P-ISSN: 2305-6622; E-ISSN: 2306-3599

International Journal of Agriculture and Biosciences

www.ijagbio.com; editor@ijagbio.com

Review Article

# Some Selected Animal Wastes and By-Products for Poultry Feed: Review

[1]Melkamu Bezabih Yitbarek and JC Okonkwo[2]

[1]Department of Animal Sciences, College of Agriculture and Natural Resources, Debre Markos, University, Ethiopia.
[2]Department of Animal Science and Technolohy, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.
**Corresponding address:** tirumelk@gmail.com

**Article History:** Received: January 04, 2019 Revised: May 12, 2019 Accepted: August 06, 2019

**ABSTRACT**

This review was carried out to assess some selected animal wastes and by-products used as poultry feed and indicate the inclusion rate of them in poultry ration. The collected animal wastes and by-products from different sources can be processed by heating, sun drying, boiling etc. and included in poultry ration in varying proportions. Blood meal is one of the animal wastes and can be included up to 25% in poultry diets, meat and bone meal up to 10 % can replace soybean meal in chick, leather meal up to 25% can replace soybean oil meal in poultry feed, About 6% fat should be included in the ration if the egg production 70% and above. The performance of broilers was not found to be depressed when 10 to 15 % dried rumen contents were fed. Dried blood rumen content mixture can be included up to 60% starter phases and up 80% for finisher phases of growth to replace soybean meal. Poultry by-product meal from 7-10% can be used in poultry diets. About 8 to 16% are recommended for hatchery by-product meal in layer diets. Eggshell meal was high source of calcium, with no effect on DM intake or egg production being observed. Dried poultry and cow manure can be included up to 5% for broilers, up to 20% - 40% for layers without any adverse effect. Therefore, animal wastes can be included in poultry ration after appropriate processing to reduce feed cost and environmental pollution for maximum return.

**Key words:** Animal by-products, Animal wastes, Egg shell meal, Poultry by-product meal

## INTRODUCTION

The world poultry population in 2015 was 19.4 billion which accounts for 35% of the global livestock production. The world poultry meat production in the same year was 111.8 million metric tons and the global egg production was 70.9 million tonnes. The world today is suffering from a serious shortage of livestock feed ingredients because of the rapid increase in human population and feed competition of people and livestock (Adeniji and Oyeleke, 2008). The poultry industry is gradually increasing in the world where protein concentrates are costly and used in formulating poultry diet that increased production cost. The total feed required to poultry in 2015 was 439 million metric tons which accounts 45% of the total world feed market (Alltech, 2015). In poultry production, the availability and cost of feed ingredients stand at the forefront which accounts 70-75 % of the total production cost (Martinez, 1999). The global price of feed ingredients such as maize, wheat, fish meal and soybean meal has increased by 160%, 118%, 186% and 108%, respectively in the last decade, while the price rise in livestock products such as poultry meat, pork, lamb and beef was only 59%, 32% , -37% and 142 % respectively(Alltech, 2015).

However, about 1.2-2 billion tons of waste (around 30 to 50% from the total production) is produced globally per year. Per capita waste by consumers is between 95 and 115kg per year in Europe and North America, and 6 to 11kg in Sub-Saharan Africa and South/South-East Asia. The direct economic consequence of this wastage is estimated to be one trillion Dollar annually (UNEP, 2015). Globally less than 3% of food waste was recovered and recycled only. But over 97% of food waste generated ends up in the landfill and on the surface of the ground. Food waste that goes to the landfill breaks down anaerobically and produces methane; methane is 21 times more potent than $Co_2$ as greenhouse gas. Large amounts of wastes that are directly applied into the soil and pollute the environment. Utilization of feed from waste in diet formulation until now has been negligible. However optimistic findings were reported by some researcher about the utilization of these abundant and inexpensive wastes and leftovers as an alternative feed ingredient in poultry ration. Therefore, this review was undertaken to provide a concise information

**Cite This Article as:** Yitbarek MB and JC Okonkwo, 2019. Some selected animal wastes and by-products for poultry feed: review. Inter J Agri Biosci, 8(5): 242-2350. www.ijagbio.com 

about the utilization of some selected animal wastes for poultry feed by reviewed different literatures to run successful poultry production within the cheapest production cost.

**Selected Animal Wastes and By Products**

Animal wastes and by-products obtained from the farms of animal production, slaughtering houses, meat process industry, tanning industry, commercial hatcheries and dairy processing industries. Animal wastes and by-products may cause water, soil, and air pollution, but if managed judiciously they are valuable resources for poultry feed. In general vegetable (plant) protein sources are nutritionally unbalanced and poor in certain essencial ammino acids (EAA) and this decreases their biological value as they may not furnish the required limiting amino acids needed by birds for egg and meat production. Poultry nutritionists have paid more attention to the use of animal protein sources wastes and by products to create a balanced diet (Akhter *et al*., 2008). Animal proteins are well balanced in terms of EAA that are necessary for body growth and development,

**Blood meal**

Blood can be collected during the slaughter of various livestock species (cattle, sheep, goats, camels, pigs, chickens, etc.) under a wide range of conditions. It is usually dried and made into blood meal so that it can be handled and incorporated into rations more easily. Blood meal is quantitatively one of the richest protein sources of animal origin. The chemical composition of blood meal indicated that it has 89.2% DM, 88.5% CP, 1.2% EE, 0.4% CF,3.9% NFE, 6% MM,0.28% Ca and 0.28% P (Gohl, 1981). Its lysine content is relatively high (7-10% DM) which makes it an excellent supplementary protein to use with plant-derived feed ingredients that are low in lysine. However, its isoleucine content is very low (about 1% DM), so diets for monogastric animals must be formulated to contain enough isoleucine for the level of performance desired (Piepenbrink *et al.,* 1998). Blood meal is rich in iron (more than 1500 mg/kg DM). Blood meal is made by steaming or boiling the blood for twenty (20) minutes, collecting of the coagulate, drying and milling (Gohl, 1981). Particularly, lysine content and lysine availability decrease when the amount of heat increases (Batterham *et al.,* 1986). Overcooked blood meals are darker, due to the destruction of the haemogobin, and less palatable. For safety reasons, blood must be heated to be used in animal feeding: a minimal temperature of 100°C for 15 minutes is necessary in order to destroy potentials pathogens (salmonella, mycotoxins, prions) (Göhl, 1982). Blood meal can be used successfully in poultry diets. It can replace 50 to 100% of fish meal (Rao et al., 2009), 50% of soybean meal (Onyimonyi *et al.,* 2007; Tyus *et al.,* 2008), and also copra meal or groundnut meal (Donkoh *et al.,* 2001) resulting in improved performance and greater profit. It is necessary to supplement blood meal with lisoleucine (Tyus *et al.,* 2008) to ensure better animal performance of broilers. Blood meal can be included in poultry diets up to a level of 25% (Hazarika, 1994). Anang *et al.,* (2001) indicated that inclusion of 1-4% blood meal in diet can improve poultry performance, while others show no adverse effect of higher levels of dietary blood meal on chicken growth (Donkoh *et al.,* 2002; Khawaja *et al.*, 2007). Sun-dried blood meal given at 4.5% of the diet has a positive effect on layer performance (feed intake, live-weight gain, egg weight and yolk colour) (Donkoh *et al.*, 2001). Blood meal improves Fe content in yolks (Revell *et al.,* 2009). Fermented cattle blood gives comparable egg production to fish meal when these products are used to replace soybean meal. However, rendered animal products can cause undesirable flavour in eggs and it is not recommended that they fully replace soybean meal in layers diets (Tuitoek *et al.,* 1994).

