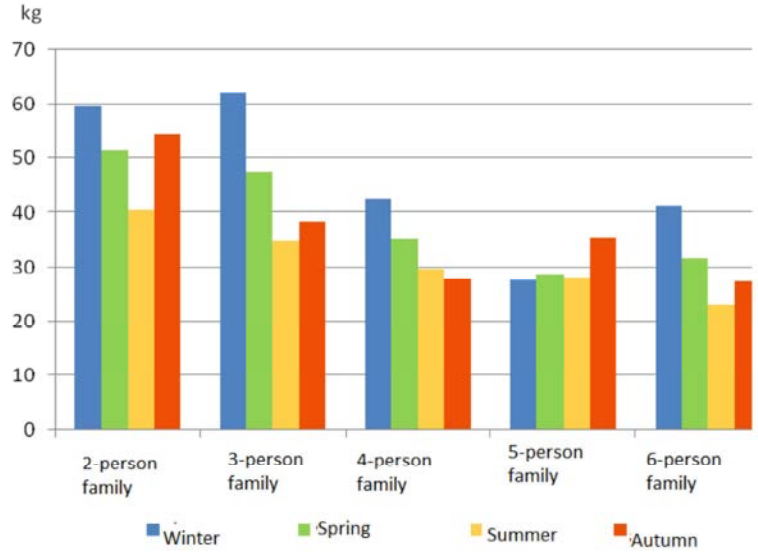

Fig. 2: The average MSW quantities received from households in rural areas in Poland during the respective seasons of the year.

300 persons) of different ages ("from an infant to a retired person"). The research was conducted using the modified European solid waste association (SWA) Tool. This method takes into consideration the MSW produced every day which is collected by the inhabitants in containers or bags. It excludes the MSW which is not produced continuously, such as e.g. large-size MSW and repair MSW. The owners of the indicated households collected MSW throughout the entire week (7 days) in specially prepared and marked bags on the premises of their properties. The collected MSW was sifted through sieves and subjected to manual sorting. Four series of studies were carried out, one during each season of the year.

While determining the sieve and the morphological compositions of MSW, a division into five basic fractions was applied: <10 mm, 10-20 mm, 20-40 mm, 40-100 mm and >100 mm. In terms of the materials, the MSW was divided into 12 fractions within the framework of which 34 were distinguished [4]. In multi-person households, the annual MSW collection index ranged between 119-135 kg/M/year and in households consisting of 2-3 persons - 183-206 kg/M/year [4].

The quantity of the generated MSW varied depending on the season (Table 4). In rural areas, many households are provided with stoves fired by solid fuels. Their use is connected with the production of MSW in the form of ashes, which significantly affects the overall mass of MSW produced during the heating season. The conducted research indicates that the average quantity of MSW produced in households in rural municipalities and urban-rural municipalities' amounts to about 157 kg/M/year [4]. The morphological composition and the resulting percentage share of the respective material fractions of household MSW in rural areas change depending on the season of the year. This must be remembered when planning projects related to the receipt and management of MSW in the area of a municipality.

During all the analyzed periods, biodegradable MSW constitutes the dominant fraction. This includes kitchen MSW (food leftovers, peelings, shells, etc.) and MSW produced during the maintenance of the areas around the property (grass, leaves, branches, weeds etc.). The quantity of kitchen MSW depends, above all, on the lifestyle of the inhabitants (whether they eat meals at home or use catering facilities) and their eating habits. In families, where processed food is used more willingly, the quantity of kitchen bio-MSW will be smaller than in families where traditional cuisine, based on raw products is preferable. In these households, a greater number of packaging MSW will appear instead.

The percentage of bio-MSW in the total mass of MSW ranges from about 42 to over 54%. Their prevailing part may be managed on the premises of the household. According to studies carried out in farms conducting agricultural activity, such a solution is often used. The majority of the bio-MSW is fit for composting and the residues of food are often used for feeding animals. In such a way, it is possible to manage even over 90% of the

Table 4: Morphology of MSW collected in Poland in rural areas during different seasons of the year.

