Global Veterinaria 19 (2): 517-524, 2017
ISSN 1992-6197

DOI: 10.5829/idosi.gv.2017.517.524

Review on Abattoir Waste Management

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Abstract: Abattoir wastes consist of several pollutants such as animal feaces, blood, bone, fat, animal trimmings, paunch content and urine from operations or areas like lairage, stunning or bleeding, carcass processing and by-product processing. These abattoir wastes can be classified as solid, liquid and gaseous forms. Abattoir wastes can have a detrimental effect on the environment, public health, animal health and economy of the country if they are not effectively managed and controlled. Abattoirs often have difficulties in disposing, treating and processing of these wastes in an environmentally acceptable fashion. Due to this reasons there is high risk on environmental pollutions like underground water pollution, air pollution, nuisance, odor, soil pollution and public health risks through transmission of zoonotic diseases to human. Good manufacturing and good hygienic practices, liquid, solid and gaseous waste management practices, are highly necessary to minimize the harmful effect of abattoir wastes. Safe disposal, treatment and processing methods like burial, composting, rendering, incineration, anaerobic digestion and blood processing are also highly important to absorb our economic benefits from abattoir wastes /by-products rather than controlling public health risks and environmental pollution.

Key words: Abattoir Waste · Environmental Pollution · Public Health

INTRODUCTION

The abattoir is a specialized facility approved and registered by the regulatory authority for inspection of animals, hygienic slaughtering, processing and effective preservation and storage of meat products for human consumption. It is a special facility designed and licensed for receiving, holding, slaughtering and inspecting meat animals and meat products before release to the public consumption [1].

Abattoirs aim at optimizing the recovery of edible portions from the meat processing cycle for human consumption [2]. But significant quantities of secondary waste materials including organic and inorganic solids not suitable for further consumption are however generated [3]. Animal production and the operation of veterinary establishments such as slaughterhouses are seen as significant contributors to land degradation, air pollution, water shortage and pollution, loss of biodiversity and climate change [4,5].

Abattoir wastes can be divided into solid wastes, liquid waste and gas wastes. The solid waste consists mainly of bones, undigested ingesta, hairs and occasionally aborted feti, while the liquids comprise of blood, urine, water, dissolved solids and gut contents. Odors and emissions produce gas wastes [6]. Effluent generated from the abattoir is characterized by the presence of a high concentration of whole blood of slaughtered food animals and suspended particles of semi-digested and undigested feeds within the stomach and intestine of slaughtered and dressed food animals [7].

Abattoir activities are responsible for the pollution of surface and underground waters as well as air quality which indirectly affect the health of residents living within the vicinity of abattoirs [8, 9]. Reports also showed that abattoir waste piled up within the environment can cause pollution and subsequently produce methane gas that intensifies greenhouse effect [10].

The waste could also be washed away by surface runoff to contaminate ground and surface water including market places and streets [11]. When the slaughter wastes are not properly managed and especially, discharged into waterways, as such practices can introduce enteric pathogens and excess nutrients into surface water. The numerous wastes produced by abattoir operation not only pose a significant challenge to effective environmental

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management but also are associated with decrease air quality of the environment, potential transferable antimicrobial resistance patterns and several infectious agents that can be pathogenic to human [12, 13].

Research works conducted on wastes in developing countries suggested that wastes can be recycled or processed for conversion into useful products such as nutrient input for agricultural production including vegetable production, fish farming and even as feed for local chicken or goats reared under extensive system in rural households of these developing nation [14].

The quality of management of abattoirs and slaughter slabs, particularly, the adherence to standard practice of meat inspection and sanitation is a key to sound public health standard. An efficient abattoir operation and meat hygiene program is a service for healthy living of the public. The benefits are human health improvement, animal disease control, processing and retail net value, reduced spoilage and fraud and improved environmental hygiene [15].

