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Management and Ecofriendly Disposal of Hatchery Waste

Snober Irshad and Islam Uddin Sheikh
Division of Livestock Production and Management
Faculty of Veterinary Sciences and Animal Husbandry, Sheri-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu & Kashmir, India
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Introduction

Hatchery operation is one of the most important activities in poultry farming. Lot of wastes generated during hatchery operation which is very difficult to manage. The poultry industry generates two main types of waste: solid waste and wastewater. Solid waste consists of infertile eggs, deceased embryos, empty shells, delayed hatchings, deceased chickens, and so on. Meanwhile, waste water primarily originates from the cleaning of hatchers, incubators and chick handling areas which ultimately pollutes the ground water. The continual leakage of waste and pollutants from various livestock operations into groundwater and water bodies is a significant factor contributing to higher concentrations of nitrates and phosphates in drinking water. Traditional methods of managing solid waste from hatcheries involve landfills, composting, rendering, and incineration. Typically, most hatchery waste is sent to landfills or undergoes composting, incurring significant disposal costs for the chicken meat industry. Rendering processes are rarely employed. As for wastewater disposal, options include sending it to landfills, using it for irrigation, direct disposal into the sewer system, or containment in wastewater lagoons. Only a small number of hatcheries implement wastewater treatment systems [1]. Hatchery waste deposited in landfills will naturally decompose, producing methane gas. With appropriate treatment, hatchery waste can be transformed into high-protein feedstuffs, other value-added products, or utilized as organic fertilizer. However, excessive use of organic waste as fertilizer can lead to nitrate (NO3) contamination of groundwater, potentially resulting in health issues such as blue baby syndrome, cancer, respiratory illnesses in humans, and fetal abortions in livestock [2].

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Handling of Hatchery Waste

Most hatcheries use a vacuum extraction system to transfer the waste into bins while some hatcheries store the waste in a room and then place the waste into a Bio-Bin. Other hatcheries will first crush the waste and then use a vacuum or auger system to transfer the waste into the bin. Another disposal option is using a centrifuge to separate the liquids from the solids of which the liquid is refrigerated and transported to a pet food manufacturing plant and the solids are sent to landfills. Hatchery waste should be separated into solid and liquid waste and then treated separately.

Separation of Waste at the Hatchery

At the hatchery, it is possible to segregate waste into its solid and liquid constituents for separate treatment. For instance, spinning can be utilized to separate the liquid content from the solid hatchery waste. Additionally, inclined screens, coupled with the use of belt or filter presses, are effective in separating the solid and liquid portions of the waste. These methods result in approximately 45% of solid materials. In other industries, a flexible multi-layer filter is employed to differentiate liquid waste from sludge waste. This process relies on gravity for the liquid waste to pass through the liner into a container.

An alternative approach to segregating liquid and solid waste involves using a conveyor system with upper and lower conveyor rollers, connected by an endless conveyor belt. A waste deflector is positioned above and along the lowest part of the upper run. The liquid and solid wastes are efficiently separated and collected in receptacles located near the upper and lower rollers.

Many hatcheries employ a vacuum extraction system to transfer waste into bins, while others opt to store waste in a designated room before depositing it into Bio-Bins. Alternatively, some hatcheries choose to crush the waste first and then use either a vacuum or auger system for bin transfer. An additional disposal method involves the use of a centrifuge to separate liquids from solids. The separated liquid waste is refrigerated and transported to a pet food manufacturing plant, while the solids find their way to landfills. Effective hatchery waste management entails the initial separation of waste into solid and liquid components, followed by individual treatment.

Separating egg shells from hatchery waste

To effectively separate eggshells from hatchery waste, several methods are employed. A robust suction vacuum is utilized to exclusively extract the dry, lightweight shells from the waste, leaving behind the heavier, infertile eggs. An example of this technique is detailed in World Intellectual

Property Organization-WO/2001/074491, which describes an eggshell waste processing method and device.