Period	Organics OR 1 kitchen wast4e	Organics OR 1 garden	Wood W2	Paper and cardboard PC3	Plastics PL4	Glass G5	Textiles T6	Metals M7	Hazardous waste	Composites 9	Fireplace waste P	Other categories U1 1	Minor waste fl 2	Sum of household waste	Sum of household waste and garden waste
Winter	17.37	2.6	0.01	2.05	2.74	3.61	0.35	0.071	0.1	1.2	13.19	3.09	0.21	44.6	47.22
Spring	13.99	5.11	0.01	1.85	3.03	3.82	0.46	0.57	0.11	1.32	6.31	2.98	0.11	34.6	39.68
Summer	13.61	5.1	0.02	2.5	3.35	4.44	0.46	0.66	0.05	1.7	1.51	1.84	0.1	30.2	35.34
Autumn	16.42	2.48	0.01	1.79	2.63	4.05	0.32	0.79	0.07	1.34	2.79	2.09	0.08	32.4	34.85
Year	61.39	15.29	0.05	8.19	11.74	15.92	1.59	2.73	0.33	5.56	23.8	10	0.5	141.8	157.1

bio-MSW. It is necessary to search for solutions encouraging the owners of properties to select the biodegradable fractions from the MSW stream and provide farms with, e.g. composters.

Another fraction with a significant share in the mass of MSW includes MSW coming from fireplaces. Its percentage during the winter season reaches almost 28% of the total MSW mass. The occurrence of this type of MSW and its quantity depend on the type of heating and the efficiency of the applied solutions. A significant part of the materials found in MSW may constitute a valuable source of secondary raw materials. The MSW "segregated at source"such as paper and cardboard, glass, plastics or metals may be delivered to recycling companies. The "source" segregation allows the raw materials with a much higher degree of cleanliness to be obtained, which increases their usefulness as secondary raw materials. At the same time, it is the cheapest and most effective method of the reduction of mixed MSW delivered to landfills. The percentage of recyclable MSW is significant. Paper and cardboard, which can, for the most part, be raw materials, constitute over 5% of MSW annually. Plastics mainly include packaging from food products, cleaning products and cosmetics. They constitute as much as 7.5% of total MSW mass. Glass is over 10% of MSW mass. Practically the whole fraction covers recyclable glass packaging. In summer, when the consumption of cold beverages increases, the quantity of glass and plastic packaging MSW as well as multi-material packaging also increases.

Additionally, the morphological composition of the MSW depends on the family composition. In families where elderly or sick persons are present, health care related MSW may be generated, i.e. syringes, needles, medicines and bandages. Despite the fact that its mass is usually not high, due to the possibility of infection or contamination with the substances contained in them, this is hard-to-dispose-of MSW. In families with small children, a significant fraction in the household MSW will include fraction U11 (other categories), which consists of, among others, used disposable diapers. This fraction constitutes over 6% of the total MSW mass.

Fig. 3: Average percentage values of biodegradable MSW in MSW in Poland.

Table 5 lists the average percentage of biodegradable MSW collected from provinces, with a division into rural municipalities, urban-rural municipalities and cities in the years 2007-2012, in % and in Fig. 3 – average values for Poland [7, 8]. The available data allow an unambiguous statement to be made that the MSW reaching the landfills without processing, both from the area of villages and cities, contain 48% (villages) and 57% (cities) of biodegradable MSW respectively.

Table 6 presents the average morphological composition of MSW in Poland, calculated on the basis of the results of analyses of MSW samples from the set of data in which the sample mass was =30 kg [9]. The data was based on the results of MSW analyses within the framework of research conducted by the Ministry of Environment (75 analyses) and 8 results of Jêdrczak's own research (4 – rural municipalities, 1 –urban-rural municipality and 3 - cities). In total, the set of data contained results of the analyses of 83 MSW samples [9].

Based on the results of the analyses of MSW with a mass of ≥30 kg, a very high diversification of shares of components in the MSW mass (coefficient of variation > 60%) were observed only for: wood, hazardous MSW, multi-material MSW and "other categories" fraction.

The total percentage of produced paper, metals, plastics and MSW amounted to 4.4%. Plastics occurred in the greatest quantity in MSW (14.6%) and metals constituted the smallest quantity – 2.7%. As a result of

Table 5: Average percentage of biodegradable MSW collected from provinces, with a division into rural municipalities, urban-rural municipalities and cities in the years 2007-2012, in %.

	Rural municipalities							Urban-rural municipalities							Cities						
Provinces	2007	2008	2009	2010	2011	2012	Average	2007	2008	2009	2010	2011	2012	Average	2007	2008	2009	2010	2011	2012	Average
Lower Silesian	49				49		49					52		52	55				52		53
Kuyavian-Pomeranian	50	28	41	25	27	11	31	33	31	42	29	28	22	33		36	48	14	16	48	38
Lublin															68						68
Lubuskie	44						44								55	48		40	56	47	50
£ódŸ																					
Ma³opolska	32	27	40	21	25	41	33	40	11	46	34	27	26	32		45	33	42	39	57	44
Mazovia	26	21	42	37	37	41	34	23	37	41	35	31	16	31			57		55		56
Opole																		44			44
Podkarpackie						42	42					22		22							
Podlaskie	40		29				35	47		62				55	50		58				53
Pomeranian	35	32	45	40	20	19	35	36	35	43	34	31		36	51	53	54	51	25		49
Silesian		49					49		53					53		55	51				53
Œwiêtkorzyskie		42	40	42	43		41														
Warmia-Masuria	40	61					47	55						55	54	61					57
Wielkopolska	35	39	47	34	29	15	34	45	40	43	40	34	36	39	45	44	38	35	24	26	36
West-Pomeranian		48			28		43	32	36	38	34	25	35	33		47	44	42	34		45

Table 6: Average morphological composition of waste in Poland, specified on the basis of the analyses of waste samples with a mass of =30 kg, with a division into rural municipalities and urban-rural municipalities, in the year 2011.

