

# Biofuel Production by Animal Wastes- A Review

Sushmita Shrivastava<sup>1</sup> and R. S. Tomar<sup>2</sup>

Amity Institute of Biotechnology<sup>1,2</sup>, Amity University Madhya Pradesh<sup>1,2</sup>

Email: rssush@gmail.com<sup>1</sup>, rstomar@amity.edu<sup>2</sup>

**Abstract:** Energy is the basic requirement of our daily life for running various activities. Since long time, we have been dependant on conventional sources of energy which majorly include fossil fuels like coal, petroleum, diesel etc. Fossil fuels are non-renewable and exhaustible sources which will get diminish due to enormous consumption. Even they are responsible for causing large amount of pollution in the surroundings. So there is need of such an efficient source of energy which is renewable, inexhaustible and environmental friendly. Although there are some other sources of energy like solar energy, hydro energy, tidal energy but their consumption and utilization is conditional. Biofuels emerge as a novel source of fuel. They are significant, sustainable and eco-friendly source of energy. Biogas, biodiesel, bio-ethanol, etc. are some popular examples of bio-fuels. Both plant and animals are capable to produce such fuels. But in the present article, emphasis has been given to fuel production by animal wastes. Animal wastes like faecal matter, unused fat etc. which are generally thrown off due to their non-utility, have proven their importance in the production of energy. These are economically beneficial, pollution less and capable to fulfil our demands of energy requirement.

**Keywords-** Bio-fuel, animal wastes, energy, conservation, environment.

## 1. INTRODUCTION

Animals are the significant part of our environment. They not only stabilize ecosystem, used as food substitutes, produce economically important products like honey, wax, lac, fibres, but also play a magnificent role in production of energy. Energy production and conservation are the key aspects of today's world. As far as energy production is concerned there are so many sources, but still there is crisis of energy. Some sources are less in amount, some are responsible for causing pollution. Most of the efficient sources like solar energy, fossil fuels are non-renewable and need to be conserved. So there is need for some worthy sources which are sufficient in quantity, renewable and pollution free means there is requirement of biofuel. Animal waste is one of the best substitutes of biofuel production. Biofuels are mainly the fuels having biological origin. They can be categorized as primary fuels and secondary fuels. Primary fuels are conventional fuels obtained by burning of wood or dry animal wastes, while secondary fuels are modern fuels obtained indirectly by plant and animals. Secondary fuels can be further sub-categorized as first generation fuel, obtained by food sources like ethanol from starch or biodiesel from waste animal fat; second generation fuels obtained by non-food cellulosic mass or by oil sources; third generation fuels obtained by microbes. [1]

In agricultural based developing countries like India dry animal dung has been the major source of fuel from several years due to its low cost but it produces large amount of pollutants like carbon monoxide, particulate matters, etc. and they impose

enormous health issues related to respiratory problems.

## 2. METHODOLOGY

Conversion of animal waste into energy is basically an anaerobic phenomenon which includes conversion of organic waste into biogas or biofuel (methane), which can be further utilized as source of energy.

### *Benefits Of Using Animal Wastes As Fuel*

1. It is highly economic, saves money.
2. It helps in production of large amount of biofuel in the form of gas which can be used as electricity source or as fuel.
3. The slurry produced in the process can be used as compost or bedding for crop production.
4. The liquid part formed can be used in the form of fertilizer.
5. Using evolved gas like methane as fuel prevents its release in atmosphere and thus reduces global warming and greenhouse effect.

## 3. PRODUCTION OF BIOFUEL

These are the energy sources obtained either by plant or animal. Plants are the efficient sources of biofuel in the form of bioethanol, bio-oil etc. In the present article, an effort is made to trace out fuels which are produced by animal wastes. Dumping and proper disposal of animal waste is one of the major problems of our society. Using of dry cattle dung as fuel is one of the traditional and main fuel among rural people. But it produces large amount of pollution and the smoke produced by this method can harm to its users. In the present text, various animal wastes used as source of biofuel are mentioned.