Alternatively, the separation of shell and non-shell materials can be achieved by employing a vibrating or shaking device, such as a shaker-sieve belt. These devices can effectively segregate the lighter components from the heavier ones within the hatchery waste. Furthermore, a stream of gas, such as a cyclone forced-air separator, can be harnessed to separate materials based on their weight, thus separating lighter from heavier substances in the hatchery waste.

Once hatching has occurred, live chicks and unhatched chicks or clear eggs from the hatching tray are carefully placed on a moving belt designed with fixed gaps that only allow chicks to pass through. Shells and unhatched eggs are retained on the belt. Subsequently, the shells can be vacuumed for further separation, while the deceased embryos are disposed of into a separate container, as elaborated in the World Intellectual Property Organization-WO/2001/074491 documentation on eggshell waste processing methods and devices.

Storage of Waste on Site; Bio-Bins and Skip Bins

The majority of hatchery waste is initially stored in dump bins before being transported for disposal at landfills or composting sites. However, some hatcheries opt for Bio-bins for waste storage, a specialized container designed for the preliminary composting of hatchery waste (developed by Biobin Technologies Pty Ltd.).

In the Bio-bin, hatchery waste is deposited and sealed to create an airtight environment. Air is then pumped through the bin, initiating the composting process while effectively eliminating odors and harmful bacteria. These bins are also utilized in the chicken meat industry for composting deceased birds. The resulting composted material serves as a valuable soil conditioner. Subsequently, the contents of the Bio-bin are transported to dedicated waste sites for the completion of the composting cycle. Bio-bins can also be used temporarily to maintain hygienic storage of hatchery waste. Bio-bins offer several advantages, including compliance with biosecurity requirements, the removal or significant reduction of odors, and the prevention of fly and rodent contamination.

Livestock Feeding with Poultry Litter

Poultry litter, composed of manure and bedding material, finds application as livestock feed in various animal diets, including poultry, lambs, ewes, swine, lactating cows, wintering cattle, and brood cows. This practice extends beyond national borders, with countries like Israel and certain U.S. states incorporating poultry litter/manure into livestock feeding programs. The drying of poultry manure represents one of the oldest methods for processing waste into reusable livestock feed. Research indicates that cage layer waste contains amino acid nitrogen, accounting for approximately 37% to 40% of the total nitrogen content. Additionally, around 40% to 60% of the total nitrogen in poultry excreta exists in the form of non-protein nitrogen (NPN). When provided as feed to ruminants, uric acid, a primary source of NPN in poultry, undergoes degradation to ammonia thanks to rumen microbes. It's important to note that the maximum recommended inclusion rate of poultry waste in ruminant feeds is 20%, as outlined by the National Research Council (NRC) in 1984.

Dried poultry waste boasts a composition of approximately 28% protein and 30% ash. It also serves as an excellent source of essential minerals such as calcium, phosphorus, potassium, iron, and zinc, as cited by the NRC in 1984. Research findings suggest that poultry waste fed at levels exceeding 35% can meet nearly the entire protein requirements of sheep while significantly contributing to the overall energy content of the diet.