Ongoing production quality control, washing and disinfection, are the main procedures of securing the hygiene of meat and meat products [16]. In the production of animal for food, more attention should be focused on the interactions between animal production and the environment, realizing environmental conditions and structures in animal production, which not only seek to produce wholesome and safe animal food but should also avoid environmental pollution and the associated human health risks. In addition, appropriate facilities to ensure safe disposal of abattoir wastes in a manner that will not constitute a potential hazard to public health, animal health and the environment is considered very essential [10]. Therefore, the objectives of this paper were to review different types of abattoir wastes, assess the effect of abattoir wastes on the environment and public health and to review different abattoir waste management practices.

Abattoir Waste and its Effects

Abattoir Waste: Definition, Sources and Classifications: Abattoir waste can be defined as waste or waste water from an abattoir which could consist of the pollutants such as animal feaces, blood, fat, animal trimmings, paunch content and urine. There are different sources of waste in abattoirs which could be categorized as: Lairage / animal pens, bleeding / stunning, carcass processing / cleaning, offal processing and byproducts processing. The waste material produced in meat establishments like slaughter houses are of three forms: solid, liquid and gas [17].

Solid wastes include manure, intestinal contents, hairs, horns, hooves, gallbladders, trimmings, internal organs, bones, condemned carcasses or body parts, paper, carton and plastics. The liquid waste of slaughterhouse consists of urine, blood and wastewater from the slaughter processes. Odors and emissions on the other hand are the forms of slaughterhouse gaseous waste [18].

Effects of Abattoir Wastes on the Environment and Public Health: Abattoir waste just like any other waste can be detrimental to humans and the environment if definite precautions are not taken. Some slaughter houses are littered with non-meat products and wastes that need to be recycled into useful by-products for further agricultural and other industrial uses. This constitutes public health risks and nuisance in most slaughter houses spread across markets, producing air, soil and water pollution as well as infestation of flies and other disease vectors [19].

For hygienic reasons abattoirs use large amount of water in processing operations; this produces large amount of waste water. The major environmental problem associated with this abattoir wastewater is the large amount of suspended solids and liquid waste as well as odor generation [20]. Ground water qualities in vicinity of the abattoir were adversely affected by seepage of abattoir effluent as well as water quality of receiving stream that was located away from the abattoir [21].

When the slaughter wastes are not properly managed and especially, discharged into waterways, as such practices can introduce enteric pathogens and excess nutrients into surface water. The numerous wastes produced by abattoir operation not only pose a significant challenge to effective environmental management but also are associated with decrease air quality of the environment, potential transferable antimicrobial resistance patterns and several infectious agents that can be pathogenic to human [12,13].

Appropriate Abattoir Waste Management Practices: In addition to good abattoir housekeeping, abattoir waste management should be progressively implemented commencing with low cost, low technology practices and thereafter progressing to more sophisticated technologies [22]. Liquid and solid waste products including specific risk material from the slaughter operation need to be handled, transported and disposed of in compliance with relevant regulations and in a manner appropriate for each processing site. There exist, however, a number of good management practices which, when applied in terms of

pre-treatment, can lessen the environmental impact of abattoir waste and potentially increase the availability of value-added products [23].

Some of these practices may require additional technology or labor, these practices may include: Primary screening to remove any solids or fats, specific risk management separation with appropriately sized screens, fat/oil removal by flotation and skimming. In addition to this, primary settling, blood separation, waste effluent balancing, pH correction (chemical correction), aerobic ponds and also anaerobic lagoons are mentioned [24].

Measure to Minimize or Control Abattoir Waste

Good Manufacturing and Hygienic Practices: The continuous drive to increase meat production for the protein needs of the ever increasing world population has some pollution problems attached. Pollution arises from activities in meat production as a result of failure in adhering to Good Manufacturing Practices and Good Hygiene Practices [25]. Consideration is hardly given to safety practices during animal transport to the abattoir, during slaughter and during dressing [26]. Better inspection of abattoir and strict enforcement of the law are needed to be able to reduce environmental contamination and related diseases especially zoonotic diseases. Attempts to control the hygiene of slaughterhouse should include visual assessment of premises and animals themselves and those that are affected by diseases should not be allowed for slaughter [27]. Failure of adhering Good Manufacturing Practices and Good Hygiene Practices often lead to contamination from hides, hooves and contents of alimentary tract during evisceration and negatively impact on the environment, including microbes in the soil and surfaces and ground water [28].