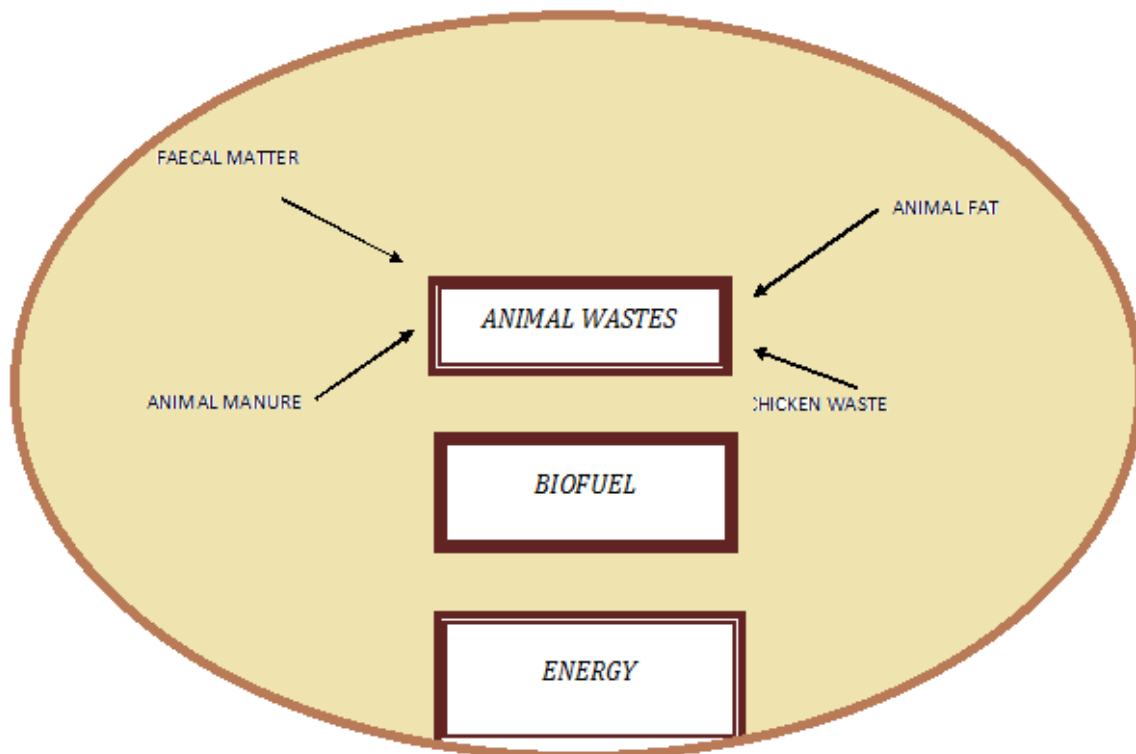


Fig.1. Diagram Showing Sources of Biofuel

### 3.1. By animal fat (Tallow)

Using animal waste was found as best way to reduce the price of biofuel. Mixture of rapeseed oil methyl esters, pork lard or beef tallow methyl esters and linseed oil methyl esters could be used as efficient fuel which had emission of CO, NO<sub>x</sub>, hydrocarbons etc. [2] Fuel in the form of trimethyl ester could be produced by waste animal fat and further its quality could be enhanced by using nickel and magnesium as additives. [3] It had been found that fish fat on pyrolysis could produce an efficient fuel for diesel engines. [4] Ozone treated fish waste oil was found as efficient in producing hydrocarbons, which further act as fuel of diesel production. It had been found that animal fat with high acid value and the fat collected through floating sludge from water treatment plant created lots of environment problems which could be managed by converting such wastes into energy production. [5]

Non-edible animal fats had been utilized as sources of biofuel production because they were found as cheap, cause no harm to environment and produced large amount of energy. In this method fuel is found to be produced by triacylglycerols present in fats by means of transesterification at high pressure with alcohol and It had been reported that chicken fat can be used as biofuel after transesterification by sulphuric acid and methanol. [6] Beef tallow was found to be most sustainable fat used in the production of biodiesel with regards to environmental protection and energy conservation as it reduces global warming. [7]

Animal fat waste was found as valuable fuel producer as it produced low nitrogen oxides which were proved as major source of air pollution; it had high cetane number and oxidative stability. Enzyme-catalysed transesterification techniques were found to be used in production of biofuel from animal fats. [8] Pork fatty waste could be used for obtaining biofuel by using *Staphylococcus xylosus* through fermentation. [9]

As fish wastes produced by certain fish processing methods found as degradable and harmless in nature so could be utilized in the production of biofuels (biodiesel). This process involved extraction of fish oil through wastes, cleaning, refining and further production of fuel through transesterification and anaerobic digestion using suitable catalysts. [10]

Ethyl transesterification process was found as cleaner technology for the production of biofuel from wet animal fat without any chemical catalyst at different thermodynamic conditions. In the presence of water and pressure almost all the fat got converted into energy. [11] Use of animal fat for production of biofuel had proved as better alternative in spite of disposing them as waste material. These animal fats were found to be easily available due well to established slaughter market. Even the fat from other animals like lamb, duck etc. can also be utilized for the production of commercially useful fuel.

