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CASE STUDY

Livestock slaughterhouses waste management in urban environment

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ABSTRACT: The current study presents an investigation on the waste management in the cattle slaughterhouse by the following objectives: a) to identify the existing waste management practices in relation to sources, quantity and characteristic of wastes; b) to identify the situation of production, collection, storage, transportation, processing and recycling, and final disposal of wastes and the problems of existing waste management practices. In order to obtain reliable information and filling the check list, site surveys were conducted when the management of the slaughter-house was interviewed in waste management practices. The total produced industrial waste in studying units' was found to be 10252 tons/year. The per capita waste generations were reported to be 54.6 kg/cattle/day and 11.1 kg/sheep/day. Also, more than 98% of the hazardous waste produced can be infectious. However, it is important to keep in mind that setting an operational program and careful monitoring of its optimal execution by the slaughterhouse manager is necessary. Consequently, findings provide useful inputs for decision making processes around construction slaughterhouses waste management.

KEYWORDS: *Slaughterhouses; Slaughterhouses waste management (SWM); Solid disposal; Waste management; Waste recycling*

INTRODUCTION

Rapid population growth and development of industry along with increasing consumption material lead to the production of industrial solid waste (Lagrega *et al*., 2001). The amount of environmental pollution resulting from such production was so much that it made administrative and scientific resources of the world (Bagchi, 2004; USEPA, 2004). Reviewing previous studies shows that the majority of industrial wastes is considered to be dangerous and in some cases are the causes of the emission of carcinogenic pollutants in the environment (Hester and Harrison, 2002; Pichtel, 2005; Sivakumar, 2016). Donnelly *et al.* (1987) are proved the existence of dangerous chemical and biological waste with the effect of mutagenic and carcinogenic in industrial waste (Padhi, 2012). Industrial waste is in different forms of solid, semi- solid and liquid when it has a wide range of variety (USEPA, 2004). These wastes not only influences on the environment's main factors such as water, soil, air and biosphere, but also influences on the society and workers' health, hygiene and safety (USEPA, 2004; Pichtel, 2005). Moreover, health and environmental problems and the effects of

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such wastes are way different from household wastes and accordingly more dangerous which is not easy to fight against them and needs high knowledge accompanying advanced and expensive technology. It is important to note that the collection and disposal of such substances have made the arisen problems double in most countries, particularly developing countries which do not have much advanced technology (Franke-Whittle and Insam, 2013). So, effective control and proper management of industrial waste for hygiene and protecting the environment and the management of resources are found to be great importance.

Misra and Pandey's (2005) have emphasized on the principle of proper industrial waste management as the most applicable solution. Moreover, the significant point of other studies on industrial wastes is also the lack of proper management of hazardous waste (Karamouz *et al*., 2006**).** Due to the specific properties of hazardous industrial waste, the management of them apart from the six elements of municipal waste management (production, collection, storage, transportation, recycling and disposal process) has two more elements, including decreasing toxicity and the potential of risk and after disposal cares (Salvato *et al*., 2003; Pappu *et al*., 2007; Bazrafshan and Kord, 2009). In addition, in this stage attempt is made to prevent the production of hazardous waste as much as it is possible and also they try to decrease the amount of produces waste by modifying the processes of production and appropriate raw material (Woodard, 2001).

So, for the purpose of purification, recycling process, storage and disposal of dangerous waste, one can divide industrial wastes quality into six categories (Bobicki *et al*., 2012): 1) Inorganic waste, 2) Greasy waste, 3) Organic-non degradable waste, 4) Organic degradable waste, 5) Low risk bulky waste, and 6) Miscellaneous waste (Lagrega *et al*., 2001; Cheremisinoff, 2003). Such substances are produced in different industries such as cattle slaughter which, among the different types of wastes; cattle slaughter waste has taken less attention. The objective of the study was to identify the sources and characteristics of slaughterhouse waste. The current system of slaughterhouse waste management is studied. This study aims to explore effective approaches to eliminate and/or minimize solid waste production in construction projects in slaughterhouses. The findings of this survey provide useful inputs for decision making processes around slaughterhouses waste management (SWM). This study has been carried out in Khuzestan Province in 2014 to 2015.

MATERIALS AND METHODS

The empirical researches were conducted in cross-sectional method between 2014 and 2015. The population of this study was the solid waste of cattle slaughterhouses in Ahvaz, Dezful and Shushtar, cities in Khuzestan province (Iran). Khuzestan Province, with 31 traditional and semi industrial cattle slaughterhouse has created numerous problems in the hygienic disposal of solid waste and actually different types of slaughterhouse waste is spread in the surrounding environment without any refining.