	Poland (P)				Rural and urban-rural municipalities RURM				Cities (C)			
Specification	Scope of values	Average value	Standard deviation	WZ	Scope of values	Average value	Standard deviation	WZ	Scope of values	Average value	Standard deviation	WZ
Number of samples	14				7				7			
Fraction <10 mm	5.8-30.0	14.5	8.7	60	8.5-30.0	20.6	8.6	42	5.8-11.8	8.3	1.7	21
Organics	13.2-33.9	27.9	5.9	21	7.6-33.4	27.8	5.4	19	13.2-33.9	28.0	6.4	23
Wood	0.0-2.2	0.7	0.7	96	0.0-2.2	0.7	0.8	107	0.0-1.5	0.7	0.6	85
Paper and cardboard	5.7-22.5	13.6	4.9	36	5.7-22.5	11.1	5.1	46	11.6-20.5	16.2	3.1	19
Plastics	7.4-25.8	14.4	4.4	30	7.4-18.6	12.2	3.6	30	13.6-25.8	16.7	3.9	23
Glass	7.4-18.4	11.4	3.5	31	7.4-18.4	10.8	3.6	33	8.5-17.3	12.0	3.3	27
Textiles	0.2-10.3	3.9	2.3	59	0.2-10.3	3.6	3.0	83	2.5-5.5	4.2	1.2	29
Metals	0.5-5.9	2.9	1.5	53	0.5-5.9	2.7	1.8	66	1.4-5.3	3.0	1.1	38
Hazardous waste	0.0-1.0	0.2	0.3	167	0.0	0.0	-	-	0.0-1.0	0.4	0.4	95
Multi-material	0.0-11.0	3.1	3.3	107	0.0-11.0	2.5	3.6	146	0.0-9.4	3.7	2.8	76
Inert	1.3-10.7	4.8	3.1	63	3.0-10.7	5.9	3.1	52	1.3-8.9	3.8	2.7	71
Other categories	0.3-4.9	2.5	1.4	56	0.8-4.4	2.1	1.2	57	0.3-4.9	3.0	1.5	50
Total	-	100.0	-	-	-	100.0	-	-	-	100.0	-	-

the separate collection of MSW, the percentage of the group of components concerned in the remaining MSW fell to 42.3%. The percentage of glass declined the most – from 13.0 to 11.4%. The percentage of paper and cardboard decreased from 14.0 to 13.6%, the percentage of plastics decreased only by 0.2% to a level of 14.4% and the percentage of metals increased from 2.7 to 2.9%.

CONCLUSION

The analysis of the MSW in the Hashemite Kingdom of Jordan in 5 different categories, which represent different lifestyles, 8 areas and 16 sample streets shows that there is a correlation between lifestyle and life-activities and the solid MSW composition. During the period of the study, some events happened, such as: the Holy month of Ramadan during the summer season (August and September), which could have effects on the MSW composition and the sorting of solid MSW was carried out for some streets during Ramadan. During the autumn season two events happened; Parliamentary Elections and Eid Al-Adha which could affect the composition of the MSW, but the sampling of the MSW avoided these two events to give more representative results. Some of the days of the solid MSW sampling were marked by precipitation which could affect the moisture content of the MSW. The high moisture content of MSW can lower the calorific value of the solid MSW and increase the leachate content in the landfill, so it is recommended to have MSW containers with covers to protect the MSW from rain. Additionally, the other main benefits of such covers include a reduction in the dispersion of MSW odors.

The analyzed results of the morphological composition of the MSW collected in the cities and villages in the territory of Poland are highly diversified. They are affected by various factors, above all, various MSW collection methods and sites, various test methods

(an excessively small mass and number of laboratory samples). Irrespective of the quantity of the produced MSW in the countryside, the problems related to it are similar to those in the cities, though still much more difficult to solve. The problems are related to: MSW transportation, collection and land filling, the protection of the environment from its detrimental impact and its ultimate management. The solution for these problems in rural municipalities is often much more difficult to find than in the cities.

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