**Bone meal**

Bone meal is a by-product of the slaughtering of livestock and rendering of dead animals. Often the skeletal system (bones) is separated from meat during the processing of meat. These bones can then be converted into bone meal using several different methods. It can be made from bones by treating them with a caustic and then with HCl and then precipitating with lime and drying. According to Pozy *et al. (*1996) bones like other animal by-products should be adequately heated in order to assure that disease agents are not spread. Bone meal can be used to provide a source of calcium, phosphorus and other minerals in poultry feeding programs (Hynek, 1991). It can be used to replace dicalcium phosphate. There are no limitations on using bone meal to replace other dietary calcium and phosphorus sources. Care needs to be taken when formulating rations to assure that the calcium and phosphorus ratio do not get out of the acceptable range. Fresh dried bones were shown to be an acceptable source of Ca and P for layers (Rajic *et al.,* 1993). The chemical composition of calcinated bone meal is 84.5% ash, 303.2 g/kg DM Ca, and 104.2 g/kg DM P, however, the steamed bone meal has 85% Ash, 325 g/kg DM Ca, and 150 g/kg DM P (Pozy *et al.,* 1996). The inclusion level of bone meal has no limitations to replace other dietary calcium and phosphorus sources. Care should be taken when formulating rations to assure the Ca and P ratio do not get out of the acceptable range. Ca:P should be between 1:1 & 2:1 for growers up to 6:1 for layers (Rajic et al., 1993).

**Meat and bone meal**

Meat and bone meal is made from carcass trimmings, condemned carcasses, condemned livers, inedible offal (lungs) and bones. It can be processed by heating. Excessive heating during processing will reduce the digestibility of the protein fraction. If the ash content is high, this indicates that it contains a higher amount of bones and is referred to as meat and bone meal. If the ash content is lower it is referred to as meat meal. Typically when the phosphorus content is above 4.5 %, then it is called meat and bone meal and when it is below that level it is referred to as meat meal.

Meat and bone is an excellent source of supplemental protein and has a well-balanced amino acid profile. The protein content of bone and meat meal is 54.9% and the digestibility of the protein fraction is normally quite high, ranging from 81 to 87% (Kellems *et al.,* 1998). It is well suited for use in feeding monogastric animals and provides not only a well-balanced protein source but also the limiting amino acids for poultry (methionine and cysteine) (Kellems *et al.,* 1998). Processing temperature was highly correlated with lysine availability, as the temperature increased the lysine availability declined (Batterham *et al.*, 1986).

In addition to the protein (amino acids), meat and bone meal is an excellent source of calcium and phosphorus and some other minerals (K, Mg, Na, etc.). The ash content of the meat and bone meal normally ranges from 28 to 36 %; calcium is 7 to 10 % and phosphorus 4.5 to 6 %. Meat and bone meal like with other animal products is a good source of Vitamin B-12.

When meat and bone meal replaced fish meal in broiler chicks diets growth was similar, but feed conversion was lower (Al-Mulsi, 1998). Up to 10% replacement levels for soybean meal in chick diets showed no differences in body weight gain and feed conversion ratio (Leitgeb *et al.*, 1998). In turkey diets, meat and bone meal replaced 20 to 60 % of the soybean meal with no effect on performance (Robaina *et al.*, 1997).

**Fats**

Fat is described by its origin, melting point (titre), amount of free fatty acids, colour and impurities (Izqulerdo *et al.*, 2003). Animal fats are described as tallows when they are solid above 40ºC, as lards when they are solid between 20ºC and 40º C, and as oils when they are liquid below 20ºC (Okelly ,1987). Generally, tallows come from cattle or sheep, lards from hogs, horses or bones of all kinds, and oils from marine animals or vegetables.

Pure fat is often the cheapest available energy source. The economy of using fat is often enhanced by the increased growth rate and the shorter time required for production; also the addition of fat permits the inclusion of other low-energy, low-cost materials. Experiments indicate that it is possible to decrease the amount of excrement to less than one half by adding about 7% fat to feed for monogastric animals, thereby minimizing waste disposal problems. The digestibility of animal fat is about 80% for monogastric animals and 85% for ruminants (Vanruth *et al*, 2010). Animal fat contains no minerals or vitamins.

Antioxidants are added to fats to prevent them from becoming rancid. Rancid fats are unpalatable to animals and may even be toxic. This is usually manifested in the form of diarrhoea, liver problems or encephalitis. It is necessary to add an antioxidant to animal fats, such as BHA (butylated hydroxyanisole), BHT (butylated hydroxytoluene) or ethoxyquin; the usual amount is 125-200 g per ton of fat (Vanruth *et al*, 2010). As a rule the first 3-4% of fat added will pay with the double advantage of growth stimulation and improved feed utilization; above this level only the advantage of improved feed utilization remains. In practical feed formulations the economic level of fat addition is 5-6%. By increasing the protein, mineral and vitamin contents and adding fat, smaller amounts of the feed need to be eaten and the presence of fat inhibits the heat- producing conversion of carbohydrate to body fat. For layers the addition of fat must be proportional to egg production. When production is less than 30% (30 eggs per day from 100 layers), no more than 3% should be used. When production is over 70%, up to 6% may be used (Vanruth *et al*.,2010).

