Research in: Agricultural & Veterinary Sciences
Vol.6, No.1, 2022, pp.28-36

ON RECYCLING OF ANIMAL WASTES: A MINI-REVIEW

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Abstract. In this study, available knowledge on the use of waste and waste materials from the meat, poultry, and their processing industries has been reviewed, considering that the need for edible animals increases with the increasing population. Animal husbandry, including poultry, is an important source of livelihood in Turkey. It is shown that if the wastes obtained in slaughterhouses are used more efficiently, the contribution of animal husbandry to agriculture, production, environment, and economy will be much higher. Not using or underutilizing waste not only results in potential loss of revenue but also incurs the additional and increased cost of disposal of these products.

Keywords: *Waste, regeneration, recycling, management of waste, by-products.*

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Received: *27 March 2022;* ***Accepted****: 18 April 2022;* ***Published:*** *28 April 2022.*

1. Introduction

The population in Turkey is approximately 85 million according to the latest data (TURKSTAT). These are the data for 2020. The data for 2021 is published in 2022. However, these data give us a general perspective. The population growth in Turkey, which was created with TURKSTAT data, is given in Figure 1. Considering that Turkey has developed very rapidly in recent years, the coming increase in the population may be expected.

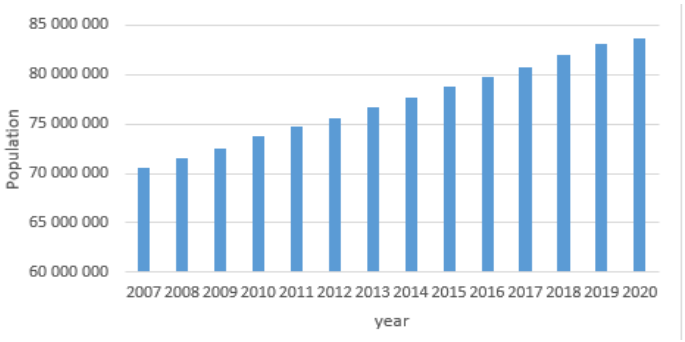

Figure 1. Population Change in Turkey Between 2007-2020

So, it is natural that consumption increases simultaneously. The consumption of white meat and red meat, which is our basic need, is also increasing depending on this situation. To meet this consumption, production must increase continuously. When the chicken production in Turkey is examined, the number of poultry in Turkey in 2020 is 386 million,

and chicken constitutes the largest part with 98.3% (Cihangir, 2020). In August, chicken meat production increased by 22.9%, the number of slaughtered chickens increased by 22%, and chicken egg production increased by 0.8% compared to the same month of the previous year. Looking at the January-August period, chicken meat production increased by 0.6% compared to the January-August period of the previous year, while the number of slaughtered chickens decreased by 1.7% and chicken egg production by 2.6% (TIGEM; TURKSTAT). The number of chickens slaughtered and eggs produced in 2020 and 2021 are given in Figure 2.

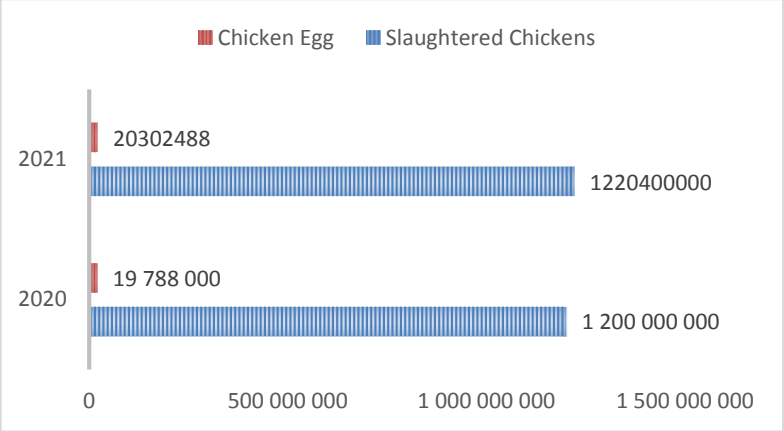

Figure 2. Number of Chicken Eggs and Slaughtered Chickens in 2020 and 2021

Red meat production amounts were last published by TURKSTAT in 2020. Total red meat production increased by 12.3% compared to the last quarter of 2019 and was estimated as 291 thousand 565 tons. It was estimated as 1 million 201 thousand 469 tons, increasing by 7.4% compared to the total of 2019 (TIGEM; TURKSTAT).