The studied slaughterhouses were selected based on the daily number of slaughters, and the variation in the type of slaughter (mechanization, semi-mechanized, traditional slaughter). Then, the project was carried out in three steps as follows: Literature review, Interviews, Check list survey and analysis the check list data. An interview was conducted with slaughterhouse industry professionals, experts and professors in the field of environmental management, as well as veterinarians and Health inspectors to gather qualitative data related to solutions for SWM and to enhance the quality of the checklist by adding solutions for SWM relevant to the Iranian context. Also, in order to identify processes, and sources of waste production, field surveys were conducted in the studied units.

After doing a literature review and interview, to evaluate the current status of waste management in slaughterhouses, the checklist prepared by The Department of the Environment (DOE) in Iran is selected. It seems that the checklist developed by The Department of Environment in Iran is an appropriate tool to investigate the status of waste management in the industry. Because of all the criteria contained in the checklist were based on the pattern of Tchobanoglous management that solid waste management system is defined for six required elements of production, collection, storage, transportation, recycling and disposal process. This check list covered all important issues to examine the different aspects of solid waste management. The first part included general slaughterhouse information: slaughterhouse name and type; slaughterhouse capacity; quantity of producing waste, processes and etc. The second part consisted

questions to evaluate the slaughterhouse waste management process in six elements, including production, collection, storage, transportation, recycling and disposal aspects. The selected check list was filled and the distribution of waste at the end of each season, the quantity, the characteristic and the producer source of waste were determined. Therefore, the current management situation was investigated based on the required elements in management, according to the pattern of Tchobanoglous management (Tchobanoglous and Kreith, 2002). Health care waste management was studied before and the results showed that it was very important (Farzadkia *et al*., 2015). Then, by analyzing the collected data, the waste was categorized based on the type of producing waste and in the final run appropriate methods were suggested for the under the study section. In fact, one of the advantages of this study is that it makes the managers and establishments of environmentally aware of the type and processes which should be controlled.

RESULTS AND DISCUSSION

In this study, five sources of contamination were determined; that included slaughtering salon, separation of offal, preparation of livestock products and bungs, Head and legs cleaning, and cleaning pre-slaughter products, that were the source of producing 7832, 1755 and 661.5 tons solid wastes annually in cattle slaughters of Ahvaz, Dezful and Shushtar, respectively. Results also showed that the per capita waste production per each head of light cattle is 11.1 kg as an average with the minimum of 10 kg and maximum of 12.3 kg, and per each head of cattle as an average 54.6 kg with a minimum of 50 kg and the maximum of 56 kg in the studied cattle slaughterhouses. In addition, type and the amount of produced waste (kg/day), source of waste, destination of pollutant(s) and frequency of disposal in the above mentioned slaughterhouses is illustrated in Table 1.

The result also shows that the total produced wastes in studying units were a 10252 ton/year among which 76.5% was produced by Ahvaz, 17% by Dezful, and 6.5% by Shushtar's slaughterhouses. According to the proposed method of EPA and the conducted investigations in this study, Ahvaz cattle slaughterhouse is categorized as a medium scale and Dezful and Shushtar cattle slaughterhouse is categorized as a small scale. Thus, naturally, more amount of waste is produced in Ahvaz slaughterhouse. On the other hand, the average produced waste in the studied cattle slaughterhouses was 11.1 kg for each head of light cattle and 54.6 kg for each head of cattle. Compared to European countries this Figure is too much. The amount of producing solid organic waste in European countries for each head of cattle is equal to 2.5 kg organic waste and 20.8 kg by production per each head of light cattle and also equal to 58 kg organic waste and 110 kg by production per each head of cattle. But the quantity of such material in Asian countries per each head of heavy cattle (Bovine) is equal to 83 kg and per each head of light cattle (sheep) is equal to 2.5 kg (Jayathilakan *et al*., 2012).