**Rumen content**

Rumen content (RC) is an abattoir waste which account for about 80% of the capacity of the adult ruminant stomach (Adeniji and Oyeleke, 2008). When ruminant animals are slaughtered the contents of their rumen can become a viable feed resource. Rumen content like other animal by-products should be adequately heated in order to assure that disease agents are not spread. Approximately 2.7-3.5 kg (DM basis) of ruminal contents are removed from cattle during slaughter (Dominguez *et al.*, 1994). The rumen contents from different types of animals (goats, cattle, sheep, etc.) will vary dramatically in their composition (Ghosh and Dey, 1993). The chemical composition of the rumen content was 88% DM, 16.2% CP, 25.4%CF, 2.3% EE,13.5% Ash and 42.6% NFE (Gohl,1981). Rumen contents from goats tended to have the highest DM and CP content. Rumen contents were found to be a good source of water soluble vitamins and protein (Ristic, 2003).

Performance of broilers was not found to be depressed when 10 to 15 % dried rumen contents were fed (Roa, 1990). Dried rumen contents replaced 25, 50, 75, and 100 % of the wheat bran in broiler diets and no depression in performance was observed (AFRIS, 2010). Including dried rumen contents up to 9 % in the diets of layers had no effect on yolk color (AFRIS, 2010). Increased digestible DM, digestible CP, digestible CF and egg yield was observed when layers were fed the dried rumen contents from goats (Singh, 1988). Emmanuel (1978) studied the effect of rumen contents on the performance of broiler and concluded that whole rumen contents did not affect growth and feed conversion when included in the diets of broiler from 1-21 days of age. According to Mahmoud *et al.* (2015) DRC can be used up to 10% as a cheap source of energy and protein with reduced feed cost and environmental pollution.

**Blood-rumen content mixture**

Blood/rumen content mixture (BRCM) is an abattoir by product that offers a tremendous potential as a cheap and locally available alternative feedstuffs for livestock. It is a novel feedstuff, processed from the mixture of blood and rumen content (Adenui and Balogun, 2003). The BBRCM is a potential viable alternative protein supplement, and of economic importance in reducing the cost of poultry feed (Adeniji, 1996). The blood and rumen content are considered as wastes which cause disposal problems in abattoirs. They are easy to process and are nontoxic when fed to poultry (Adeniji and Jimoh, 2007). Different methods have been used to process bovine blood and rumen digesta mixture: application of heat (Adeniji and Balogun, 2002), sun-drying, oven drying and open air drying (Tukur *et al.*, 2001). The nutrient composition of bovine blood rumen content mixture was 93.3% DM, 7.5%MM, 15.75% CF, 36.93% CP, 1.48% EE, 1.43% Ca, 31.64% NFE and 2328.49 kcalME/Kg DM (Melkamu *et al.*, 2016). The proximate composition of BBRCM at 1:1 ratio mixture showed that it contains 92.86 % dry matter, 45.35 % CP, 8.81% CF, 4.10 EE, 15.42% Ash, 26.32% NFE (nitrogen free extractives) and 2599.49 kcal/kg ME (Onu *et al.*,2011).

According to Onu *et al.* (2011), body weight gain increased linearly ($P < 0.05$) with increase in the level of bovine blood rumen content meal of broilers while the feed intake decreased with increase in the level in BBRCM. The improved weight gain of birds fed BBRCM diets could be attributed to higher protein content of the diets which were efficiently metabolized for growth. Dietary SDRBM up to 10% inclusion level was beneficial for growth performance and that total replacement of fishmeal was possible in broiler diets (Olukayode *et al*., 2008). The inclusion of fermented dried bovine blood and rumen digesta as feed ingredient in broiler finisher diets up to 20% dietary level is recommended since it enhanced production, reduced cost of production and control environmental pollution and hazards that accrue from inadequate waste disposal (Esonu *et al*, 2011). According to Melkamu *et al.* (2016) dried blood rumen content mixture can be included up to 60% inclusion level for starter phases and up 80% for finisher phases of growth to replace soybean meal to reduce a kilogram feed cost, the cost of total feed consumed and the total production cost in general and it maximizes the net profit and the economic efficiency due to its locally availability and cost effectiveness without affecting the body weight gain, feed conversion ratio, mortality rate and carcass characteristics of birds in 56 days of growth period.

**Tannery by-product meal**

Before hides are tanned, the flesh and epidermis are removed by either hand or machine scraping. About 45 % of the weight of the hide is wasted: 5 to 10 % as waste hair, 5 to 10 % as dissolved proteins, 15 % as fleshing and trimmings and 15 % as splits (Pinheiro *et al.,* 1989). A fresh cattle hide contains 64 % water, 33 % protein, 2 % fat, 0.5 % mineral salts and 0.5 % other substances. The protein is composed mostly of collagen (88 %) and the rest is keratin (6 %), nonstructural protein (5 % of albumins, globulins, etc.) and elastin (0.9 %). To make leather, the tanner removes most of the noncollagenous materials (NRC, 1983). Leather scraps associated with the production of various leather products can be collected and hydrolyzed in a similar manner to poultry feathers. The by-product from this process is usually used as fertilizer, but it can be solvent extracted, dried and ground to a meal for animal feeding and used as a supplemental protein source for poultry

The digestibility of unhydrolyzed leather meal is very low so it has little value as a feed. Normally CP content ranges from 70 to 75 %. Normally only low levels of leather meal are normally incorporated into diets, because of the poor balance of amino acids that it contains. Limited research has been conducted evaluating the feeding characteristics of leather meal. It is very rich in glycine (> 20 % DM).

Chromium (Cr) is commonly added during the leather tanning process, therefore Cr poisoning is a potential problem when leather meal is fed as Cr level sometimes reaches toxic levels. The Cr level in the leather meals should not exceed approximately 2.75 %. Chromium can exist in several different forms and the form present in leather meal seems not to be absorbed really by animals and does not seem to accumulate in the meat or fat of animals consuming it (Waldroup *et al.,* 1970). Still care should be taken when formulating rations.