Resource Efficiency is defined by the United Nations Environment Program (UNEP) as “reducing the negative effects of products and services on the environment during their production and consumption throughout their entire life cycle” (UNEP), and by the European Commission (EC) as “the world's limited resources can also affect the environmental impacts". minimizing and using it in a sustainable way” (Ghosh, 2001). Considering the resource efficiency, the evaluation of chicken and meat wastes gains great importance.

In the simplest definition, waste is the parts of the materials we use to meet our needs that are not used at that time or are thrown away after use. Industry, transportation, agriculture, tourism, construction, chemistry, metallurgy, machinery, food, etc. While producing and serving in sectors, many substances and materials change form. While providing and using energy for these activities, various wastes and residues in gas, liquid, and solid form arise. While some of these wastes are finally disposed of, some of them can be recovered and reused. The main principle in waste management; Reducing wastes at their source, inevitably reusing and recycling the wastes at the highest possible rate.

Estimates show that losses and waste are about one-third of the food in the world's food chain. The estimated food waste in the European Union is 89 million tons (Buzby & Hyman, 2012). The amount of solid waste generated due to population growth and unconscious consumption in Turkey has reached 32 million tons per year.

In addition to the economically valuable meat and processed products in poultry slaughterhouses, unwanted blood, feathers, head, feet, crops, inedible internal organs, and

their fats are also produced. When viable waste management plans are not used, these wastes create various environmental, public health, and managerial problems both on and off the facility. Assuming an approximate live weight of 2 kg per broiler, the poultry slaughterhouse waste from each broiler can be estimated as $2 \times 0.25 = 0.5$ kg. According to this rate, tons of waste is generated in slaughterhouses where thousands, sometimes hundreds of thousands of poultry are slaughtered in a day. When these wastes are not managed within a waste management plan, they threaten the environment and food safety as a result of aerosol and odor spread and occupational health and safety of the working environment, formation and spread of pathogenic microorganisms. Wastes as much as prohibited in the regulations are rendered harmless by rendering process (Cebeci, 2019), While it is dried after the cooker to make feed additives with high protein and fat content (Hursev & Ahmed, 1996), feed production cannot be made after 2002 and a gap has formed.

These wastes with different properties can be converted into products with economic value. For example, the feet can be converted into export products by passing through a special processing process, or the residues with high oil content can be converted into gas, liquid, or solid fuel. Inedible organs in poultry; contain organs such as lungs, intestines, trachea, pancreatic gland, and spleen. Feed additives called chicken meal with high nutritional value are obtained by mixing and blending the organs that are not used in human nutrition, which has no economic value, and mixed with feathers (Cebeci, 2019). After the reuse of chicken waste feeds in the feeding of chickens was banned in 2002, rendering products consisting of blood, internal organs, and feathers can be used as fish feed or added to their feeds as additives. The feeds prepared by the rendering method contain approximately 55% protein and 13% mineral ash. On the other hand, chicken fat; is an oil that is appreciated for its smell and taste. It can be produced as biodiesel as well as used in cooking oils. Hatchery waste can be processed into many products after meticulous separation. Its nutrients can be used for ambient heating, steam boiler heating, gasification, methane gas production, fertilizer production, and algae or fish feeding in hydroponic cultures. When slaughterhouse wastes with high protein and fat content are guaranteed to be processed into hygienic products, they are valuable resources that can be used as cat and dog food and as feed for aquaculture. Considering the economic value, processing into feed raw materials and renewable energy sources stands out as widely used methods (Cebeci, 2019; Hursev & Ahmed, 1996; Parsons & Ferket, 1990; Poss, 1990).

Considering the evaluation of slaughterhouse waste, leather is a slaughterhouse waste. Significant wastes arise as a result of the removal of the meat and fat remaining on the skin during the production stages by scraping it with a machine. These wastes; can be used to make glue, gelatin, oil, feed, fertilizer, artificial leather, cream, lotion, etc. Various usage items such as knife handles and buttons can be made from animal bones. In addition, products such as artificial fertilizer, gelatin, glue, and bone ash are obtained by going through some chemical processes. Bone charcoal, which is obtained by burning bones, is used for black varnish, deodorization, and the purification and whitening of sugar.

