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Guidelines to Industrial Waste Management of Some Small and Medium Sized Food Processing Plants in a Semiurban Area of Kafr El-Dawar

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Abstract: The increasing loads of pollution generated by the discharge of variable food proce ssing High Institute of Public Health, Alexandria University ssing waste is creating massive eutrophication and fish kill. The current waste management of seven small and medium sized food processing plants in a semiurban area, Kafr EL-Dawar, EL-Beheira Governorate has been studied during this work. The surveyed plants include: Frozen vegetables plant, two confectioneries, and four dairy products plants. Tap water and storage water samples analysis proved that they are in compliance with the Egyptian drinking water standards. All the generated wastewater are biodegradable and there is no available treatment. Wastewater of all the surveyed plants are directed either to the nearest drains or conveyed to the sewage treatment plant. These drains are used for irrigating lands. None of the surveyed plantsírepresentatives have an idea about the laws governing wastes discharge. There are no abnormal results of the measured parameters for all the collected wastewater samples except in two of the dairy products plants [cheese and milk separator]. The results of almost all the Biochemical Oxygen Demand, Chemical Oxygen Demand, and Most Probable Number of Coliform are beyond the limits of law 48 for 1982 regarding discharge of liquid wastes into drains. As the cost of the conventional treatment is high, the surveyed plants are surrounded by agricultural land of clay loam soil which is best suited for growing most plants, and in sparsely populated districts, it is beneficial that the wastes of the dairy and vegetable frozen plants are to be reclaimed and used in land irrigation to grow plants not eaten raw. The amount of solid waste for all the plants is considerably small [1-35 kg/day] except in two plants of confectioneries where the amounts are [0.25 and 0.5 ton/day]. This is attributed to that the confectioneries solid waste included biscuits residues generated during production. This amount is of benefits as animal food. After subtracting these amounts, the amounts of waste will be very small [2-3 kg/day]. The daily generation rate of solid waste per employee ranged between 30 gm and 1.7 kg. None of the solid waste generated is biodegradable except the waste of the frozen vegetable plant. The current methods of solid waste disposal included dumping on banks of drains, streets and/or any vacant area as there is no dumpsite in the area. Open incineration is resorted to as well. In order to alleviate the environmental impacts of these practices, it is advisable to allocate a suitable site in the area to be used as a dumpsite for the non-compostable solid waste. However, it is preferable to co-compost the compostable solid waste anaerobically with manure.

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INTRODUCTION

Food-processing industries are those enterprises whose main concern is the production of edible products for human or animal consumption. The increasing loads of pollution generated by the discharge of variable food processing waste, full of plant nutrients to bodies of water, is creating massive eutrophication and fish kill. The characteristics of food processing wastes exhibit extreme variation, the Biochemical Oxygen Demand [BOD] may range from 100 to 100,000 mg/l while suspended solids may range from zero to 120,000 mg/l. Food wastes usually contain dissolved colloidal organic matter which makes it particularly suitable for biological treatment.[1]

Dairy and food preserving industries are considered within the most important industries in food processing where their effluent constituents are heavy organic loads and basic plant nutrients. The conventional treatment cost is high, so the reuse of those wastes in land irrigation can achieve several benefits.[2]

Dairy wastes are made up, for the most part, of : various dilutions of whole milk, separated milk, butter-milk, and whey. These products are wasted through accidental or unintentional spills, drippings allowed to escape into the waste through inefficient design and operation of process equipment, and/or washes containing alkaline or other chemicals used for cleansing. The dairy wastewater usually contains solids [butter, fat, casein and other milk proteins, lactose, and inorganic salts], and detergents and chemicals used in the plant cleaning operation.[3]

Food preserving industry generates waste which fall into two general classes: solid and liquid waste. Their concentrations vary widely with the kind of raw materials being processed and with the methods employed in the plant. As expected, the generated wastes are rich in suspended solids, dissolved solids, and BOD loading. Wastes from this industry are primarily organic and result from trimming, blanching, and pasteurizing of raw materials, the cleaning of processing equipment, and the cooling of the finished product. The process waste usually consists of : solids from sorting, peeling, and coring operations; spillage from filling and sealing machines; and wash water from cleaning floors, tables, walls, belts, and so forth [1].

This work aims at revealing the current

wastewater and solid waste management of seven small and medium sized food processing plants in the semiurban area of Kafr EL-Dawar, EL-Beheria Governorate. In addition, guidelines for proper waste management will be presented.

MATERIAL AND METHODS

Seven industries were selected and surveyed for once.

1- Frozen vegetables :

Producing all types of frozen vegetables.