Vegetable-tanned leather trimmings were ground and added to broiler diets replacing 25 and 50 % of the fish meal and meat and bone meal, it was found that gain and feed conversion were less for the leather meal supplemented groups (Kalous *et al.*, 1986). As the level of unhydrolyzed leather meal was increased (0, 3, 6, or 9%) in broiler diets gain and feed intake was reduced (Pinheiro *et al.*, 1989). It has been used to replace up to 25% of the soybean oil meal in poultry feed. It does not affect feed efficiency, but it tends to depress growth. The addition of tannery waste up to 10% in broiler ration is better than imported protein concentrate in respect of chemical composition, and it may be used in the diet of broiler replacing costly protein concentrate without deleterious effect and high profitability observed (Alam *et al.,* 2002).

**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 (Meeker *et al.,* 2006). It is made by combining the by-products coming from poultry slaughterhouses or poultry processing plants. Poultry by-product meal is the ground, rendered, clean parts of the carcass of slaughtered poultry such as necks, heads, feet, undeveloped eggs, gizzards, intestines (provided their content is removed) and feathers (Watson, 2006). 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 (Hertrampf *et al.,* 2000).

Processing poultry offal into poultry by-product meal requires several steps. Poultry offal are primarily collected in containers then 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 (El Boushy *et al.,* 2000).

Poultry by-product meal is rich in protein, fat and minerals, and is a good source of essential amino acids for monogastric species. The composition of poultry by-products depends on processing conditions and on the source of raw materials (Johnson *et al.,* 1997). Some poultry by-products have very high protein content in the 75-90% range with relatively low contents of ash (less than 10%) and fat (less than 15%).

Poultry by-product meal can be used in poultry diets at up to 7 to 10% without impairing bird performance. However, diets containing poultry by-product meal should be formulated to take into account the fact that the digestibility of amino acids are lower than those of soybean meal (Bandegan *et al.,* 2010). When introduced at up to 4% in balanced broiler diets, performance was unchanged (Kirkpinar *et al.,* 2004). Including poultry by-products up to 10% in broiler diets there was no change in performance of broilers (Mendonca *et al.,* 1989). In laying hen diets, poultry by-products have no detrimental effects on performance and egg quality up to an incorporation level of between 5% (Senkoylu *et al.,* 2005) and 7.5% (Hosseinzadeh *et al.,* 2010).

**Hatchery by product meal**

Hatchery by-product meal results from the processing of poultry hatchery wastes, such as shells of hatched eggs, infertile eggs, dead embryos and dead or culled chicks (Al-Harthi *et al.,* 2010). The methods for handling and processing of hatchery wastes have been extensively reviewed by Glatz *et al.* (2011), who conclude that finding practical techniques for recycling the nutrients in hatchery waste has become a high priority. Hatchery wastes contain protein and minerals and can be rendered by cooking, drying and grinding into a meal (hatchery by-product meal or hatchery waste meal) suitable to feed poultry. Heat treatments followed by adequate drying are effective ways of destroying pathogens (Glatz *et al.,* 2011). The calcium content can be quite high, depending on the proportion of eggshells (Göhl, 1970).

Fresh hatchery waste has high moisture content, from 40 to 70% (Glatz *et al.*, 2009). Hatchery by-product meal contains 22% to 33% protein (less than other rendering by-products) with 1.1-1.8% lysine and 0.5-0.8% methionine. As can be expected, crude fat (11-30%) and ash (about 60% but values as low as 22% have been reported) are extremely variable (Glatz *et al.*, 2009). In addition to supplying energy and protein, hatchery by-product meal is an important source of calcium (17.2-24.6%) though it contains little phosphorus (0.3-0.6%) (El Boushy and Van der poel, 2000). Due to the fat content, gross energy can be as high as 28.8 MJ/kg (Glatz *et al.*, 2009).

Hatchery by-product meal is a suitable poultry feed due to its protein, fat and high calcium content. Its calcium availability is similar to that of bone meal or limestone and it can be used as a source of dietary calcium (Lilburn *et al.*, 1997). Hatchery by-product meal is a valuable protein source in broiler diets at any age. Its amino acid balance is better than that of fish meal (Khan *et al.*, 2002). However, recommended levels of inclusion are not fully consistent among authors and range from 3-4% (Mehdipour *et al.*, 2009) to 8-12% (Rahman *et al.,* 2003). Cooked or extruded hatchery by-product meals could totally and successfully replace fish meal in broiler diets (Rahman *et al.,* 2003). Broilers fed on hatchery by-product meal instead of fish meal had better protein utilization and higher body weight gains (Rahman *et al*., 2003). Feeding hatchery by-product depressed broiler growth, feed conversion and feed intake, though this might have been related to the elevated levels of dietary calcium (Al-Harthi *et al.,* 2010). Hatchery by-product meal included at 8% of the broiler diets let to a higher feed conversion ratio and had deleterious effects on broiler meat quality (reduced shelf-life) (Shahriar *et al*., 2008).

Hatchery by-product meal can replace fish meal, soybean meal or meat and bone meal in layer diets (Al-Harthi *et al.,* 2010). It had no negative effect on animal health or egg production and it is reported to improve egg quality: thicker eggshells, higher yolk and albumin weights (Abiola *et al*., 2004). Inclusion levels ranging from 8 to 16% are recommended for hatchery by-product meal in layer diets (Al-Harthi *et al.*, 2010). An extruded mixture of ground maize and centrifuged hatchery by-product included in the diet was free of aerobic pathogens and gave the same results as the control diet for feed conversion, egg production, egg weight and egg specific gravity (Tadtiyanant *et al.,* 1993).

**Egg shell**

Egg shells can be available in large quantities from hatcheries and from plants that shell eggs or prepare dried egg powder. Approximately 84% of the eggshell is ash of which most is calcium carbonate. Where sources of calcium are unavailable, eggshells can be sterilized, ground and used as a highly available source of calcium. Adequate heat needs to be applied to assure that all pathogenic organisms are destroyed prior feeding. Biological availability of calcium in eggshell meal was determined to be 93.8% and true absorption of calcium was 96.3% (Bao *et al.*, 1998). When eggshell meal was added to a commercial layer diet it was found that eggs where heavier and shells thicker (Simeonova *et al.*, 1984). It was found that eggshell meal or bone meal could be used to replace all of the limestone in layer diets (Walton *et al*., 1977). It was found to be a suitable replacement for any inorganic calcium source in application in layer diets and performance was found to be similar or superior (Sim *et al*., 1983). Eggshell meal was found to be a highly available source of calcium, with no effect on DM intake or egg production being observed (Scheideler, 1998). An extruded mixture of ground maize and centrifugated eggshells included in the diet was free of aerobic pathogens and gave the same results as the control diet for feed conversion, egg production, egg weight, egg specific gravity (Tadtiyanant *et al*., 1993).

