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EVALUATION POSSIBILITIES OF CHICKEN MANURE IN TURKEY

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ABSTRACT

Pollution caused by industrial poultry production, which is increasing along with the population growth, is one of the most important environmental problems for developed and developing countries. Particularly in the countries which are leading in the world poultry farming, such as Turkey, share of poultry manure in animal waste is increasing day by day. Due to its amount and characteristics, problems posed by poultry waste are among the priority issues. According to data obtained in 2010, there were 70,933,660 laying hens and 163,984,725 broilers in Turkey and the estimated annual production of fresh manure exceeded 5 million tons. Therefore, development of waste management systems in order to reduce the environmental risks, has become extremely important for poultry industry. Chicken manure causes environmental problems, but also has a significant economic potential. Although there are country-specific methods for the evaluation of chicken manure, evaluation as fertilizer after composting is a common practice across the globe. Also using biogas obtained from waste for the production of energy is one of the common practices. Evaluation of broiler manure as fertilizer in agriculture or burning for heating, are some of the common methods used in Turkey. But in recent years, interest in modern methods such as production of biogas and converting biogas into electrical energy is increasing. In this study, widely used applications for the evaluation of poultry manure in Turkey and development studies of these methods have been examined extensively.

Introduction

Industrial poultry production in Turkey started in the 1980s and developed rapidly with the modern integrated facilities after the 1990s. In the last decades the industry has achieved quality standards at a competitive level with the leading countries (Sarica et al., 2012). Broiler meat production in Turkey showed high growth rates of 14% and 13% in 2010 and 2011 respectively and it was followed by an increase of less than 5% in 2012 but it exceeded 1.8 million tons for 2013. Also in 2012, there were 83,048,395 hens in the total of 3,103 production units at 994 different enterprises. The number of produced eggs in

these facilities was 84,677,290 (Yum-Bir, 2013). In total, over 250 million chickens are produced each year. As a result, presently Turkey is a global poultry producer and also one of the most important exporters for the surrounding markets especially in the neighboring countries (USDA, 2013, 2014).

Poultry manure is produced during two main operations of broiler and egg production. Most of the broiler operations result in the production of solid poultry manure, which is referred to as poultry litter or broiler litter. The primary difference between broiler litter and cage layer manure is that the broiler manure is diluted with litter material. Broiler litter is a mixture of manure, bedding material, wasted feed and feathers. Bedding materials are used to absorb liquid fractions of excreta (Edwards and Daniel, 1992). The type of used material depends on locality, but typically includes wood chips, saw-dust, wheat straw, peanut hulls, rice hulls, and recycled paper products. Under most circumstances, this results in a manure containing mixture that is easier to handle because it is usually drier and has fewer problems with odor and insect control than pure manure (Naber and Bermudez, 1990).

Poultry production spent a significant structural evolution with the implementation of a contract manufacturing model and the increase in the number of the integrations, and it has been the biggest part of the Turkish animal production. But, this rapid growth has inevitably resulted in various environmental problems. All poultry wastes have to be well-managed to minimize environmental hazards sourced from the poultry operations. Especially, evaluation of the chicken manure is one of top priority issues for poultry production sector. The waste produced from concentrated poultry operations raises serious concerns for treatment and disposal. A very rough estimate of the amount of poultry manure produced in Turkey is approximately 5.93 million tons (2.99 million tons of this waste from broiler production, 2.94 million from egg production) every year.

During handling and storage of solid poultry manure, a considerable nitrogen (N) loss from ammonia volatilization can occur (Wood, 1992). Because of the phosphorus (P) fraction is readily transported in runoff water during intense rainfall events, dissolved P from fields receiving poultry litter can occur. The chemical composition of poultry manure is important in that it has very direct bearings on the environmental effects of poultry manure as well as the specific applications of poultry manure. Because it is so high in certain macronutrients, excessive land applications can lead to water pollution and soil toxicity. The components of poultry manure cause it to produce various toxic gases as well as noxious odors (Samer, 2013). Also, because of its chemistry, poultry manure is a good fertilizer and can be a very useful, inexpensive feedstuff for animals. Although poultry litter is one of the best organic fertilizer sources available, excessive application of litter can cause environmental problems (Altan et al., 1996).