For example, the butchers who carry out illegal slaughtering of animals generally throw visceral material at the community bins and wash the small intestines at their shops itself and thus create pollution problem. At slaughter houses adequate compartments for immediate separation and disposal of condemned material must be provided. During dressing, the esophagus of cattle and sheep should be sealed to prevent leakage of animal contents. The authority must take care that intestines are not punctured during evisceration to avoid contamination of carcasses [2].

In abattoirs, a strategy needs to be adopted to replace ozone depleting gases, Chlorofluorohydrocarbons (CFCs) [16]. The adoption of standard operating procedures and modern air pollution control equipment effectively controls each of the contaminants, ensuring that the most stringent emissions standards can be achieved [29].

Liquid Waste/Effluent/ Management: During the operations in abattoir, the waste generated is of liquid and solid nature. The liquid waste should be washed away by safe potable and constant supply of fresh water at adequate pressure throughout the premises of slaughtering. Drainage lines of abattoirs need to be well constructed and strategically located to be able to properly drain liquid wastes and prevent stagnation that emits foul odor [30]. Waste water or effluent generated from the abattoir is characterized by the presence of a high concentration of whole blood of slaughtered food animals and suspended particles of semi-digested and undigested feeds within the stomach and intestine of slaughtered and dressed food animals [7]. The waste water from slaughter house is heavy in pollution, therefore, it should not be allowed to mix with the municipal drain system without treatments like anaerobic treatment which means the effluent is digested in the absence of oxygen in an enclosed digester; aerobic treatment in which oxygen assists bacterial action to reduce biochemical oxygen demand level and filter press for dewatering of the sludge [31].

Due to inadequate facilities at the slaughter houses and scattered illegal slaughtering of animals, very few slaughter houses collect blood. Uncollected blood in slaughterhouse becomes a serious sanitary problem. It quickly clots, choking drains, septic tanks, etc. and rapidly decomposes serving as an ideal medium for bacterial growth [32]. Bleeding areas should be clearly identified in the slaughter houses and blood drains and collection should be done immediately so that its full potential could be utilized [33].

Contaminated storm water, waste waters and wash waters should be collected in lagoons and aerated and irrigated without any off-site runoff; clean storm water must be kept away from the contaminated areas and directed to the storm water drainage system. All process areas must have concrete floors graded to wash down drains [22].

Solid Waste Management Practices: Sources of solid waste in abattoirs include animal holding areas, slaughterhouse and processing areas, waste treatment plant, unwanted hide or skin pieces and unwanted carcasses and carcass parts. Solid waste should be kept

separate from wastewater streams via the use of bucket traps and skips. This decreases the volumetric and organic load on the wastewater treatment stream [34].

At each slaughter house adequate tools should be provided for de-hiding of the animals and also hides and skins should be immediately transported out of the slaughtering area in a closed wheel barrow or similar other devices. In no case, the hides and skins should be spread on the floor of the slaughtering area for inspection. Legs, bones, hooves etc. should also be removed immediately from the slaughtering area through a spring load floor chute or closed wheel barrow [2].

The rumen contents (RC) consist of partially digested feed material eaten by animal before slaughter together with digestive juices and microbial flora. It either wasted or composted into manure. It causes solid disposal problem in slaughter house [32]. Generally, Proper disposal, burial and incerination can be used to avoid potential risks of environment and public health which can be occurred due to these and other solid wastes [18].

Gaseous Waste or Odor Management Methods: The tropical climate enhances the process of degeneration of any tissue material remaining as a waste in the premises of the slaughter houses. Therefore, the slaughter house premises always give a particular stink. In order to avoid this stinking odor proper ventilation of slaughtering halls, washing of the floors with non-poisonous disinfectants and when needed, the use of aerobic deodorants must be provided at each slaughter house. Odor control may be a significant issue, particularly when the abattoir is located near residential areas or in a hot environment [24]. All chemical storage areas and chemical-based odor control equipment must be located on impermeable concrete floors with bunding capable of containing 100 per cent of any spillage [22].