**Manure and poultry litter**

The current interest in manure as a feedstuff is mostly due to the problem of waste disposal from intensive livestock and poultry operations. Apart from this problem it has been recognized that large amounts of nutrients are wasted. The re-use of manure is one way of creating edible protein from waste material which is often disposed of uneconomically and also creates a nuisance. The amount of excreta produced is considerable: a 2-kg hen produces 0.8 kg a week, a 650-kg cow 150 kg, an 80 kg pig- 40 kg, and a 45 kg pig- 22 kg (Bagley *et al.*, 1996).

**Table 1:** Chemical composition of waste feeds based on Dry matter basis

| Feed stuffs | DM %DM | CP %DM | CF %DM | EE %DM | Ash %DM | Ca g/Kg DM | P g/Kg DM | Source |
|---|---|---|---|---|---|---|---|---|
| Blood meal | 93.8 | 94.1 | 0.5 | 0.8 | 3 | 1. | 2.2 | Nadeem *et al*,2005 |
| Bonemeal(calcinated) | 95.4 | 0 | 0 | 0 | 84.5 | 303.2 | 104.2 | Pozy *et al*,1996 |
| Bonemeal (steamed) | 92.5 | 8 | 1 | 2 | 85 | 325 | 150 | Pozy *et al.*, 1996 |
| Rumen Content | 88 | 16.2 | 25.4 | 2.3 | 13.5 | 1.79 | - | Gohl,1981 |
| Blood rumen content mixture | 93.3 | 36.9 | 15.75 | 1.48 | 7.5 | 1.43 | - | Melkamu *et al.*,2016 |
| Egg shell | 98.9 | 5.6 | 0.3 | 2.9 | 92.3 | 366.5 | 1.6 | AFZ,2011 |
| Hatchery by product meal | 99.3 | 22.9 | 2.1 | 11.3 | 61.4 | 191.4 | 3.1 | AFZ,2011 |
| Leather meal/Hydrolized/ | 92.7 | 71.7 | 0 | 3.5 | 20.9 | 22 | 0.2 | Knowiton *et al.*,1976 |
| Cattle manure fresh | 16.7 | 11.7 | 22.4 | 2.8 | 14 | - | - | Wilkinson,1978 |
| Poultry manure /Dehydrated/ | 87.6 | 24.2 | 18.5 | 2.4 | 17.4 | 50.4 | 19.8 | AFZ,2011 |
| Meat and bone meal/ high fat/ | 95.8 | 54.9 | - | 11.4 | 30.5 | 101.1 | 48.7 | Gowda *et al*.,2004 |
| Poultry by product meal | 93.7 | 82.2 | - | 11.2 | 5.1 | 15 | 6.1 | AFZ,2011 |

Note: DM-Dry Matter; OM-Organic Matter; CP- Crude Protien; EE-Ether Extract; CF Crude Fiber; Ca-Calcium; P-Phosphorus; g- gram; Kg- Kilo gram; MJ Mega Joule.

The results of many experiments indicate that dried poultry manure can be successfully included in the feeds of both ruminants and nonruminants. Poultry litter can be used as a dietary source of crude protein and minerals. Dried fresh cow manure included in rations for growing birds (but not for layers) has produced much faster growth in some cases, possibly because of hormone activity in the manure. In poultry diets it has been found that dried poultry manure can be included up to 5% for broilers, up to 20%-40% for layers without adversely affecting production; however, feed efficiency was inversely proportional to the amount included in the diet. No difference in performance of young pullets and layers when sun-dried poultry waste was compared to oven-dried (Coligado *et al.,* 1982). Poultry litter was found to be a viable supplemental crude protein source for broilers (Bagley *et al.,* 1996). As the level of poultry dried waste increased (10 to 30 %) in the diets of broilers there was a decrease in body weight gains and feed conversion (Martin *et al.,* 1985).

## Conclusions

To reduce the environmental pollution, stop the spread of pathogenic organisms, and reduce production cost of birds; the waste materials and by products obtained from animals must be recycled and used for poultry feed. Appropriate processing methods should be employed before using of wastes and by-products. The inclusion level of some selected wastes and by products are blood meal up to 25%, meat and bone meal up to 10 %, tannery by-product meal (leather meal) up to 25%, fat 3%-6%, dried rumen contents 10 to 15 %, dried blood rumen content mixture 60% -80% Poultry by-product meal 7-10% hatchery by-product meal 8 to 16%, Dried poultry and cow manure can be included up to 5% for broilers, up to 20% - 40% for layers without any adverse effect. Based on the this review it can be recommended that by using appropriate processing method, incorporate these animal wastes and by-products as a feed ingredient in poultry ration based on the recommended inclusion level to reduce the overall poultry production cost and environmental pollution.

## REFERENCES


Abiola SS, Onunkwor EK, 2004. Replacement Value of Hatchery Waste Meal for Fish Meal in Layer Diets. Bioresource Technol., 95: 103–106

Adeniji AA and Balogun OO, 2002. Utilization of flavour treated blood-rumen content mixture in the diet of laying hens. Niger. J. Anim. Prod 29 (1): 34-39

Adeniji AA, 1996. The values of bovine bloodrumen content meal as afeedstufffor pullets (Ph D Thesis). Department of Animal Production, University ofIlorin, Nigeria.

Adeniji AA and Jimoh A, 2007. Effects of Replacing Maize with Enzyme- Supplemented Bovine Rumen Content in the Diets of Pullet Chicks. Int. J. Poult. Sci., 6 (11): 814-817

Adeniji AA and Oyeleke MM, 2008. Effects of Dietary Grit Fed on the Utilization of Rumen Content by Pullet Chicks, Department of Animal Production, University of Ilorin, Ilorin, Nigeria. J. appl. sci. res. 4: 1257-1260.