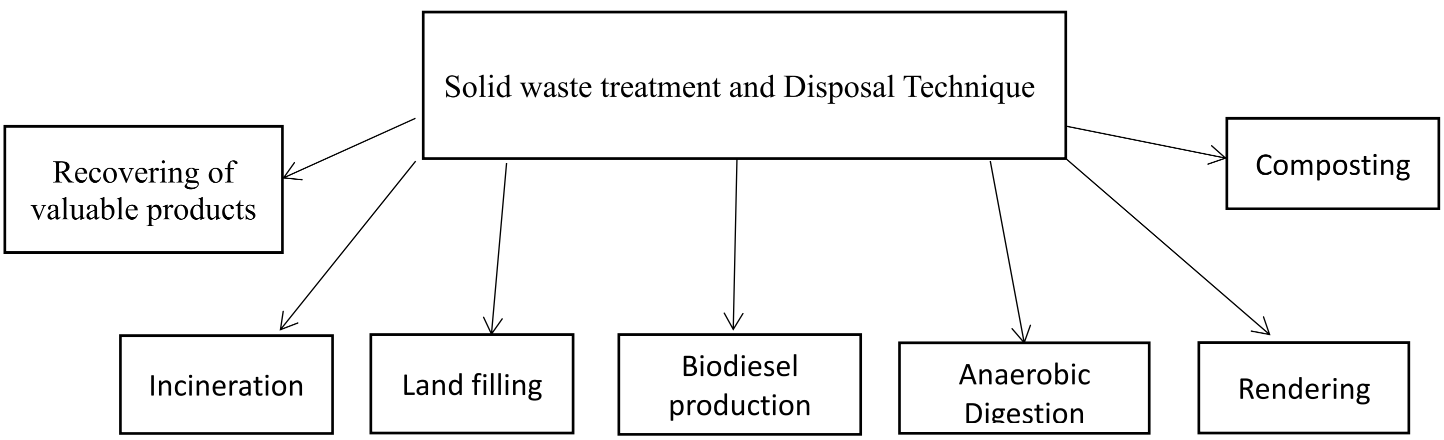

Fig: Solid Waste Treatments Systems

Power generation

One method for handling hatchery waste involves automated feeding via conveyor belts, directing it into a furnace equipped with a rotating shredder unit designed to chop and grind solid waste effectively. This finely ground waste can then be processed in an incinerator system, functioning as a furnace, to heat both the solid and liquid waste, ultimately generating steam.

The produced steam can serve a dual purpose: it can power a turbine generator, resulting in the generation of electricity. However, the economic viability of employing a steam turbine at a hatchery largely depends on the scale of waste production. This approach is more economically feasible for hatcheries that generate a substantial volume of waste.

Rendering

The rendering process offers a dual benefit by both drying the material and separating the fat from the protein. This process yields fat and a protein meal, known as hatchery waste by-product meal, which is similar in nature to meat and bone meal or can be used as a fertilizer. This protein meal is particularly valuable as there is a global shortage of protein meals for use in various diets, especially in the pig and poultry industries. The decision to render hatchery waste hinges on whether it is more cost-effective to transport the waste to a rendering facility or simply send it to a landfill. One significant concern when incorporating by-products like hatchery waste meal into diets is ensuring that they are free from pathogens, as food safety is of paramount importance.

Autoclaved and extruded

Extruded or autoclaved hatchery waste could be used as livestock feed which will reduce the cost of production.

Boiling

Hatchery waste could be treated in the same way as poultry waste (feathers, heads, feet and inedible entrails (intestine, lung, spleen) by boiling at 100 °C with a pressure of 2.2 kg/cm^2 for 15 min; then boiled again at 100 °C for 5 hours, followed by boiling at 130 °C for 1 h then cooled to ambient temperature. Likewise dead embryos could be boiled for 100 °C for 30 min, soaked in cold water for 20 min to remove shells, sun dried for 4d and used in poultry feed. Cooking hatchery waste with water (2:1) then dehydrating to a dried product has been used as livestock feed. Nutritive value of the dried dead embryos is 36% CP, 27% ether extract, 17% ash, 10% calcium and 0.6% phosphorus.

Ensiling

The eggs were mixed in a 1:1 ratio with formic and propionic acids for 8 weeks at room temperature. Formic acid is suitable for the ensiling of materials such as wet and protein-rich resources. Propionic acid and formic acid have been used to preserve and ensile non fertile eggs and dead embryos. The acids act by intervening specifically in the metabolism of the microorganisms involved in spoilage. In addition, the reduction in the pH creates an environment which is unfavourable for microorganisms. The rapid reduction in the pH diminishes the growth of bacteria which produce butyric acid and ammonia and promotes the growth of lactic acid-producing bacteria. The lactic acid is responsible for the low pH necessary for storage of the by-product before being used in animal feed.