In Indonesia, Ratnawati and Trihadiningrum (2014) reported the total slaughterhouses solid waste generation rate from the caged 758 ruminants in studying slaughterhouses is 15.2 t/day. The average weight of wet solid material produced by cutting and emptying of the stomachs of ruminants was estimated by Fernando (1980), as 60 lb (27 kg) for cattle, 6 lb (2.7 kg) for sheep and 3.7 lb (1.7 kg) for lambs. The characteristic of industrial solid wastes in each of the studied slaughterhouse is indicated in Figs. 1(a), 1(b)

Table 1: Characteristics of study cattle slaughterhouse

Slaughterhouses No	Slaughterhouse capacity		Produced waste (ton/year)	*Per capita* waste (kg/day)	
	Heavy livestock (per cattle)	Light livestock (per sheep)		Heavy livestock (per Cattle)	Light livestock (per Sheep)
Ahvaz	392	1960	7836	54.6	11.1
Dezful	85	390	1755		
Shushtar	36	180	661.5		

and 1(c). The characteristic of producing wastes in Ahvaz slaughterhouse indicated 20% inedible fats, 0.01% testicles, 1% womb, 3% spleen, 47% digestive contents, 15% large intestine, 3% horn, 5% udder and less than 5% sludge (Fig. 1(a)). The wastes of Dezful slaughterhouse contain 18% inedible fats, 1% testicles, 18% womb, 6% udder, 1% spleen, 15% large intestine, 56% rumen content, 1% horn, 1% sludge and 1% distrain organs (Fig. 1(b)).

In addition, a similar analysis was done for the data related to the industrial wastes in Shushtar slaughterhouse. The wastes of Shushtar slaughterhouse contain 22% inedible fats, 2% testicles, 5% udder, 2% spleen, 16% large intestine, 50% rumen content, 1% horn. As also seen, rumen content had the highest portion among other wastes of the studied units (Fig. 1(c)).

Totally, the characteristic of wastes in slaughterhouses depends on automation and facilities applied in recycling inedible by-products and the consumption (Molapo, 2009). Therefore, the wastes are various in different societies. However, most parts of the wastes are rumen content, digestive system, soft meaty organs like pancreas, lungs and distain organs which are compatible with the results of the present study. The fats are saved in a place by the name of wastes storage and then are sold. 79% of the wastes contain other organs and digestive content. They are transferred to an approved place for burying garbage of Ahvaz city, Borumi district, by open trucks while the leachate leaks. They are left without any hygienic burying activities. Less than 0.0024% of the wastes, including distrain organs is burned by a non-standard carcass-*burning furnace* (Fig. 2).