2- Confectioneries:

The study includes two plants. The first one produces biscuits, chocolates, and wafers. The other produces only biscuits fortified with iron for Ministry of Education.

3- Dairy products:

The study includes one ice cream production plant, one cheese production plant, and two milk separators.

A designed questionnaire has been used to collect information about wastewater quantity, solid waste generation rate, and the current methods of wastewater and solid waste management. Drinking water samples from tap and storage tanks [whenever available], and wastewater samples from the final effluent of the surveyed industries were collected. The samples collected were analyzed for physical, chemical, and bacteriological parameters according to the Standard Methods for the Examination of water and Wastewater.[4]

RESULTS & DISCUSSION

Water Characterization

Tap water and storage water samples [whenever available] have been analyzed physically, chemically, and bacteriologically to evaluate their suitability for food production and cleaning practices. The results are presented in table [I]. The results reveal that all the parameters are in compliance with the Egyptian drinking water standards issued by the decree No 108 for 1995 of the Minister of Health.[5] Residual chlorine for all the samples, except the storage water sample collected from Confectionery plant [1], is present in high concentrations [1-1.2 mg/l]. The exceptionally low residual chlorine in the storage water is attributed to its volatilization and the long retention time. All the samples are free from total plate count, and total and fecal coliforms.

Wastewater Management

The gathered information about the current wastewater management in the surveyed plants showed that two of these industries [confectioneries] are generating domestic waste only. Industrial waste generated from these plants results only from the washing of tanks which is carried out only at the end of the day or in case of the change of the kind of products. Two of the dairy products plants [Ice Cream and milk separator] are generating mixed domestic and industrial waste. While the other plants are generating both domestic and industrial waste in separate lines. All the generated wastes are biodegradable and no treatment is available. All the surveyed plants except the cheese plant, discharge their wastes into sedimentation tanks and once these become full, they are collected and discharged. They believe that the wastes are directed either to the nearest drains which are available everywhere in this rural area, or to be delivered to the sewage treatment plant which is quite far making this option not reasonable. The cheese factory is discharging its waste into a percolation pit. Drains which receive the waste are used by the farmers for irrigating their lands. The waste quantity generated from the surveyed plants is considered very small except in the frozen vegetable plant which requires a considerable amount of water during the process of preservation. It has been found that none of the surveyed plantsírepresentatives have any idea about the law governing discharge of the wastes.

The results of the physical, chemical, and bacteriological analyses of the wastewater samples collected from the final effluent of the forementioned plants are presented in table [II] and figure [1]. It reveals that there are no abnormal results of the Hydrogen Ion Concentration [pH], Total Dissolved Solids [TDS], Ammonia [NH3--N], Nitrates [NO3-N], Sulphates [SO4], Phosphates [PO4-P], Chlorides [Cl], BOD, and Chemical Oxygen Demand [COD] parameters for all the samples collected except two of the dairy products plants [milk separator [1] and cheese plants]. The abnormal result of pH [3.4] of the cheese production plant is attributed to the fermentation of the milk lactose sugar to Lactic acid. This agreed with another study [1], which stated that dairy wastes were largely neutral or slightly alkaline, but had a tendency to become

acidic quite rapidly because of the fermentation. The high value of TDS [39,257 mg/l] in the same plant is due to that this plant uses huge amount of Sodium Chloride [NaCl] during production which is reflected also in the result of Chloride [29,500 mg/l]. The high content of Suspended Solids in the same plant [13,400 mg/l] is due to whey. The high values of BOD [900 and 11,800 mg/l] and COD [1344 and 31,104 mg/l] respectively, of these two dairy products plants are attributed to the organic nature of the milk. The exceptionally low results of BOD and COD of the third dairy products plant [milk separator] are attributed to the high dilution by water.

It has been found that the wastewater of the cheese plant in the present study are higher in all the measured parameters than that of a study carried out at Misr Dairy Plant for the effluent of cheese plant.[6] For example, the Chloride, BOD, and COD in the present study are [29,500, 11,800, and 31,104, respectively] and in the previous study were [1894, 4533, and 12,853, respectively]. This may be attributed to the dilution factor in case of the previous study and to the infiltration of the water through the percolation pit which concentrates the pollutants in the present study. However, there is another study[7] where its COD [55,000 mg/l] is higher than that of the present study. It is clear from the results that almost all the BOD, COD, and Most Probable Number [MPN] of Coliforms results of all the samples are beyond the limits of law 48 for 1982 regarding discharge of liquid wastes into drains.