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Composting

Composting is a common method for solid organic waste disposal. In this process, mesophilic and thermophilic micro-organisms convert biodegradable organic waste into a value-added product [3]. The decomposition of organic waste is performed by aerobic bacteria, yeasts and fungi. The composting process kills pathogens, converts ammonia nitrogen to organic nitrogen and reduces the waste volume. The product can be used as a fertilizer. Disadvantages of composting are loss of some nutrients including nitrogen, the land area required for the composting and odour problems. When hatchery waste is composted with poultry litter it will produce a safe and rich organic product which is a good organic fertilizer. It is important to control the moisture content and keep raising the temperature of the compost to eliminate the pathogens. Composting hatchery waste with poultry litter produces a product that contains 1% nitrogen, 2.5% phosphorus and 0.25% potassium on a dry weight basis. The product also contains high calcium and other micro-nutrients.

A potential method for treating hatchery waste on a hatchery site is to use an 'in-vessel' composting technique to decompose and stabilize the un-separated hatchery waste obtained directly from the hatchery. The hatchery waste can be mixed with wood shavings to reduce the moisture then composted. There are a number of 'in vessel' composters on the market that could be used for stabilizing hatchery waste. The composter turns manure, litter, sour feed stuffs and carcasses into compost in 4 days with minimal labour and mechanical devices.

Anaerobic Digestion Systems:

Anaerobic digestion represents the degradation of organic waste by microbial organisms in an oxygen-deprived environment, generating methane and inorganic byproducts[4]. This highly efficient process produces biogas for power generation or heating and yields bio solids suitable for high-quality fertilizer. The system offers cost-effective and environmentally beneficial advantages, including waste recycling and the production of bioproducts, such as algae, zooplankton, and fish for livestock feed.

Challenges Associated with Disposal of Hatchery Waste

The global chicken population currently stands at around 8 billion birds, with 90% of them originating from commercial hatcheries, resulting in large volume of hatchery wastes required proper disposal. Traditional methods like landfill disposal pose environmental concerns, including the release of methane into the atmosphere and the potential for spreading microbial contamination. Future regulations may restrict hatcheries from using landfills, endangering their sustainability. The challenge lies in designing systems that can convert waste on-site into valuable products for on-site use or sale.

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For the poultry industry as a whole, the key challenge is to transform all waste into economically valuable outputs through cost-effective treatment systems. Given the industry's substantial waste production, bioprocessing is essential to generate feed, fertilizer, and fuels. This necessitates waste characterization, separation, product development, system design, risk assessment, and quality control. These approaches maximize the conversion of carbon, nitrogen, phosphorus, and water in waste streams into biofuels and agricultural products while simultaneously addressing pathogen and odor control.

Conclusion

All the waste generated during hatchery operation should be converted into economically valuable outputs using low-cost treatment systems for ecofriendly utilization of wastes without polluting the environment. The huge volume of waste generated by the industry needs to be treated using bioprocesses to produce feed, fertilizer and fuels. These processes need to be applied to the organic waste streams like poultry manure, hatchery waste and turn the cost of waste disposal into a source of income, recycle nutrients and reduce pollution.

References

1. Das, K.C. Minkara, M.Y. Melear, N.D. and Tollner, E.W. (2002). Effect of poultry litter amendment on hatchery waste composting. *J. Appl. Poult. Res.* **11:** 282–290.
2. Imbeah, M. (1998). Composting piggery waste: A review. *Bioresour. Technol.* **63**:197–203.
3. Kelleher, B.P., Leahy, J.J., Henihan, A.M., O'Dwyer, T.F., Sutton, D. and Leahy, M.J. (2002). Advances in poultry litter disposal technology—A review. *Bioresour. Technol***.** **83:** 27–36
4. Lin, C.Y., Sato, K., Noike, T. and Matsumoto, J. (1986). Methanogenic digestion using mixed substrate of acetic, propionic and butyric acids. *Water Res.* **20:** 385–394.

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