Adenui AA & Balogun OO, 2003. Influence Of Bovine Blood-Rumen Content Meal In The Diets of Growing Pullets on Their Subsequent Laying Performance. Department of Animal Production, University of florin, Nigeria, Ghana J. Agric. Sci." 6, 47-51.

AFRIS (Animal Feed Resources Information System), 2010. file://C:Documents and Setting/ADMIN/My Document Retrieved 26/4/2010.

AFZ, 2011. io - La Banque de données de l'Alimentation Animale / French feed database. Association Française de Zootechnie

Akhter S, Khan M, Anjum M, Ahmed S, Rizwan M, Ijaz M, 2008. Investigation on the availability of amino acids from different animal protein sources in golden cockerels. J Anim Plant Sci 18:53

Alam MJ, Amin MR, Samad MA, Islam MA and Wadud MA, 2002. Use of Tannery Wastes in the Diet of Broiler. Asian-Aust. J. Anim. Sci., 15 (12 ): 1773-1775

Al-Harthi MA, El-Deek AA, Salah El-Din M, Alabdeen AA, 2010. A nutritional evaluation of hatchery by-product in the diets for laying hens. Egypt. Poult. Sci., 30 (1): 339-351

Alltech, 2015. Global Feed Survey. Lexington, Kentucky, USA. pp: 1-8.

Al-Mulsi, A. M., 1998. Possibility of using some local feed material for fattening broilers instead of imported feed in Yemen. Agricultura Tropica et Subtropica, 31: 211-215.

Anang D, Atuahene C, Donkoh A, Koomson B, Oppong H. 2001. Further studies on the use of solar-dried blood meal as a feed ingredient for poultry. J Anim Feed Sci 10:159e67.

Bagley CP, Evans RR, Burdine WB, 1996. Broiler litter as a fertilizer or livestock feed. J. Prod. Agric., 9: 342–46

Bandegan A, Kiarie E, Payne RL, Crow GH, Guenter W, Nyachoti CM, 2010. Standardized ileal amino acid digestibility in dry- extruded soybean meal, extruded canola seed-pea, feather meal, and poultry by-product meal for broiler chickens. Poult. Sci., 89 (12), 2626-2633.

Bao SF, Windisch W, Kirchgessner M, 1998. Calcium bioavailability of different organic and inorganic dietary Ca sources (citrate, lactate, acetate, oyster-shell, eggshell, beta-tri-Ca phosphate). J. Anim. Physiol. Anim. Nutr., 78 (3): 154-160.

Batterham ES, Lowe RF, Darnell RE, 1986. Availability of lysine in meat meal, meat and bone meal and blood meal as determined by the slope-ratio assay with growing pigs, rats and chicks and by chemical techniques. Br. J. Nutr., 55 (2): 427-440.

Church DC, Daugherty DA, Kennick WH, 1982. Nutritional evaluation of feather and hair meals as protein sources for Ruminants. J. Anim. Sci., 54 (2): 337-344.

Coligado C, Genciana Y, Dela Cruz A, 1982. Recycling of dried poultry waste in the diets of growing pullets and layers. In: Animal production and health in the tropics, Jainudeen, M.R.Omar, A.R. (eds.).- Serdang, Selangor (Malaysia): UPM Press, pp: 233-236.

Dominguez-Bello MG, Michelangeli F, Ruis MC, Garcia A, Rodriguez E, 1994. Ecology of The Folivorous Hoatzin (Opisthocomus hoazin) On the Venezuelan Plains. The Auk 111 (3): 643-651.

Donkoh A, Anang D, Atuahene C, Hagan M, 2002. Influence of processing temperature on chemical composition of solar-dried blood meal and on performance of broiler chickens. J Anim Feed Sc 11: 1-5

Donkoh A, Anang DM, Atuahene CC, Koomson B, Oppong HG, 2001. Further studies on the use of solar-dried blood meal as a feed ingredient for poultry. J. Anim. Feed Sci., 10 (1): 159-167

Economides S and Antoniou Y, 1990. The Effect of Feeding Cheese Whey on the Milk Yield of Cows and the Growth Rate of Heifers. Agricultural Research Institute, Miscellaneous report No. 42. Nicosia, pp: 1-6.

El Boushy ARY, van der Poel AFB, 2000. Handbook of poultry feed from waste: processing and use. Springer-Verlag New York, pp: 428.

Emmanuel B, 1978. Effect of Rumen Content of Fraction Thereon In Performance of Broiler Birds. J. of poultry science, 19: 13-16.

Esonu BO, Azubuike JC, Udedibie AB, Emenalom OO, Iwuji TC and Odoemenam V, 2011. Evaluation of the Nutritive Value of Mixture of Fermented Bovine Blood and Rumen Digesta for Broiler Finisher. J. Nat. Sci. Res 1(4): 65-71.

European Community, 2002. Regulation (EC) No 1774/2002 of the European Parliament and of the Council of 3 October 2002 laying down health rules concerning animal by-products not intended for human consumption. O.J. Eur. Comm., 45, L 273: 1-95 EN 14.11.2009

Ghosh TK and Dey, 1993. Availability of Rumen Content and their Utilization in Diets for Goats.Indian J.Anim.Sci.,63:1194-1196.

Glatz P, Miao Z, Rodda B, 2011. Handling and Treatment of Poultry Hatchery Waste: A Review. Sustainability, 3: 216-237.

Glatz P and Miao Z, 2009. High value products from hatchery waste. RIRDC Publication No. 09/061, RIRDC Project No PRJ-000078. Australian Government, Rural Industries Research and Development Corporation, Australia.

Gohl B, 1981. Tropical Feeds: Feed Information Summaries and Nutritive Value: FAO Animal production series, FAO, Rome, Italy. pp: 301-405.

Göhl, B., 1970. Animal feed from local products and by-products in the British Caribbean. Rome, FAO. AGA/Misc/70/25.

Göhl B, 1982. Les aliments du bétail sous les tropiques. FAO, Division de Production et Santé Animale, Roma, Italy.

Gowda NKS, Ramana, JV, Prasad CS, Khub Singh, 2004. Micronutrient content of certain tropical conventional and unconventional feed resources of Southern India. Trop. Anim. Health Prod., 36(1): 77-94.

Hazarika M, 1994. Utilization of animal by-products as animal feed. Livest Advis 19: 14.