Safe Disposal, Treatment and Processing Methods: The appropriate facilities to ensure safe disposal of abattoir wastes in a manner that will not constitute a potential hazard to public health, animal health and the environment is considered very essential to be minimized [10]. Often, re-using or recycling by-products reduces waste production. Recovering valuable materials from waste streams can be economically and environmentally sensible. Government regulations must be followed in all operations done in abattoirs including the construction of the building itself along with the drainage, water supply and waste disposal systems [16].

Burial: Burial is a commonly used option for farmers although, if used for all slaughter waste, valuable nutrients are discarded. The SRM component is suitably contained for long-term on the farm using burial methods. The primary regulatory restrictions relating to burial of SRM are that the landfill must be covered immediately after use, it must have a means of keeping out wild life and records must be kept of the locations and volumes buried [34].

Controlled Incineration: Controlled Incineration is the burning of waste materials in safe way which requires temperature to reach 850°C or above, for at least 15 minutes and until all organic matter has been reduced to ash. In fact, incineration destroys most pathogens (sterilizes the waste) including the prion responsible for bovine spongiform encephalopathy (BSE). Incineration reduces volume by approximately 90% - 93% and the resultant ash is considered prion-free, as long as the incineration is conducted correctly. Thus, for slaughter waste containing SRM, if the correct burn is achieved, there would be no requirement for permitting in the disposal of the ash to landfill, or for its use as a soil amendment. Raw slaughter waste can have a negative energy value due to the high moisture content. There may be resistance to incinerators by the public and meeting emissions standards can be an obstacle for some incinerators [35].

Composting: Composting is natural biological decomposition process where aerobic organisms break down materials in the presence of oxygen, (air). For environmental and sanitation reasons, the composting of should be done in pits or bunkers instead of stacks and heaps. Both structures must be roofed or provided with sheds for security against rain [22]. Many farmers and an estimated 15 to 20 abattoirs are currently composting waste. The cost to compost has been estimated to be approximately one-third the cost of rendering. However, the composting process for full carcasses or significant quantities of waste takes several years is labor intensive and may be ineffective in disposing of hides and bones. The permissible uses of the final product – the compost – are still uncertain and may depend on the nature of the compost. The compost process is effective to break down the waste, kill some pathogens and produce final compost which is relatively safe [36].

Rendering: Rendering is the optimal disposal method so failure to use the rendering industry for the disposal of abattoir waste and mortalities will erode the infrastructure developed to safely handle these materials, resulting in sanitation and environmental challenges in the future [37]. It involves mechanical, thermal and/or chemical treatment of solid livestock slaughter waste and/or whole carcasses to produce pelleted soil additives or animal feedstock such as meat and bone meal (MBM) and tallow (fats and oils). MBM is used as a non-ruminant stock feed or fertilizer and the tallow can be used in the pharmaceutical, cosmetic and soap industries, as well as in animal feeds etc. [38].

In the absence of the rendering, the cost of disposal of waste animal material would be very high and would place a significant economic and environmental burden on areas involved in industrial scale slaughtering. This cost may manifest itself through the expensive use of sanitary landfills, incinerators and other similar waste disposal techniques without yielding profit directly out of it leading to the incurrence of opportunity costs [37].

Advantages are costs associated with disposal by rendering are lower in comparison to some other options though significantly higher than composting the waste on-site as part of the farm operations, considerably reduces the volume of material for disposal, beneficial by-products are generated during the rendering process, destroys most pathogens, can create a value added by-product [39].

Disadvantages of rendering is its use as a mean of reduction, not destruction. Rendering does not destroy the BSE prion so SRM must be removed or rendered products containing SRM require further disposal or management [39].

Anaerobic Digestion (Biogas Production): Anaerobic digestion involves the breakdown of materials by organisms in the absence of oxygen within a specialized containment unit. Anaerobic digestion technology is practicable for the treatment of organic solid slaughterhouse waste to combine material recovery and energy production. Assuming that the operation conditions can be optimized and the process made economically sustainable, anaerobic digestion is fully competitive with other treatment options for the above wastes [40].