It is suggested that the wastes of the dairy and food preservation industries, located on farms, are to be reclaimed and used in land irrigation as recommended before.[6]. This also agreed with a study carried out by ELdidge who stated that irrigation, if properly regulated, might provide a satisfactory solution of some milk waste disposal problems.[8] The use of dairy wastes in irrigation is recommended in many studies.[9,10] Also, it has been recommended to use the vegetable processing plants wastes in irrigation.[11,12] As the surveyed plants are surrounded by agricultural land of clay loam soil, which is best suited for growing most plants, this will save the water resources and reduce the environmental impacts.

The suggested reclamation must be done through in-plant control followed by treatment.

For cheese waste, the treatment must

include:

- in-plant control to reduce waste generation,
- whey segregation, concentrating it, and mixing it with other materials to be used as animal food,
- desalination to decrease the dissolved solids,
- biological treatment, and
- disinfection.

For the other dairy wastes and frozen vegetables waste, the biological treatment and disinfection will be enough. For more precautions, it is preferable to irrigate the lands with these wastes after the recommended treatment, and to grow plants not eaten raw but those which have to be extracted before use, for example, medicinal plants. This has been recommended as well by Salem et al..[13] This will eliminate the direct exposure of human consumers to any possible pathogens transferred through liquid wastes application as a source for irrigation.

Solid Waste Management

The gathered information about the current solid waste management in the seven surveyed plants is presented in table [III]. It is clear from the results that all the industries are belonging to the private sector. It has also been found that the amount of solid waste for all the industries is considerably small [1-35 kg/day] except in two plants [confectioneries] where the amounts are [0.25 and 0.5 ton/day]. The high amounts of solid waste of the confectioneries are attributed to biscuits residues generated during production. The amount is of benefits where the owner is selling it as animal food. After subtracting the amounts of biscuits residues from the amount of generated waste, it has been found that the amount of waste ranges between 2 to 3 kg/day which is very small. The generation rate of solid waste per employee ranged between 30 gm in one of confectioneries and 1.7 kg in one of the dairy products plants [Ice Cream]. None of the solid waste generated is biodegradable except the waste of the frozen vegetable plant where it includes vegetable residues, resulting during preparation and production, which are considered a good material for composting. The current methods of disposal for this solid waste includes dumping on the banks of the nearest drains in the majority of cases, followed by open burning which is considered one of the sources of air pollution in the area. Some solid waste is thrown into streets or any vacant area as there is no

Table (I): The physicochemical and bacteriological analyses of Tap water and Storage water samples of some small and medium sized enterprises of food processing plants in the semiurban area of Kafr EL-Dawar, EL-Beheira Governorate, 1997

