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The Poultry Industry: Converting Waste to Gain

Agriculture, though largely under-developed, is the most important sector to the Nigerian economy after oil of which animal production is a very crucial part. Crop and animal Agriculture should be combined together for best results in the economy. Animal products are responsible for one-sixth of the human food energy and also more than one-third of the protein requirement on a global basis. With a growing population of Nigeria, animal production is also expected to grow so as to meet the needs of Nigerians.

At the moment food industry is tending to minimize the amount of the waste material arising during processing. There is a growing interest to commercially utilize the different by-products generated during various food processes. Many individuals and organizations worldwide rely upon the poultry industry for substantial portion of their income and low-cholesterol animal protein intake. The introduction of commercial poultry in Nigeria resulted into its rapid evolutionary changes, poultry meat and eggs provide affordable, quality food products that are consumed by most ethnic populations worldwide.

Issues related to the environment, human health and the quality of life for people living near to and distant from poultry production operations make waste management a critical consideration for the long-term growth and sustainability of poultry production in larger bird facilities located near urban and peri-urban areas, as well as for smaller commercial systems associated with live bird markets, and for village and backyard flocks located in rural areas.

Waste Management Alternatives

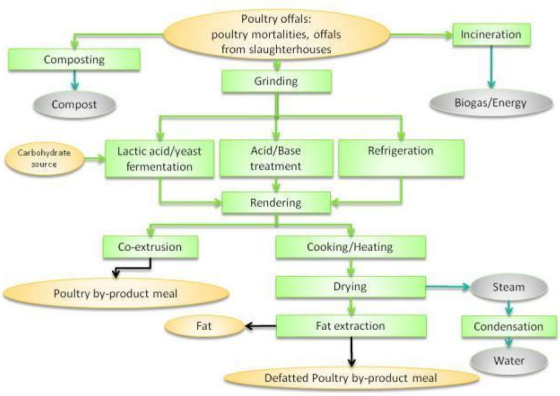
The production of poultry results in: hatchery wastes, manure (bird excrement), litter (bedding materials such as sawdust, wood shavings, straw and peanut or rice hulls), and on-farm mortalities. The processing of poultry results in additional waste materials, including offal (feathers, entrails and organs of slaughtered birds), processing wastewater and biosolids. Most of these by-products can provide organic and inorganic nutrients that are of value if managed and recycled properly, regardless of flock size. However, they also give rise to potential environmental and human health concerns as the sources of elements, compounds (including veterinary pharmaceuticals), vectors for insects and vermin, and pathogenic microorganisms.

Parts of the Carcass of Slaughtered Poultry

Poultry by-product meal

Poultry by-product meal is one of the most important sources of animal protein used to feed domestic animals, along with meat and bone meal, blood meal, feather meal and fish meal. It is made by combining the by-products coming from poultry slaughterhouses or poultry processing plants. Poultry by-product meal is ground, rendered, clean parts of the carcass of slaughtered poultry such as necks, heads, feet, undeveloped eggs, gizzards and intestines (provided their content is removed), exclusive of feathers (except in such amounts as might occur unavoidably in good processing practices). Whole poultry carcass meal can also be obtained from culled laying hens (spent hen meal), notably in areas where there is no market for culled hens. Poultry by-product meal is golden to medium brown in colour with a fresh poultry odour

Processing poultry offals into poultry by-product meal requires several steps. Poultry offals are primarily collected in containers where they can be stabilized through fermentation with molasses or brewer's grain. This operation reduces pH and stops bacterial and viral development. Stabilization may also be achieved with acid or basic treatments. Mineral acids such as sulfuric or phosphoric acids are effective in preserving poultry wastes. Organic acids are also potential preservative treatments. Among chemical bases, NaOH treatment is also a potential preservative.



The traditional way of processing offals used to be wet-rendering (cooking under steam pressure) but it was replaced by dry-rendering, which resulted in meals of higher quality. The stabilized (or not) poultry offal is cooked/sterilized and dried down to 8% moisture. When the resulting meal appears to be too fat (above 16% fat), rancidity problems may occur during storage. Fat extraction is therefore recommended and yields a 10-12% fat content poultry by-product meal.