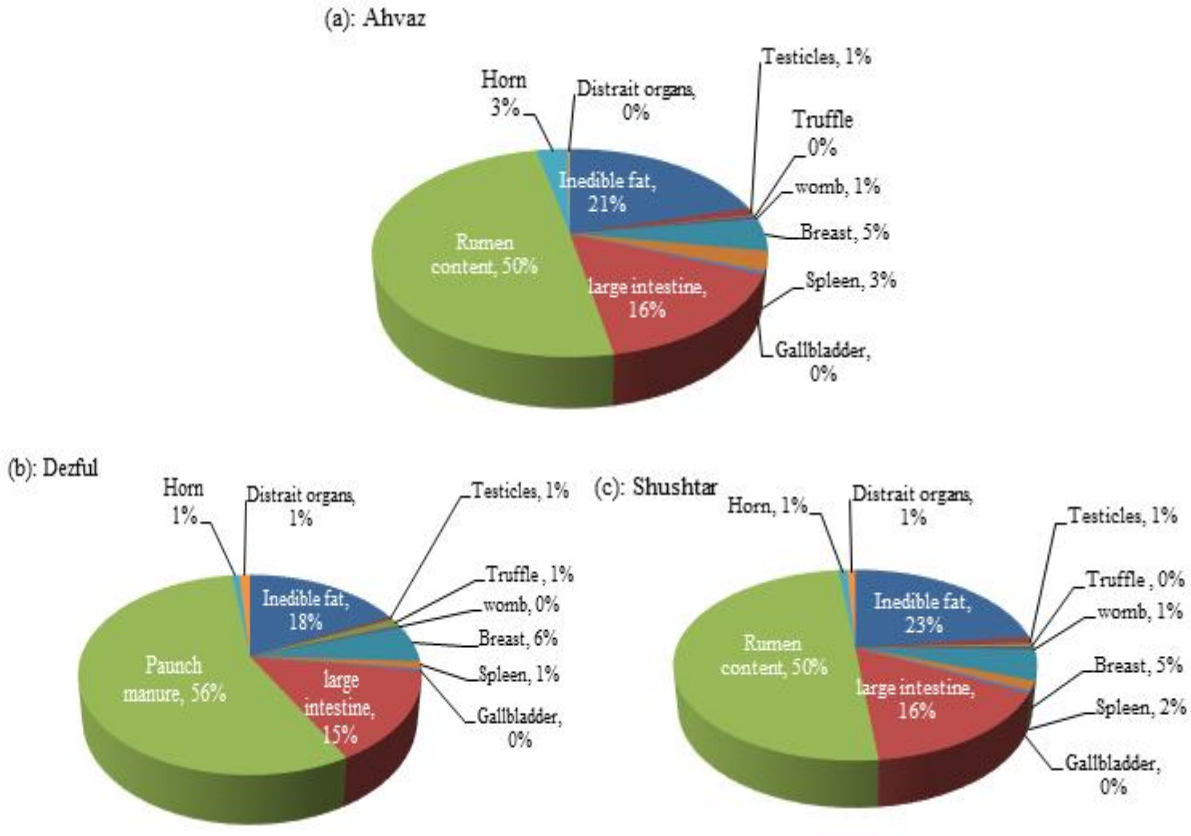

Fig. 1: The characteristic of waste in each of slaughterhouses in the different cities: (a) Ahvaz, (b) Dezful, (c) Shushtar

Looking at the slaughterhouses revealed that cart is used as a one of the most typical tools for the collection and transportation of waste to temporary storage. This action increases the risk of creating an inappropriate condition such as leaking and discharging garbage outside. This is while the most ideal method to carry such material from the place where they were produced the center for collecting is a particular corridor an elevator. It is important to note that implementing such methods is barely possible, however, it can be considered in designing new slaughterhouses.

Other findings indicated that transferring the wastes by the private sector, related to the municipality, and by 6 ton trucks was done. Slaughterhouse wastes were transferred to the city landfill while leaking the leachate and serous fluid. It is done without any hygienic techniques and completely unethical. While there are specific cases should be considered in transferring the wastes from production to disposal like the probability to touch the wastes by workers (when gathering and transferring during loading and unloading waste) and evaluating the accident probability such as the material leakage in the environment.

On the other hand, it should be noted that garbage trucks must not be regarded as waste keeping container.

Therefore, the slaughterhouse wastes should be packed before unloading to the waste trucks, but these activities are not conducted in mentioned slaughterhouses. While, recycling and reusing the industrial wastes is an advantageous and also an economic option in waste management. In most industrial units, recycling the wastes had much benefit of the owners and economic gain is one of the most important motivations for the industrial units to do reducing contamination activities. Recycling can be done in production location, out of the production location and in an intersection exchange.

This depends on wastes characteristic, recycling equipment's adjacency to the producer, the costs of transferring the wastes out of the producing unit, wastes content, saleable capability, storage costs, compared to transferring them out of the producing unit (Nabizadeh-Noudehi *et al*., 2006).

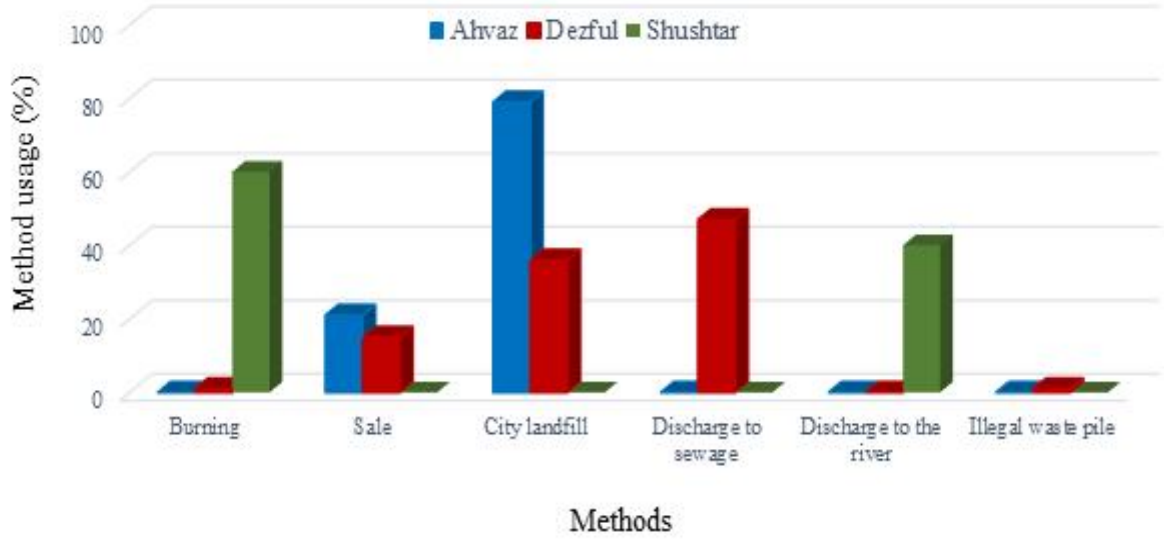

Fig. 2: The disposal methods of waste in each of Ahvaz, Dezful and Shushtar slaughterhouses