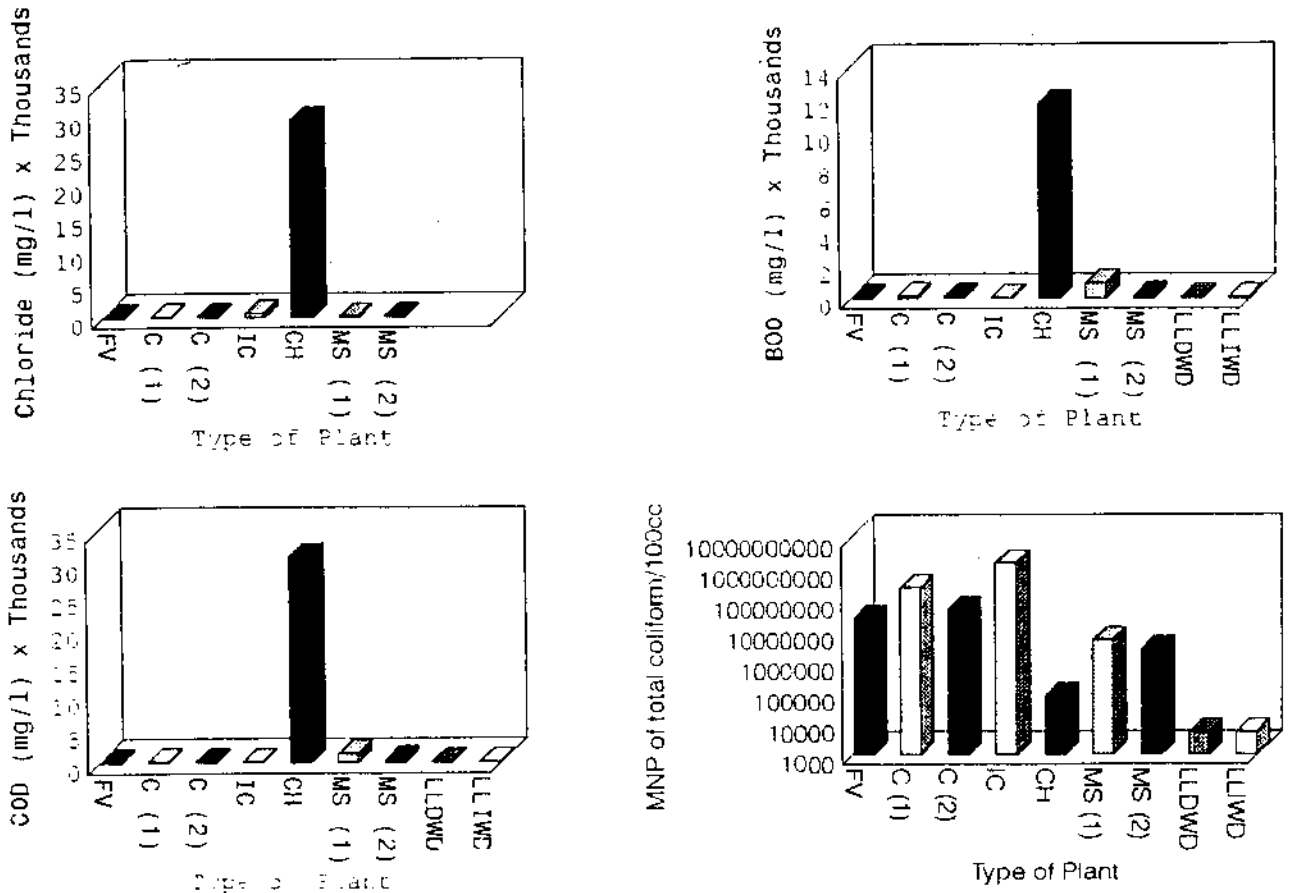
Type of Plant / Parameter	Unit	Frozen Vegetable	Confectionery (1) Tape Water	Confectionery (1) Storage Water	Confectionery (2)	Ice Cream	Cheese	Milk Separator (1)	Milk Separato (2)	Egyptain Drinking Water Standards (Decree No. 108 for 1995)
Taste		Palatable	Palatable	Palatable	Palatable	Palatable	Palatable	Palatable	Palatable	Palatable
Odour		Free	Free	Free	Free	Free	Free	Free	Free	Free
Turbidity	NTU	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	5
pH		7.2	7.2	7.3	7.2	7.3	7.2	7.3	7.2	6.5-9.2
TDS	mg/l	400	410	400	395	390	400	395	410	1200
NO2-N	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005
NO3-N	mg/l	0.3	0.35	0.02	0.4	0.3	0.3	0.4	0.3	10
SO4	mg/l	40	35	40	40	35	35	40	40	400
Cl	mg/l	90	80	90	80	80	80	90	80	500
Total Hardness	mg/l	190	220	200	220	210	190	200	220	500
Alkalinity	mg/l	200	180	190	190	200	180	190	200	
Residual Chlorine	mg/l	1.1	1	0.4	1.1	1.2	1	1.2	1	Not less than 0.5
Total Plate Count/1cc		Zero	Zero	Zero	Zero	Zero	Zero	Zero	Zero	50
MPN of Total Coliform/100cc		Zero	Zero	Zero	Zero	Zero	Zero	Zero	Zero	Zero
MPN of Faecal Coliform/100cc										

Table (II): The physicochemical and bacteriological analyses of wastewater samples collected from some small and medium sized enterprises of food processing plants in the semiurban area of Kafr EL-Dawar, EL-Beheira Governorate, 1997

Type of Plant		Frozen Vegetable	Frozen Vegetable	Confectionery (2)	Confectionery (2)	Cheese	Milk S eparator (1)	Milk Separator (2)	Limits of Law 48/1982 regarding discharge into Drains	
Paramete	Unit									
Quantity	m3/day	20	20	1.5	1.5	4	0.5	0.5		
Type of waste collected		Industrial	Industrial	Domestic	Domestic	Industrial	Industrial	Mixed	Domestic	Industrial
pH		6.9	6.9	7.1	7.1	3.4	7.1	7.3	6 9	6 9
TDS	mg/l	478	478	580	580	39,257	456	583	2000	2000
TSS	mg/l	71	71	90	90	13,400	560	277	50	60
NH3-N	mg/l	0.12	0.12	16	16	7.2	0.16	50		
NO3-N	mg/l	0.48	0.48	<0.05	<0.05	3.6	0.2	<0.05	50	40
SO4	mg/l	72	72	110	110	100	120	110		
PO4-P	mg/l	0.02	0.02	0.4	0.4	144	1.32	3.4		10
Cl	mg/l	70	70	120	120	29,500	110	160		
BOD	mg/l	86	86	.20	120	11,800	900	168	60	60
COD	mg/l	99	99	180	180	31,104	1344	442	80	100
MPN of total Coliform/100cc		2.40E+07	2.40E+07	4.60E+07	4.60E+07	7.50E+04	4.60E+06	2.40E+06	5.00E+03	5.00E+03