Hertrampf JW and Piedad-Pascual F, 2000. Handbook on ingredients for aquaculture feeds. Kluwer Academic Publishers, 624 pp.

Hosseinzadeh MH, Ebrahimnezhad Y, Janmohammadi H, Ahmadzadeh AR, Sarikhan M, 2010. Poultry byproduct meal: Influence on performance and egg quality traits of layers. Int. J. Agric. Biol., 12 (4): 547-550

Hynek J, 1991.Glueless bone meal in the nutrition of nursing sows. Zivocisna Vyroba - UVTIZ (CSFR), 36 (1): 27-36

Izquierdo M, Obach A, Arantzamendi L, Montero D, Robaina, L, Rosenlund G, 2003. Dietary lipid sources for seabream and seabass: growth performance, tissue composition and flesh quality. Aquacult. Nutr., 9 (6): 397-407

Jensen GK, 1978. The range of animal feeding products manufactured by the dairy industry. Composition, properties and factors of significance for future development. Mejeribrugets foderprodukter. Aktuel status og udviklingsmuligheder, 5-21

Johnson ML and Parsons CM, 1997. Effect of raw material source, ash content and assay length on protein efficiency ratio values for animal protein meals. Poult. Sci., 76 (12): 1377-1387

Kalous J and Stradal M, 1986. Inclusion of hide meat scrap meal in mixed feeds for broiler fattening. Sbornik Vysoke Skoly Zemedelske v. Praze. Fakulta Agronomicka, B 44: 287-296

Kellems RO and Church DC, 1998. Livestock Feeds and Feeding. 4th edition, Prentice Hall, Upper Saddle River, New Jersey, USA.

Khajarern S, Khajarern J, Phalaraksh K, Churasatein S, 1982. The utilization of hydrolysed feather meal as a protein source in pig and poultry rations. In: Animal production and health in the tropics, Jainudeen, M.R.Omar, A.R. (eds.), Serdang, Selangor (Malaysia): UPM Press, 1982. p. 237-240

Khan SH, Bhatti BM, 2002. Effect of feeding cooked hatchery waste on the performance of broilers. Pakistan Vet. J., 22 (1):27-30

Khawaja T, Khan SH, Ansari NN, 2007. Effect of different levels of blood meal on broiler performance during two phases of growth. Int J Poult Sci; 6:860-865

Kirkpinar, F, Acikgoz Z, Bozkurt M and Ayhan, V, 2004. Effects of inclusion of poultry by-product meal and enzyme-prebiotic supplementation in grower diets on performance and feed digestibility of broilers. Br. Poult. Sci., 45 (2): 273-279 web icon

Knowiton PH, Hoover WH,.Sniffen CJ, Thompson CS, Belyea PC, 1976. Hydrolized leather scap as protein source for ruminants. J. Anim. Sci., 43 (5):1095-1103

Kornegay ET, 1978. Protein digestibility of hydrolysed hog hair meal for pigs. Anim. Feed Sci. Technol., 3: 323-328

Kornegay ET, Vander Noot GW, Barth KM, MacGrath WS, Welch JG, Purkhiser E.D, 1965. Nutritive value of garbage as a feed for swine. I. Chemicals composition, digestibility and nitrogen utilization of various types of garbage. J. Animal Sci 24:319-324

Leitgeb R, Oberrauch P, Baumann F, Wetscherek W 1998. Use of meat and bone meal in broiler diets. Bodenkultur, 49 (3): 193-199

Lilburn MS, Barbour GW, Nemasetoni R, Coy C, Werling M, Yersin AG, 1997. Protein quality and calcium availability from extruded and autoclaved turkey hatchery residue. Poult. Sci., 76 (6): 841-848

Mahmoud O.A. Elfaki, Khadiga A. Abdelatti and Huwaida E.E. Malik 2015. Effect of dietary dried rumen content on broiler performance, plasma constituents and carcass characteristics. GJ Anim Sci Res 3: 264-270.

Martin EA, Gabertan AE, 1985. Performance of broilers fed dried poultry waste with sodium bentonite. Philippine J. Vet. Anim. Sci., 11 (3-4): 30

Martinez WS, 1999. Vertical coordination in the pork and broiler industries: implications for pork and chicken products. Agricultural Economic Report No 777, U.S. Department of Agriculture, Washington D.C

Meeker DL and Hamilton CR, 2006. An overview of the rendering industry. In: Essential rendering. Meeker (Ed). National Renderers Association

Mehdipour M, Shams Shargh M, Dastar B, Hassani S, 2009. Effects of different levels of hatchery wastes on the performance, carcass and tibia ash and some blood parameters in broiler chicks. Pakistan J. Biol. Sci., 12 (18): 1272-1276.

Melkamu Bezabih Yitbarek, Berhan Tamir and Ashenafi Mengistu, 2016. The Effect of Dried Blood Rumen Content Mixture (DBRCM) on Carcass Characteristics of SASSO C44 Broiler Chicks. Eur Sci J 12(12):166-185

Mendonca CX, Jensen LS, 1989. Effect of formulating diets with different assigned energy data for poultry by-product meal on the performance and abdominal fat content of finishing broilers. Poult. Sci., 68 (12):1672-1677

Miranda CO and Uy FM, 1981. Carcass and product quality evaluation of broilers and layers fed with hydrolyzed feather meal. Philippine J. Vet. Anim. Sci., 7 (1): 39

Munguti JM, Wald bacher H, Liti DM, Starif M. Zolliltsch WJ, 2009. Effect of substitution of fresh water shrimp meal with hydrolized feather meal on growth performance and apparent digestibility in Nile tilapia under different culture conditions. J. livestock res rural dev, 21(8):129

Nadeem MA, Gilani AH, Khan AG, Mahr-Un-Nisa, 2005. True Metabolizable Energy values of poultry feedstuffs in Pakistan. Int. J. Agric. Biol., 7 (6): 990-994

NRC,1983. Underutilized resources as animal feedstuffs. National Academies Press, Washington D. C.