The leather sector includes the skins and furs of all kinds of animals, accessories such as suitcases, bags, chests, gloves, belts, harnesses, clothing products, and shoes made of leather and fur. The leather sector operates in a wide range of production areas from tanning and leather processing, saddlery products, leather clothing, fur goods, and

footwear. The supply of quality raw materials in the sector is of great importance. Raw material needs are mostly provided from cattle, sheep, and goat skins (ODTU).

Tannery waste; process-specific wastes, side-process wastes, non-process wastes can be examined in three classes. The wastes classified in the secondary process waste category are the wastes that are likely to arise as a result of the activities carried out in addition to the main production process in the facilities. In the leather industry, no by-process has been defined. Process-specific waste and non-process waste were compiled using the reference. For waste codes, please review the reference.

2. Materials and Methods

Slaughterhouse waste is the name given to the parts of the slaughtered animal that cannot be eaten or used in meat products. Most of these wastes are generated during the slaughter of animals. As an example of waste; bones, tendons, skin, gastrointestinal tract contents, blood, and internal organs can be given. These wastes vary according to the slaughtered animal species (Grosse, 1984; Jayathilakan *et al*., 2012; Sielaff, 1996). The percentage of waste by animal species is shown in Figure 3.

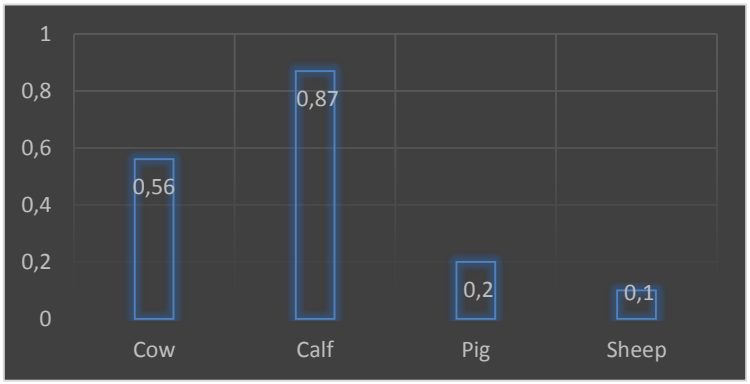

Figure 3. The specific waste index for slaughterhouses concerning the type of animal (Poss, 1990)

The efficient use of slaughterhouse waste, that is, by-products, is important for the profitability of the meat industry. It is estimated that 11.4% of the gross income from beef comes from by-products. In the past, by-products were used as food, especially in Asia. Since it can cause health problems, it is used in fields such as pet foods, medicines, cosmetics, and animal feed (Rivera *et al*., 2000).

When the literature is examined, it is seen that beef, pork and lamb by-products constitute 66.0%, 52.0%, and 68.0% of animal weight, respectively. More than half of animal by-products are inedible due to some of their properties. Unused meat products cause serious environmental pollution and economic losses. However, with improved processing, meat by-products can provide meat processors with a good profit (Jayathilakan *et al*., 2012). Therefore, not using by-products results in the loss of a valuable potential source of income and increases the cost of disposing of these by-products.

According to TURKSTAT data, the number of cattle between the years 2019-2021 is given in Figure 4. The number of sheep and goats between the years 2019-2021 is given in Figure 5. The number of poultry between the years 2019-2020 is given in Figure 6.

Considering the amount of waste to be generated, as shown in the figure, it can be understood that a lot of waste will be generated in animal slaughtering. The United States considers everything produced from animals, except meat, as a by-product. But in the US, some of the animal by-products are edible. These by-products are sorted, cooled, and processed. Edible by-products vary in different parts of the world. For example, in some regions, blood is defined as an edible by-product, while in some regions, blood is an inedible by-product. If a product is an edible by-product, it should not be a health concern. The edible by-product may become a non-edible by-product if it is considered a health concern. For example, although the UK has a brain and spinal cord as edible by-products, these products were not removed from the list of edible by-products after BSE (Schrieber & Seybold, 1993).