Table (iii): The current solid wasta management of some small and medium sized enterprises of food processing plants in the semiurban area of Kafr EL-Dawar, EL-Beheira Govarnorate, 1997

Type of plant	Sector	Years of Activity (Years)	Number of employees	Quantity (Kg/day)	Generation Rate (gm/employee)	Storage Container	Nature of waste Compos-table	Nature of waste others	Method of disposal
Frozen Vegetable	Private	3 to 4	100	35	350	Plastic Barrel	X	X	*Dumpsite by governorate workers
Confectionery (1)	Private	3	110	25	After excluding biscuits residue 30	Plastic Barrel		X	* Drains banks * Selling the biscuits residue as animal food
Confectionery (2)	Private	10	25	500	After excluding biscuits residue 80	Plastic Bags		X	* Dumpsite by governorate workers (2kg/day) * Selling the biscuits residues as animal food (0.5 ton/day)
Ice Cream	Private	10	30	25	830	Plastic Barrel		X	*Dumpsite by governorate workers
Cheese	Private	3	3	1	333	Metal Barrel		X	* Drains banks * Dumpsite by governorate workers
Milk Separator (1)	Private	5	6	10	1700	Metal Barrel		X	* On-site Burning
Milk Separator (2)	Private	7	3	3	1000	Plastic Barrel		X	* Drain Banks * Vacant areas



FV: Frozen Vegetable C[1]: Confectionery[1] C[2]: Confectionery[2] IC: Ice Cream CH: Cheese
MS[1]: Milk Separator[1] MS[2]: Milk Sepaarator [2] LLDWD: Law 48/1992 Limits for Domestic Waete Discharge
LLIWD: Law 48/1982 Limits for Industrial Waste Discharge

Figur 1: Variations in Cl, BOD, COD, and MPN of total coliform of wastaweter samplas collected from small and medium sizec enterprises of food processing plants in the semiurban araa of kafr El-Dawar, El-Beheira Governorate, 1997

official dumpsite in the area. This entails the governorate to allocate a suitable site in the area to be used as a dumpsite for the generated non-compostable solid waste. However, for the compostable solid waste, it is preferable to co-compost it anaerobically with manure.

CONCLUSION

This study aims to investigate the current wastewater and solid waste management of seven small and medium sized food processing plants in the semiurban area of Kafr EL-Dawar, EL-Beheira Governorate. The plants include : Frozen vegetables, two confectioneries, four dairy products plants [cheese, ice cream, and two milk separators]. All the plants are belonging to private sector. All the tap and storage water parameters are in compliance with the Egyptian drinking water standards. All the generated wastes are biodegradable and there is no treatment. Wastes of all the plants are directed either to drains or into the sewage treatment plant. These drains are used for land irrigation. The waste quantity generated from the plants is considered very small except the frozen vegetable plant. None of the plantsírepresentatives have an idea about the laws governing wastes discharge. There are no abnormal results of the measured parameters for all the collected samples except two of the dairy products plants [cheese and milk separator]. Two of the dairy products plants have high values of BOD and COD while the other two have low results [ice cream and milk separator]. Almost all the BOD, COD, and Most Probable Number of Coliforms results of all the samples are beyond the limits of law 48 for 1982 regarding discharge of liquid wastes into drains. As the surveyed plants are surrounded by agricultural land, it is preferable for the wastes of the dairy and vegetable frozen plants to be reclaimed and used in land irrigation. This will save the water resources and reduce the environmental impacts. In addition, it is recommended to grow plants not eaten raw. The amount of solid waste for all the plants is considerably small [1-35 kg/day] except in two plants of confectioneries where the amounts are [0.25 and 0.5 ton/day]. Solid waste generation rate per employee is ranged between 30 gm and 1.7 kg. None of

the solid waste generated is biodegradable except the waste of the frozen vegetable plant. The waste is of benefits as animal food. The major current methods of solid waste disposal include dumping on banks of drains, burning, streets and/or any vacant area as there is no dumpsite in the area. This requires allocating a suitable site in the area to be used as a dumpsite for the non-compostable solid waste. Recycling could be resorted to for plastics, metals,...,etc. However, it is preferable to co-compost the compostable solid waste anaerobically with manure.

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