Waste treatment system in the form of anaerobic lagoons facilitates the degradation of organic matter by microorganisms in the absence of oxygen into methane. It is by far the most frequently utilized method of treating wastewater from slaughterhouses. With anaerobic lagoons, wastewater move through the treatment process with the influence of gravity unlike other technologies with pumps, screens, aerators and mixers. Its disadvantages, however, include requirement for a large land area and emission of odor, especially in improperly designed, poorly operated or too small systems. Mosquitoes may also breed in the water. These can be addressed by constructing the lagoon far away and down-wind from populated areas or by covering lagoon cells [5].

At high temperatures, the anaerobic digestion destroys pathogenic bacteria at considerably higher levels than aerobic digestion, when used as part of an integrated waste management system, anaerobic digestion reduces the emission of landfill gas into the atmosphere, anaerobic digestion produces biogas consisting of methane and carbon dioxide [27].

Biogas is produced by anaerobic digestion with anaerobic bacteria or fermentation of biodegradable materials such as manure, sewage, municipal waste, green waste, plant material and crops. The embedding of biogas power-plants is the best solution for bio waste utilization. The use of gut contents, manure and solid waste to produce biogas as fuel for heating and lighting would to a great extent help alleviate shortage of fuel and conserve environment [41].

Blood Processing: Blood is a rich source of iron and proteins of high nutritional and functional quality. Because of the high protein content of blood, generally about 18% of it sometimes referred to as “liquid protein.” Thus, a valuable protein source is lost if animal blood is discarded as waste. Many countries require that animal blood be disposed of in an environmentally friendly manner, which is a capital intensive process. Accordingly, to eliminate a sizeable pollution hazard and prevent the loss of a valuable protein source, efforts have been made to ensure the utilization of animal blood on a massive scale. A further incentive is the increased profits to be made through adding value to the blood [42].

When processed and incorporated in the livestock feeds, it would provide a valuable source of animal protein and as a fertilizer it would enrich the soil. The blood available from the slaughter houses should be collected and made use of in pharmaceutical industry. Blood collection on efficient lines will be possible only in modern slaughter houses as collection has to be done

speedily only and without dilution with water. Otherwise processing would be pronged making moisture removal highly expensive [32]. By passing steam directly in to blood, allow it to dry and pulverize into a meal is simple method of preparing blood meal. Blood meal is a dry, inert powder made from blood used as a high-nitrogen fertilizer and a high protein animal feed. N = 13.25%, P = 1.0%, K = 0.6%. It is one of the highest non-synthetic sources of nitrogen. It usually comes from cattle as a slaughterhouse by-product [33].

Economic Importance of Abattoir Waste Management: Promotion of production, processing and utilization of other livestock by-products would increase returns from abattoir and meat plant business and help cover some of the operating costs and thus make it more profitable. Establishment of factories to produce various products and goods including glue, combs, buttons, gelatin, brushes, lubricants, grease will create employment to urban dwellers and through that contribute to the national economy [43, 44].

By-products such as blood and bone meal are ingredients with high protein content are needed in the manufacturing of poultry and pig feed. Promotion of production of blood and bone meal will assist in promoting poultry industry which in turn will contribute to the economy. The use of gut contents, manure and solid waste to produce biogas as fuel for heating and lighting would to a great extent help alleviate shortage of fuel and conserve environment [45]. There is decreasing use of chemical fertilizers in African agriculture because of their high cost, unavailability and poor infrastructure for marketing and their detrimental effects on the environment [46]. Due to these reasons, farmers in most part of Africa were developing the use of slaughterhouse wastes composting and apply as soil fertilizer. This practice will improve the economic income of that country [47].

CONCLUSION

During abattoir operations there are different types of wastes released which are of solid, liquid and gas. Abattoir wastes can affect water, land or air qualities and human health if proper practices of management are not adhered to. The problems of waste generated in an abattoir can be better managed and corrected if proper assessment of the amount and type of waste generated are properly documented. This would help in accurate prediction of the best method to manage the waste generated. We can manage it by implementing appropriate liquid, solid and gaseous waste management practices and by safe disposal, treatment and processing methods in order to prevent or minimize the potential hazards to environment and public health. By doing so it is also possible to gain more economic benefit from abattoir wastes or by-products.

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