Slaughterhouses wastes contain high amount of decomposable organic materials that are infected without a correct hygienic management, lead to an unpleasant smell, and propagate pathogens, especially zoonotic diseases. Almost all slaughterhouse wastes are utilizable. However, recycling all wastes cannot be possible in different conditions. In this case, the wastes should be processed for composts, biogas, rendering and non-hazardous systems like incineration. Choosing a suitable method depends on the type and amount of wastes. By increasing population, increasing need for food and especially the deficiency of food resources make most countries to use the wastes of food industries and slaughterhouse wastes and also agricultural ones as the material of providing livestock food.

The wastes are considered as garbage in Iran, while they can provide livestock food cheaply through transformation processes. The most effective aspect of this function is preventing contaminations. The costs of waste management like transferring and excreting the wastes from producing units, administration, investment, infiltration and refining, dangers of impulsive costly expenditure, the amount of hazardous wastes in the environment, the cost of making them non-hazardous, bureaucracy, income by selling and reusing wastes and their reduction, environmental and human health is increased in recycling the wastes. Therefore, according all advantages of novel management in waste recycling and preventing contaminations, developing minimizing the wastes amount in the country is important and necessary.

As the administrators of the province slaughterhouses are public (municipality), lack of appropriate management resulted in huge expenses to the public sector. The conducting recycling procedure can make this industry into a profitable one along with covering current expenses of slaughterhouses. Also, managing the wastes can reduce contaminations of this industry to the environment, effectively. Burying the hazardous slaughterhouse wastes in the environment is as important as gathering, separating, packing and transferring them. This study shows transferring and burying the slaughterhouse wastes is given to the municipality and in some cases to private units with insufficient knowledge and experience in burying these wastes; and it is not supervised adequate. Moreover, unsuitable use of the equipment's like burying machines resulted in the fact that hygiene becomes one of the most important problems in managing slaughterhouse wastes.

Due to current limitations, burying some parts of the wastes is done by interring them, but it is necessary to inter the distrain organs in separated places and the place should be isolated; but the actions are not seen currently. Omrani *et al*. (2001) indicated that 55% of gathering and burying the wastes was done by municipality and 27.7% of private sector companies and 16.8% of manufactories management, in Tehran.

CONCLUSIONS

From the above discussion, the primary conclusions resulting from this work can be summarized as follows:

a) The total produced industrial waste in studying units was the 10252t / year among which 76.5% were produced by Ahvaz slaughterhouse, 17 % by Dezful, and 6.5 % by Shushtar 's slaughterhouse. The daily per capita waste generations were reported to be 54.6 kg/cattle and 11.1 kg/sheep.

b) About 97%, 99%, and 98% of the produced industrial wastes in Ahvaz, Dezful and Shushtar slaughterhouses are hazardous, respectively, that can be infectious.

c) The status of waste management was far beyond the expectations among studies slaughterhouse and no processing was done on the wastes in studied slaughterhouses. While bone, digestive contents and other solid material with organic sources (except distrain organs) can transform into the power of meat and bone through composting and rendering method; they are used as livestock and fishes' food.

d) The main challenges are designed, planning, and implementation of a suitable recycling program. Accordingly, setting an operational program and careful monitoring of its optimal execution by the slaughterhouse manager is necessary. The main focus of these programs should be primarily on waste recycling and reuse.

e) Improving the rate of recycling can make this industry into a profitable one along with covering current expenses of slaughterhouses.

Recommendations

The procedures to manage industrial wastes can be suggested as follows:

1) Separating by-products like fat and using them in industrial applications

2) Separating digestive content from other wastes and transferring them to specific places and recycling them by biogas and compost

3) Controlling and cleaning the screens and fats, gathering and administering them.

4) The gathered material should be managed like fat recycling and using it for soaping industries; and also the wastes gathered by the screens should be transferred to landfill and buried sanitary.

5) Adequate capacity of slaughter hall,

6) Coordination between the hall or excreting room and cleaning and packing the digestive organs,

7) Generating separated rooms to store fats, skin, horn and hoof,

8) Separating skin and wool appropriately and transferring them to suitable placed to be used in leather industry,

9) Gathering horns and hoofs and using them to produce buttons,

10) Gathering the blood resulted by slaughtering livestock completely to be used as complementary for livestock, in vaccine and other medicinal products,

11) Not feeding the livestock 8 hours before slaughtering to reduce digestive content and garbage

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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