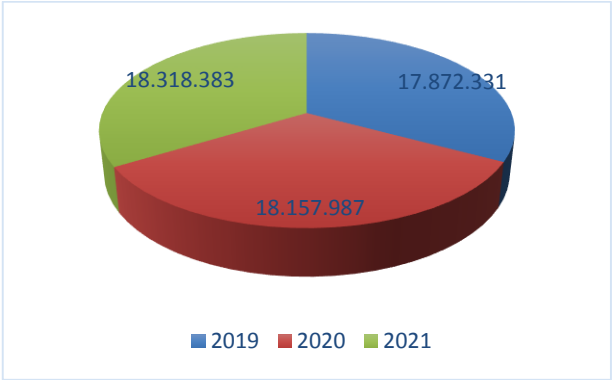

Figure 4. Cattle data by year (TIGEM)

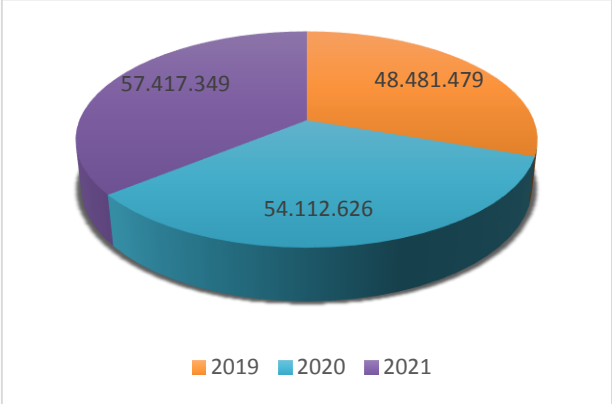

Figure 5. Ovine data by year (TIGEM)

Animal blood, which is considered an edible by-product, is used in products such as pudding, sausages, biscuits, and animal feed in Europe. In addition to edible products, animal blood is also used in non-edible products such as fertilizers. If we are sure that the animal is healthy, we can be sure that the blood of the animal is clean. Healthy animal blood contains high protein. Blood makes up the bulk of the animal's body mass. The average percentage of blood that can be used from pigs, cattle, and lambs is 3.0-4.0, 3.0-4.0, and 3.5-4.0, respectively (Silva & Silvestre, 2003; Wan *et al*., 2002).

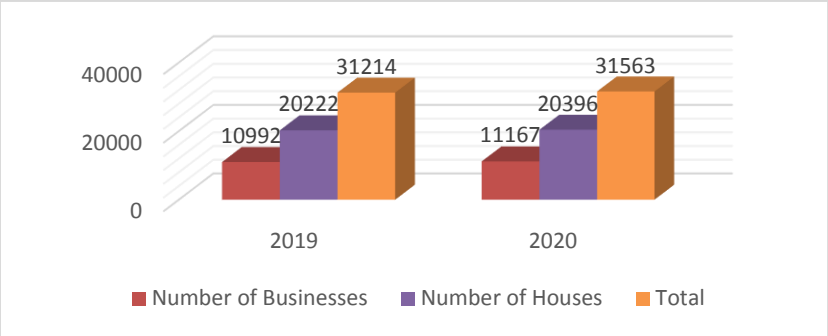

Figure 6. Poultry data by year (TIGEM)

Plasma is the most striking part of the blood due to its colorless properties (Parsons & Ferket, 1990). Blood plasma is the best water and fat binder and can form a gel similar to cooked egg white as it contains 60.0% albumin (Silva & Silvestre, 2003). Plasma forms a gel at a protein concentration of 4.0–5.0%, and the strength of the gel increases with increasing concentration (Autio *et al.*, 1985). Blood plasma has a high foaming capacity and can be used as a substitute for egg white in the bakery industry (Del Hoyo *et al.*, 2008; Ghosh, 2001).

From prehistoric times to the present, animal hides have been used as shelter, clothing, and containers. 4% to 11% of the live animal weight consists of animal skin. E.g; 7.0% of cattle; 7% of sheep and 3.0% of pigs are made of leather. Skins and hides are some of the most valuable by-products in most animals. Examples of cattle, pig, and sheep leather/skin products are leather shoes, leather bags, rawhides, sporting goods and cosmetics, edible gelatin, and adhesives (Benjakul *et al*., 2009).