Poultry manure is usually applied in the immediate vicinity of the production site, where the poultry operations are concentrated. There are several ways in which poultry manure can be collected and processed. Several factors such as the operation size, climate, animal type etc. will determine what type of system is used in what kind of circumstances. It should be noted that in many instances, the strongest influence on the system which is used has the economics of the system. Each system has its own merits and costs, but careful consideration must be used in order to select a system which will make the most efficient use of the factors in which it will be operated. This study provides current information about the usage options of chicken manure in Turkey. These include both recycling and

disposal options as well as speeding and incineration. All of these methods of processing poultry manure were viewed under main headings below.

The use of chicken manure as a fertilizer

It has been recognized that poultry manure and litter is a good source of plant nutrient mainly N, P and potassium (K) (Table 1). In addition, poultry waste also contains calcium, magnesium, sulfur and other micronutrients needed for the crops (Oliveira et al., 2012). In a layer system, a typical laying hen will consume feed which contains 1.1 kg N while producing approximately 250 eggs in a year. In a broiler system, a typical broiler year will also consume 1.1 kg N per year of which 0.6 kg N is excreted and 0.5 kg N is assimilated into body tissues. With adequate application rates, animal manure constitutes a valuable resource as a soil fertilizer, as it provides a high content of macro and micronutrients for crop growth and represents a low-cost, environmentally friendly alternative to mineral fertilizers.

Table 1
Chemical composition of poultry litter

Macronutrients	($g \cdot 100\ g^{-1}$)	Micronutrients	($\mu g \cdot g^{-1}$)
Nitrogen (N)	2.08	Copper (Cu)	303
Phosphorus (P)	1.01	Iron (Fe)	1,786
Potassium (K)	2.61	Manganese (Mn)	294
Calcium (Ca)	2.08	Zinc (Zn)	217
Magnesium (Mg)	0.53	Sodium (Na)	2,629
Sulfur (S)	0.028	Lead (Pb)	22

Oliveira et al., 2012

Even with its beneficial effects on plant growth, however, manure constitutes only a small percentage of the nutrients applied to cropland when compared to commercial fertilizer. On the other hand, many environmental problems of current concern are due to the high production and local accumulations of organic wastes that are too great for the basic degradation processes inherent in nature. The primary reason behind this is that there are dangers to over application of poultry manure to fields. The EU Nitrates Directive caps organic manure applications to land at 170 kg organic N/ha. Most poultry farms operate far above this limit and it is estimated that more than 90% of poultry litter has to be exported off the home farm. The potentially adverse effects of such indiscriminate applications include an excessive input of harmful trace metals, inorganic salts and pathogens;an increased nutrient loss, mainly nitrogen and phosphorus, from soils through leaching, erosion and runoff-caused by a lack of consideration of the nutrient requirements of crops; and the gaseous emissions of odors, hydrogen sulphide (H_2S), ammonia (NH_3) and other toxic gases. In fact, the agricultural contribution to total greenhouse gas emissions is around 10%, with livestock playing a key role through methane emission from enteric fermentation and through manure production. More specifically, around 65% of anthropogenic nitrous oxide

(N_2O) and 64% of anthropogenic NH_3 emissions come from the worldwide animal production sector.

Many poultry breeders have managed this manure by spreading it on fields without any treatment traditionally. Undoubtedly, spreading waste in the fields is the easiest and cheapest option for disposal of chicken manure, and this method has been widely practiced for a long time in Turkey as well. Combination of industrial production and the diminishing amount of manure spread fields resulted in more manure than crops can use, the excess minerals flowed into the streams or ground waters. Surface and ground water pollution, accumulation of the trace elements, problems with odors and flies are common problems associated with over-application (Altan and Bayraktar, 1998).