High-fat whole poultry meal can also be obtained by alkaline hydroxide treatment of whole poultry carcasses followed by freeze-drying (lyophilisation). Freeze-drying is an interesting way of stabilizing poultry carcasses before transformation into meal in places where odours are not tolerated by the neighbourhood. The resulting meal was found to be free of pathogens. It has a higher fat content and a lower crude protein than poultry by-product meal.

Environmental impact

Processing poultry by-products into feed is a good way to mitigate the environmental problems caused by poultry processing. If not properly managed poultry offals released in the environment are vectors for insects, vermin, bacteria and viruses, which may result in water contamination (leaching of nutrients and pathogenic microorganisms) and air pollution (noxious gases and nuisance odorants).

Poultry Manure or Litter

Land application of crop nutrients

Globally, poultry manure or litter has been applied to land to enhance crop production for centuries. When properly managed, this is an effective and beneficial option. Environmental pollution occurs when manure or litter is applied to the land in excess of the receiving crop's capacity to utilize the nutrients. Other factors that influence the environmental fate of the manure and litter applied include methods of collecting, storing, handling, treating, transporting and applying the waste by-products to the receiving land. For example, with non-liquid-flush systems, the poultry housing and manure storage area should be designed so that the manure and litter are kept as dry as possible, to minimize aerial emissions of gases and assist fly control. Manure and litter storage should be planned to prevent contact with rainfall or rain runoff.

Land application should be based on the agronomic uptake of the receiving crop, accurate analysis of the nutrients contained in the manure (particularly nitrogen, phosphorus, copper and zinc) and properly calibrated application methods; it should be avoided when the land is frozen or excessively wet. Land application methods that incorporate the manure or litter directly into the soil minimize odour and gas emissions and surface runoff. These principles also apply to small family operations, whose sanitation will be improved by periodically removing manure or litter from areas where just a few birds are housed, and by storing, composting and/or land-applying the product at least 100 m from where the live birds are kept.

Composting is a natural aerobic biological process to breakdown organic matter, which provides a practical and economically feasible method for stabilizing poultry manure and litter before land application. Correctly managed composting effectively binds nutrients such as nitrogen and phosphorus in organic forms, and reduces pathogens, insect eggs and weed seed owing to the heat generated during the biological processing. Composting can also reduce nuisance odour emissions from poultry waste storage and treatment areas. A variety of composting approaches, from very simple to more complex automated systems, are available for both large and small poultry producers. In areas where manure or litter is land-applied near streams or surface waters, an exceptionally simple and effective approach for mitigating surface runoff or the subsurface flow of potential harmful nutrients is to maintain a natural riparian buffer next to the water resources.

Riparian buffers (vegetated areas) may comprise native grasses, shrubs or trees, or a combination of these. The width and make-up of a riparian buffer are specific to its location, and the width of the buffer from the stream edge determines its effectiveness. Natural grass buffers of approximately 10 m wide have been shown to reduce nitrogen and phosphorus from field surface runoff by approximately 25 percent, while combined grass and tree buffers are much more effective. This practice is a documented inexpensive natural method of protecting water resources from the nutrients and pathogenic microorganisms contained in nearby land-applied poultry manure or litter.

Bioenergy production

Poultry manure and litter contain organic matter that can be converted into bioenergy under certain processing technologies. One of the most common approaches for poultry excrement managed by water flushing (e.g., some layer operations) is anaerobic digestion, which yields biogas, a gas mixture with varying concentrations of combustible methane. The biogas can be used as an on-farm energy source for heat or as a fuel for various engines that generate electricity. An additional advantage is that, depending on processing conditions, anaerobically digested manure solids and liquids are further stabilized and more acceptable and safe for use as a fertilizer or feed supplement.

Numerous technologies and approaches are available for on-farm or centralized anaerobic digestion, and all are influenced by multiple variables that affect biogas yield and efficiency – operational feasibility and effective management are critical to the success of this process, especially with some of the more complex anaerobic digester technologies. Unfavourable economic and other issues associated with operational feasibility, and low biogas yield from litter-based systems have discouraged many poultry producers worldwide from implementing this technology.

Poultry litter and dry manure can be incinerated for on-farm production of heat in small furnaces, or transported to central locations where they are combusted on a large scale for the generation of electricity. For both approaches, the amount of energy produced depends on the efficiency of the equipment utilized and the moisture content of the manure or litter burned. Operational feasibility and emission issues also affect this process, especially for on-farm small conventional furnaces.