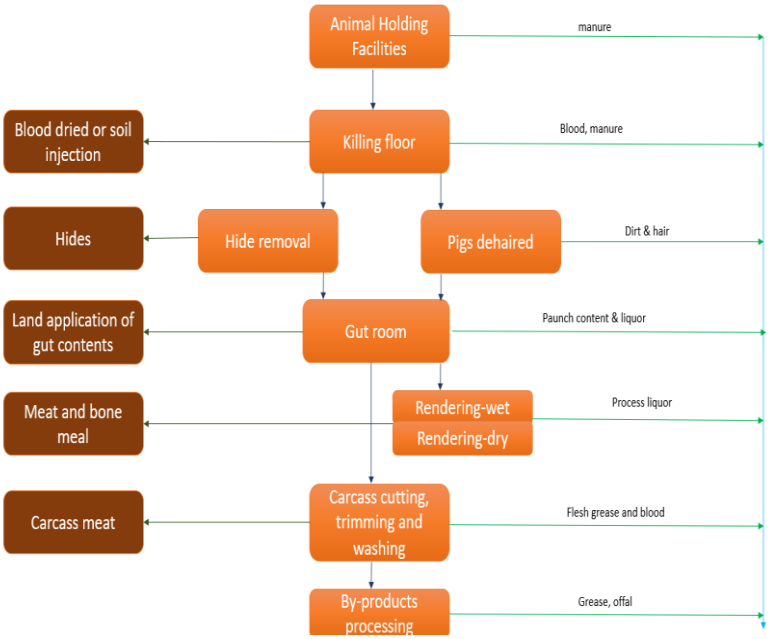

Figure 7. Treatment of Meat Wastes Processes (Banks & Wang, 2005)

Gelatin is produced by the controlled hydrolysis of water-insoluble collagen derived from protein and contains a high amount of collagen. Gelatin can be produced from skin and bone when used as an edible by-product. The production of gelatin from

the skin consists of three steps. The first step is to remove the non-collagen material from the raw material. The second is the controlled hydrolysis of collagen to gelatin. The final step is the recycling and drying of the product.

A product made from extracted collagen can be used to induce blood coagulation in the healthcare field. Pigskin is similar to human skin and can be used for dressings for burns. Pigskin used as dressing should be cut into strips or patches, trimmed, divided into 0.2-0.5 mm thickness, cleaned, sterilized, and packaged (Jayathilakan *et al*., 2012).

To summarize all these, the management of meat waste is done as in Figure 7.

3. Result and Discussion

Almost half of the weight of animals slaughtered in slaughterhouses is considered waste. These wastes can be turned into a great source of income industrially. Recycling or the evaluation of by-products is a great source of income, and if the wastes are not evaluated, it causes serious problems in terms of health and the environment.

With the waste management regulation published in Turkey in 2015, it has been started to ensure that the recycling of slaughterhouse waste is regulated. However, the wastes generated in slaughterhouses are not used most efficiently.

It is very important for both the economy and health to fully use the wastes generated in slaughterhouses with the methods used in recycling these wastes or by developing these methods further.

Proper waste management is the most important part of the evaluation of bovine or ovine waste. Knowing the amount and type of waste that will be generated from the animal creates a more conscious waste evaluation. With the increase in population, the number of consumption increases, and naturally the amount of waste also increases. Considering Turkey's rapid population growth, it is necessary to focus more on the evaluation of waste and to establish new strict rules.

4. Conclusion

Today, population growth in Turkey and the world is quite high. Therefore, the need for quality nutrition is increasing day by day. The world has come to a critical threshold in terms of environmental pollution with the increasing costs and decreasing raw material availability in the meat sector. Accordingly, the importance of recycling is gradually increasing. Especially in the meat sector, the need for recycling is quite high. Recycling wastewater and animal by-products are very important. These wastes should be used for higher-value useful products. Efforts must be made to reduce costs using efficient processing methods and on-site treatment.

In addition to the dangerous situation in environmental pollution, meat waste has the potential to be recycled in many cases. The use of meat industry waste is receiving increasing attention, especially given the fact that these wastes are a possible and usable source to be converted into useful products. Conversion of waste into usable materials both increases the value of the carcass and increases the profits of animal breeders. Therefore, wastes from cattle, ovine, or poultry should be evaluated in the creation of new useful products.

Acknowledgments

Dr. Senthil Rethinam acknowledges the funding support granted by the 2232-International Fellowship for Outstanding Researcher Program of TUBITAK (Project No: 118C350).

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