Poultry litter has a relatively high dry matter (DM) content, but is P rich. As this P originates from imported cereals it contributes to the P surplus of local agriculture. Nitrate leaching into the groundwater, nonpoint source P runoff into surface water bodies, and release of pathogenic microorganisms are three of the main problems encountered with improper management of this resource. An analysis of the used litter for nitrogen, phosphorus and potassium should be used as the basis for the application rate to soils. In most cases, the dilution of the manure with litter means that substantially higher rates of application of the applied litter can be used than those previously suggested for cage layer manure.

Composted chicken manure can be used as a fertilizer with or without balancing as well, and it provides good results in soils suffering from depletion of organic contents for amendments (Bayraktar and Altan, 1998). Even though composting has not been widely recognized as an alternative method to evaluate chicken manures yet, some of the poultry integrations has produced more manure in last years. An increase could be expected in the number of composted chicken manure producers in the near future.

The use of chicken manure as a feed for ruminants

Ruminants have a unique digestive system that allows them to use waste and other types of by-products as sources of dietary nutrients. The cattle-feeding industry has been built largely on the use of by-products and other materials that can be digested only by ruminants. Micro-organisms in the rumen have the unique ability to utilize uric acid and other forms of non-protein nitrogen (NPN) contained in the waste to make their own body protein which is subsequently digested in the lower gut for use by the host animal. The rumen microbes also degrade cellulosic materials used as a bedding contained in the waste. One of the by-products that can be used as a cattle feed was chicken manure. Even though literature on this issue is vast, there is no report on using chicken manure as a feed for ruminants in Turkey. At the same time using poultry waste in feed is not a legal practice according to the regulations of the Ministry of Food, Agriculture and Livestock.

The use of poultry waste as a feed additive for ruminants is an old practice. U.S. Food and Drug Administration (FDA) estimates that farmers feed 1 million to 2 million tons of poultry litter to their cattle annually in the USA. However, in recent times, the dangers of such practice have become more apparent and these practices become to be prohibited in some countries. Also, using the chicken manure as a feed for ruminants increases the risk of cows becoming infected with bovine spongiform encephalopathy (BSE), or mad cow disease. Although it is rare, people can contract a fatal form of the disease by eating meat from

cows with BSE. Animal Welfare Approved (AWA) standards prohibit the feeding of animals with processed industrial chicken waste or any other unnatural feed (Animal By-Products Statement, 2012). Also poultry litter can contain a range of disease-causing bacteria which cattle can transmit to humans, such as campylobacteria, salmonella and E. coli, as well as veterinary drug residues or moulds and yeasts.

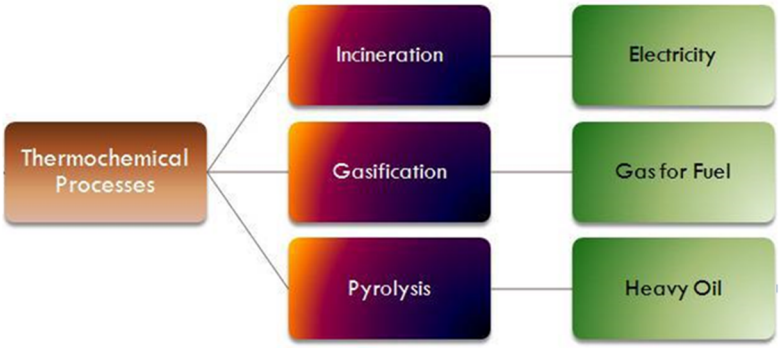
The use of chicken manure as a fuel

Although some of power plants operate using poultry litter in the UK, large scale incineration of poultry waste is not common practice in Turkey. Only some local broiler breeders at Ege and Marmara region of Turkey has used broiler litter with little rates in solid fuel stoves for heating. Because of the tiny parts of total manure it can be used as a fuel, manure burning is not mentioned as an alternative method for Turkey. On the other hand nearly 20% of the electric energy comes from thermal reactors. If some of chicken manure might be used as an alternative fuel source for these reactors, significant amounts of broiler litter can be burned.