O'Kelly, J. C., 1987. Influence of dietary fat on some metabolic responses of cattle to hyperthermia induced by heat exposure. Comparative Biochemistry and Physiology, A Comparative Physiology, 87 (3): 677-682

Olukayode M, Babafunso S and Segun A, 2008. Conversion of Abattoir Wastes Into Livestock Feed: Chemical Composition of Sun-Dried Rumen Content Blood Meal And Its Effect on Performance of Broiler Chickens, Conference on International Research on Food Security, Natural Resource Management and Rural Development University of Hohenheim, Nigeria. pp 1-10

Onu PN, Otuma MO, Odukwe CA and Aniebo AO, 2011. Effects of Different Levels of Bovine Blood / Rumen Content Mixture on Productive Performance, Carcass Characteristics and Economics of Production of Finisher Broilers. Int.J. Food, Agri and Vet Sci, 1 (1): 10-16

Onyimonyi AE, Ugwu SOC, 2007. Bioeconomic indices of broiler chicks fed varying ratios of cassava peel/bovine blood. Int. J. Poult. Sci., 6 (5): 318-321.

Petkova G, Tsvetanov I, Bal'ozov D, 1976. Development and study of recipes for compounded broiler rations including local products. I. Effect of dried buttermilk. Zhivotnov'dni Nauki, 13 (1): 75-81

Piepenbrink MS, Schingoethe DJ, Brouk MJ, Stegeman GA, 1998. Systems to evaluate the protein quality of diets fed to lactating cows. J Dairy Sci, 81: 1046-1061.

Pinheiro JW, Mizubuti YI, Rocha MA, da; Reddy KV, 1989. Utilization of leather meal in broilers. Semina: Ciências Agrárias, 10 (1): 41-45

Pozy P and Dehareng D, 1996. Composition et valeur nutritive des aliments pour animaux au Burundi. Institut des Sciences Agronomiques, Atelier du Burundi / Université Catholique de Louvain / Université du Burundi - Publication Agricole n°37

Rahman, M. ; Akter, M. N. ; Howlider, M. A. R., 2003. Replacement of fish meal by hatchery wastes in broilers diets. Bangladesh Veterinarian, 20 (1):29-35

Rajic I, Mihajlovic B, Jovic M, Pavic P, Rackov V, 1993. Nutritional value of Pikos (raw bone meal) in laying hens feeding. Tehnologija mesa, 34 (2-3): 105-108

Rao BJ, Kumar GSN, Patil VM, 2009. Utilization of different levels of blood meal in broiler feed. Indian Vet. J., 86 (6): 642-643 2009

Rao NM, Fontenot JP, 1987. Ensiling of rumen contents and blood with wheat straw. Anim. Feed Sci. Technol., 18 (1): 67-73

Revell DK, Zarrinkalam MR, Hughes RJ, 2009. Iron content of eggs from hens given diets containing organic forms of iron, serine and methyl group donors, or phytoestogens. Br. Poult. Sci., 50 (4): 536-542

Ristic M, 2003. "Quality of poultry meat obtained using different production systems and EU regulations for production and marketing of poultry carcasses." Tehnologija Mesa 44 (3/4): 149-158.

Robaina L, Moyano FJ, Izquierdo MS, Socorro J, Vergara JM, Montero D, 1997. Corn gluten and meat and bone meals as protein sources in diets for gilthead seabream (Sparus aurata): Nutritional and histological implications. Aquacult, 157 (3-4): 347-359

Scheideler SE, 1998. Eggshell calcium effects on egg quality and Ca digestibility in first- or third-cycle laying hens. J. Appl. Poult. Res., 7 (1): 69-74

Senkoylu N, Samli HE, Akyurek H, Agma A, Yasar S, 2005. Performance and egg characteristics of laying hens fed diets incorporated with poultry by-product and feather meals. J. Appl. Poult. Res., 14 (3): 542-547

Shahriar HA, Nazer-Adl K, Doolgarisharaf J, Monirifar H, 2008. Effects of dietary different levels of hatchery wastes in broiler. J. Anim. Vet. Adv., 7 (1): 100-105

Shih JCH, 1993. Recent development in poultry waste digestion and feather utilization: a review. Poult. Sci., 72 (9): 1617-1620

Sim JS, Awyong LM, Bragg DB, 1983. Utilization of eggshell waste by the laying hen. Poult. Sci., 62 (11): 2227–2229

Simeonova, J, Ingr I, Valentova J, 1984. The effect of adding eggshell meal to layer diet on the quality and composition of eggshell. Zivocisna Vyroba, 29 (3): 271-278

Sucheep Suksupath, 1980. The improvement of the utilization of feather meal as protein source for duck. Kasetsart Univ., Bangkok (Thailand). Graduate School.

Tadtiyanant, C. ; Lyons, J. J. ; Vandepopuliere, J. M., 1993. Extrusion processing used to convert dead poultry, feathers, eggshells, hatchery waste, and mechanically deboned residue into feedstuffs for poultry. Poult. Sci., 72 (8): 1515-1527

Tuitoek, J. K. ; Ayangbile, A. O., 1994. Small pelagic fish and fermented blood as complementary protein supplements for poultry. Bull. Anim. Hlth. Prod. A, 42 (2): 135-140

Tukur HM, Maigandi SA and Mohammed AA, 2001. Effect of different drying methods in chemicalcomposition of forestomach digesta. Proceedings of the 25th Annual Conference of the Nigerian Society of Animal Production. Vol. 26, 2001.

Tyus J, Nahashon SN, Adefope N, Wright D, 2008. Growth performance of Single Comb White Leghorn chicks fed diets containing blood meal supplemented with isoleucine. J. Poult. Sci., 45 (1): 31-38

UNEP (United Nations Environmental Program), 2015. Food Waste the Facts, Washington.USA. PP1

Van ruth SM, Rozijna M, Koota A, Perez Garcia R, van der Kamp H, Codony R, 2010. Authentication of feeding fats: Classification of animal fats, fish oils and recycled cooking oils. Anim. Feed Sci. Technol., 155: 65-73

Waldroup PW, Hillard CM, Abbott WW, Luther LW, 1970. Hydrolyzed leather meal in broiler diets. Poult. Sci., 49: 1259-1260

Walton HV, Vandepopuliere JM, Jaynes W, Cotterill OJ, 1977. Using eggshells in poultry feed. Agric. Eng., 58 (6): 15-16

Watson H, 2006. Poultry meal vs poultry by-product meal. Dogs in Canada Magazine

Wilkinson JM, 1978. Laboratory Evaluation Of Ensiled Mixtures of Alkali Treated Cattle Excreta And Whole Crop Maize . Anim.Feed. Sci. Technol.3: 335-344.