Gasification technology is a way of producing bioenergy that is receiving renewed interest for small on-farm systems and central electric power stations in some regions. The process involves incomplete combustion in a limited-oxygen environment. As noted for both anaerobic digester technology and incineration units, economic costs and returns, operational feasibility and emission issues have an impact on the implementation of this technology. However, increasing energy costs, environmental policy related to mandated renewable energy production goals in some regions, and the evolving carbon credit market are stimulating interest in all technologies for processing poultry and other waste products that yield bioenergy and reduce greenhouse emissions.

Feather

Feather meal

Feather meal is a byproduct of processing poultry; it is made from poultry feathers by partially grinding them under elevated heat and pressure, and then grinding and drying. Although total nitrogen levels are fairly high (up to 12%), the bioavailability of this nitrogen may be low, feather meal is used in formulated animal feed and in organic fertilizer. The hesitance to use feather meal is due to the believe that feather meal is poorly digestible and its smell could influence the feed intake when administered at high levels. However, there is a growing interest in it as many studies show

that feather meal gives significant opportunities to improve the cost-effectiveness of fish feeds without losing fish performance.

Feather meal is made through a process called rendering. Steam pressure cookers with temperatures over 140 °C are used to "cook" and sterilize the feathers. This partially hydrolyzes the proteins, which denatures them. It is then dried, cooled and ground into a powder for use as a nitrogen source for animal feed (mostly ruminants) or as an organic soil amendment.

Containing up to 12% nitrogen, it is a source of slow-release, organic, high-nitrogen fertilizer for organic gardens. It is not water-soluble and does not make a good liquid fertilizer. It can be used to:

- Increase green leaf growth
- Activate compost decomposition
- Improve soil structure

When adding it to a garden as a nitrogen source, it must be blended into the soil to start the decomposition to make the nitrogenous compounds available to the plants. As an organic garden fertilizer, it is not synthetic or petroleum-based.

Issues

A 2012 study found that feather meal contributes to inorganic arsenic exposure to humans whether it is in the form of animal feed or organic fertilizers.

Nutritional Value of Feather Meal

Rich in protein

The most important poultry by-product at a rendering plant is FM. Feathers are rich in protein content called keratin and constitute 7% weight of the live bird, therefore producing a considerable mass which can be converted to valuable meal. Feather meal is also an excellent source of escape protein.

Typical compositional components of FM

Dry Matter	90%
Crude Protein	82%
Digestibility	75% min
Fat	6%
Ash	4%
Crude Fiber	0.60%
Available Lysine	1.80%
Methionine + Cysteine	4.90%
TMEn	3.07 Kcal/g (12.8 MJ/kg)

Source: Ewing, 1997, TMEn (True Metabolizable Energy (nutritional science)

Underestimated amino acid profile

Feather meal is very high in crude protein and its amino acid profile is quite similar to that of fish meal, whereby some essential amino acids even exceed those in fish meal. A deficiency is only given in Methionine, Lysine and Histidine, whereby Cysteine can partly replace Methionine. Lysine and Histidine could be balanced by using other types of processed animal proteins such as blood meal, rich in both amino acids.

Formulation of fish feed is about balancing nutrients, more than applying a minimum and maximum constraints of raw materials. Therefore, since the amino acid composition of different rendered animal proteins appears to be complementary, feeds can be formulated to contain higher levels of rendered animal protein ingredients if these were used in combination instead of as a sole ingredient to achieve an optimum amino acid balance.

True amino acid Availability of FM.

Amino Acid	TAAA %
Lysine	59.2
Methionine	74.4
Cystine	64.2
Leucine	76.9
Phenylalanine	79.2
Arginine	82.8

Source: (Liu et al 1989

FM is an excellent source of high quality protein but with the less digestibility, whereas with the easy application of some modified processing steps the quality of FM can definitely be increased. he easy availability of raw materials for the production of FM and economically viable processing methods can make it the most promising protein rich feed for both ruminant and monogastric animals. The energy value, amino acid composition and its availability has made it a top preference in feed. Based upon the price of FM, nutritionists should consider more regular use of this commodity. The effective utilisation of FM can surely increase animal production in terms of milk and meat; therefore it surely will secure its position in animal diets in the near future as a convenient, economically viable, protein rich feed ingredient for all sorts of domesticated animals.

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