Broiler production requires energy for heating houses nearly through the whole year. Heat energy obtained in the burning process of fossil fuels and biomass cause the greenhouse gas (GHG) emissions. Incineration of poultry litter has been receiving a lot of attention in the recent times. Litter (unlike manure) is an excellent fuel because of the presence of bedding material. Its heat content is higher than firewood and therefore lends itself to good combustion. Poultry litter has an approximate BTU value ranging from 7,900 to 17,300 per kg depending on the moisture content, while coal has an average BTU value of 22,000 – 34,200 per kg. Typical poultry litter has a moisture content of around 30%. For this reason, adding more wood chips into the poultry litter to ensure more consistent heat energy is suggested. A combination of 30% wood chips and 70% chicken litter was recommended. From July 15, 2014 all poultry farmers across the EU will be allowed to combust poultry litter on-farm to create energy. Thus, biomass is no “green energy”, poultry waste is not a clean fuel.

Combustion technology is the controlled combustion of waste with the recovery of heat to produce steam which in turn produces power through steam turbines. Pyrolysis and gasification represent refined thermal treatment methods as alternatives to incineration and are characterized by the transformation of the waste into product gas as energy carrier for later combustion in, for example, a boiler or a gas engine (Figure 1).

Biomass pyrolysis has been garnering much attention due to its high efficiency and good environmental performance characteristics. It also provides an opportunity for the processing of agricultural residues, litter or chicken manure into clean energy (Oliveira et al., 2012). In addition, biochar sequestration could make a big difference in the fossil fuel emissions worldwide and act as a major player in the global carbon market with its robust, clean and simple production technology.



Zafar, 2014

Figure 1. The principal methods of thermochemical conversion

The use of chicken manure in biogas production

Manure is the largest and cheapest resource for biogas production. The anaerobic digestion process has an environmental advantage compared to burning of organic wastes. Biogas technology is one of the most environmentally friendly production methods from biomass by the anaerobic fermentation process, as it is usable for a relatively "clean" heat and power energy production, as the biogas contains no ashes.

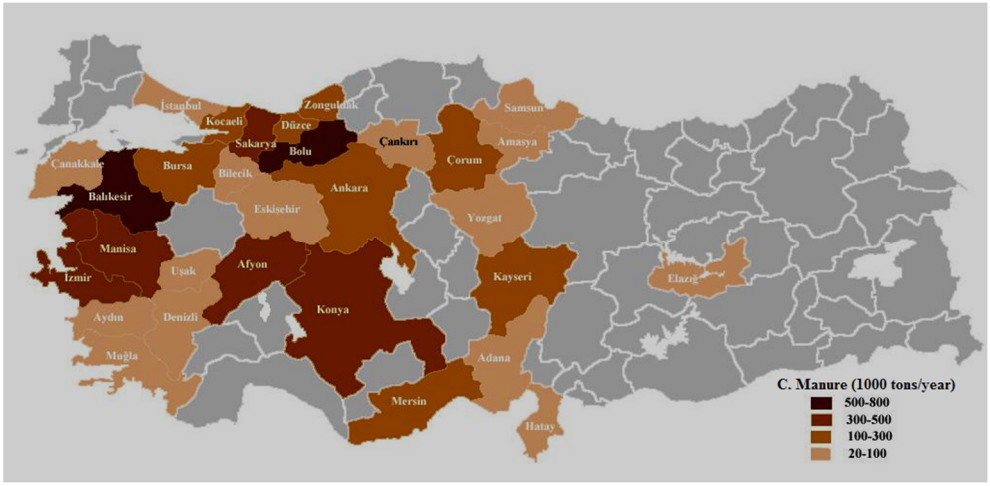
Biogas is a potentially important energy source that can be used for the production of heat, electricity and fuel. It can be produced at wastewater treatment plants, landfills, food and other industrial operations throughout the world. There is a largely untapped potential in agricultural operations where animal waste is often land applied or otherwise disposed of without conversion to energy.

Controlled combustion in a power plant converts virtually all of the carbon in the biomass to carbon dioxide (CO_2). As methane (CH_4) is a stronger greenhouse gas than CO_2, shifting CH_4 emissions to CO_2 by converting biomass residues to energy significantly reduces the greenhouse warming potential of the recycled carbon. Anaerobic treatment of manure reduces emissions of methane and other harmful substances into environment to great extent. Also it appears to offer solution to the environmental problems and the energy shortage. But, higher financial investments and considerably management knowledge requirements reduce the practicality of this method. Other disadvantages are the amount of management required due to the sensitivity of the digesters, the high initial investment required for equipment, and the fact that the wastes still must be disposed of after digestion.

According to the last agricultural census in Turkey, there are a total of 3,076,650 agricultural enterprises and approximately 70% of these enterprises are running livestock farming. 10,811,165 of total animal is cattle, 26,877,793 of total animal is small ruminant and 234,082,206 is poultry. The amount of wet waste of these animals is about 120,887,280 t. These wastes could be a major problem for enterprises and cannot be utilized properly. The best way to utilize waste is to produce biogas. In this study, biogas amount which will be obtained from animal waste was calculated for all provinces by using the number of livestock animals and also considering various criteria such as the rate of dry matter and avail-

ability. Animal origin waste map of Turkey was also produced with these calculated values (Figure 2). The biogas energy potential of Turkey was found to be 2.18 Gm^3 by using the animal number in the last agricultural census. The total biogas potential is originated from 68% cattle, 5% small ruminant and 27% poultry. The biogas potential of Turkey calculated from the number of chicken is 390 million m^3. The biogas energy from poultry waste equivalence of Turkey is approximately 8.853 million GJ. When the chicken waste map of Turkey is examined, provinces that have more than 10 million m^3 biogas potential are found to be Bolu, Balikesir, Sakarya, Manisa, Afyon, Konya, Izmir, Ankara, Corum and Bursa (Avcioglu et al., 2013).

The calculated regional biogas potential from animal manures is about 3,275 million m^3, including 40.01% from large animals 47.14% small animals, 12.85% from poultry (Table 2).



Avcioglu et al., 2013

Figure 2. Amount of chicken manure according to the provinces in Turkey

Table 2
Biogas Energy Potential of Turkey

Animal kind	Number of animals	Total amount of manure (1000 $t \cdot year^{-1}$)	Amount of available biogas (1000 $m^3 \cdot year^{-1}$)	Available biogas (%)
Large animals	11,054,000	39,794.4	1,313,215.2	40.01
Small animals	38,030,000	26,621.0	1,544,018.0	47.14
Poultry	243,510,453	5,357.2	417,863.9	12.85
Total	292,594,453	71,772.6	3,275,097.1	100

Demirel et al., 2010

At the beginning of the 2010s, there are many biogas plants constructed but some of them were successfully in Turkey (Table 3). At the moment, 5 power plants producing energy from landfill gas with license exist. In addition, 9 biogas plants have obtained

license for electricity production with a total production capacity of 17.59 MW. Four of these plants are operating now, with a total production capacity of 6.12 MW (Demirel et al., 2010).

Table 3.
Companies which obtained a biomass based on biogas

Company Name	License Type	Location	Installed Capacity (MW)
Cargill Tarim	Auto Producer	Bursa	0.12
Yeni Adana	Auto Producer	Adana	0.8
GASKI Enerji	Auto Producer	Gaziantep	1.66
ESES Eskisehir	Auto Producer	Eskisehir	2.042
Konbeltas Konya	Generation	Konya	2.434
Mersin Metropolitan	Generation	Mersin	1.9
Samsun Avdan	Generation	Samsun	2.472
Pamukova Renewable Energy	Generation	Sakarya	1.4
IZAYDAS	Generation	Kocaeli	0.7
Sigma Elektrik	Generation	Amasya	2
Derin Enerji	Generation	Ankara	0.576
Her Enerji	Generation	Kayseri	1.56

Yazgan, 2013

Conclusions

When properly managed, poultry litter provides an excellent source of plant nutrients and organic matter for application to field and cropland. Poultry manure fertilizer contains all the essential nutrients required for crop production, and its value as an organic fertilizer and a source of plant nutrients has been recognized for centuries. It will also look into the environmental impact of poultry manure production as well as some management aspects. Each system of collection, handling and processing has its own merits and uses. The relationship between good waste management and sustainable production management must be well analyzed. Properly managed manure applications improve soil quality, recycle nutrients to crops, and minimize the water pollution. One of the most promising ways for aerobic processing of poultry manure is by composting it. Composting is a relatively fast aerobic process in which organic matter is degraded by bacteria and fungi to produce a relatively stable humus-like material.

Turkey is theoretically capable to produce biogas from poultry waste. In this context, the new objective for the near future can be increasing the share of the renewable energy sources from biomass to minimize detrimental effects of animal waste. Production of biogas from different types of biomass offers great opportunities to reduce emissions from poultry waste and therefore to protect the environment.

Slurry on the base of poultry manure management can be a new alternative for Turkey. Anaerobic lagoons are created from manure slurry, which is washed out from underneath the animal houses and then piped into the lagoon. Vermicompost production is another

alternative method, and has been already experimentally used for animal manures (Lazcano et al., 2008).

Ultimately, alternative methods and technologies will help us to understand the importance of stabilization of organic matter and minimize the potential risks related to the use of animal manure as an organic amendment.

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MOŻLIWOŚCI OCENY ODCHODÓW KURZYCH W TURCJI

Streszczenie. Zanieczyszczenia pochodzące z przemysłowej produkcji drobiu, których ilość wzrasta wraz ze wzrostem populacji, jest jednym z najważniejszych problemów środowiskowych w krajach rozwiniętych i rozwijających się. Szczególnie w krajach, które przodują w hodowli drobiu, takich jak Turcja, udział odchodów kurzych w odpadach zwierzęcych rośnie z dnia na dzień. Ze względu na ilość i charakterystykę, problemy stwarzane przez odpady pochodzenia kurzego znajdują się wśród najważniejszych. Według danych z 2010, Turcja posiadała 70 933 660 kur niosek oraz 163 984 725 brojlerów a szacowana roczna produkcja świeżego nawozu przekraczała 5 milionów ton. Zatem, rozwój systemów gospodarki odpadami w celu zmniejszenia ryzyka środowiskowego stał się bardzo ważny dla przemysłu drobiowego. Odchody kurze są źródłem problemów środowiskowych, ale także posiadają istotny potencjał ekonomiczny. Mimo, że istnieją krajowe metody oceny odchodów kurzych, ich ocena jako nawozu po kompostowaniu jest popularną praktyką na całym świecie. Ponadto, popularną praktyką jest także zastosowanie biogazu otrzymanego z odpadów na cele energetyczne. Ocena odchodów brojlerów jako nawozu w rolnictwie lub źródła ciepła jest często stosowaną metodą w Turcji. Jednakże, w ostatnich latach, zainteresowanie nowoczesnymi metodami takimi jak produkcja biogazu i przekształcanie biogazu w energię elektryczną stale wzrasta. Niniejsza praca skupia się na gruntownej analizie oceny odchodów kurzych w Turcji i badań rozwojowych nad metodami oceny.

Słowa kluczowe: odchody kurze, gospodarka odpadami, biogaz, energia