### 3.2. By faecal matter

Faecal matter of animals like cow dung can be directly used for the production of methane gas. In

this method, waste material gets collected and stored, which results in release of methane gas that can be used as fuel. Cow dung, fish waste and waste chicken could also be used as fuel for the production of methanol. [12]

### **3.3. By broiler chicken waste**

Generally wastes from poultry slaughters cause a large amount of pollution. To prevent this, chicken wastes could be used for production of diesel by means of transesterification [13] or but by dry rendering process broiler waste can be utilized in the production good quality fuel and it also controls pollution. [14]

Birds feathers also kept utmost importance in the production of biodiesel. Chicken feathers which generally found as waste product of poultry industry could be used in the production of biodiesel. [15]

### **3.4. Electricity production by cow dung**

Although burning of cow dung produce pollution instead use of dung as source of biogas plant helps to generate green energy in the form of electricity which is one of the better substitutes of energy production in remote areas. Even the slurry produced by the plant acts as best manure for crop production.

### **3.5. By animal manure**

Animal manure basically consisted of animal excreta having rich amount of nitrogen and phosphorus. These organic manures generally used for the production of methane. Cow, pig, hog were found as animals whose manure used as raw material in the production of methane. Biogas plant is one of the best example of fuel production through animal manure, which had reduced the consumption of natural gases.

Combustion of horse manure had been widely used for the emission of heat. The oxides of carbon and nitrogen produced in this process suited in appropriate range, even the ash produced in the combustion showed low concentration of heavy metals which could be recycled. [16] Even the horse manure had found to be enhanced the production of methane gas in biogas plant. [17]

### **3.6. By animal intestinal bacteria**

Now it has been found through that intestinal fauna of animals could be used in the production of energy. Studies revealed that the some strains of *Clostridium* bacteria found in faecal matter of Zebra which were found to be capable to convert cellulosic waste into butanol fuel. In the same way faecal waste of Panda also found capable for the conversion of plant wastes into fuel.

## **4. MAJOR BIOFUELS OBTAINED BY ANIMAL WASTES**

### **4.1. Biogas**

Biogas is one of the efficient biofuel produced by animal wastes. Even this can be produced by any type of organic waste, plant wastes, domestic wastes, etc. It is a renewable source of energy, obtained by anaerobic digestion through methanogens. The gases evolved through biogas plant involves methane, carbon dioxide, hydrogen sulphide. It yields enormous energy which can be used to run electrical appliances, can be utilized in cooking purposes, etc. The slurry left by the plant can be used as manure for agricultural purposes.

Although biogas is quite efficient but there are certain risk factors in this plant, like production of methane gas which is main component of green house effect with carbon dioxide, hydrogen sulphide is also a toxic gas. It can catch fire and can be explosive. By taking proper precautions, such risk factors can be solved out.

The various dairy effluents including liquid dairy waste, dung, waste water, urine, waste milk, residual feed all can be utilized in the production of biofuel. Even a proper tank or pond could be prepared for collecting wastes and separating solid wastes from that which could be utilized as manure. Liquid waste can be used for irrigation purposes. Dairy waste can be converted into energy by two ways:

(a) Anaerobic digestion- this is very common method used by farmers. In this anaerobic digestion of animal wastes takes place by bacteria which results in the production of biogas, which can be further used in electricity, as natural gas etc.

(b) Thermochemical methods- this process includes heating of animal wastes at high temperature and chemical treatment which forms solid (biochar), liquid (bio-oil) and gases (syngas) on the basis of speed and temperature. Liquid and gas could be used as biofuel.

Feedlot manure can also be used in the production of energy either by anaerobic fermentation or by thermochemical treatment. Similarly piggery wastes and poultry litter could be used as source for production of biogas.

### **4.2. Biodiesel**

Biodiesel is long chain, animal fat based biofuel. It is used to as fuel either in pure form or in mixed form with petroleum diesel to run domestic equipments, air craft, train, generators, etc. It is a good fuel but still its efficiency depends on its blend, viscosity and density. It is renewable, best alternative of fossil fuels like petroleum.

Biodiesel	Petroleum Diesel
Renewable source of energy.	Non- renewable source of energy.
Causes less pollution.	Causes more pollution.
Lack sulphur contents.	Contains more sulphur.
Can be easily blended with other oil or other fuels.	Cannot be easily blended with other fuels.
Good lubricating property.	Less lubricating property.
Expensive.	Less expensive

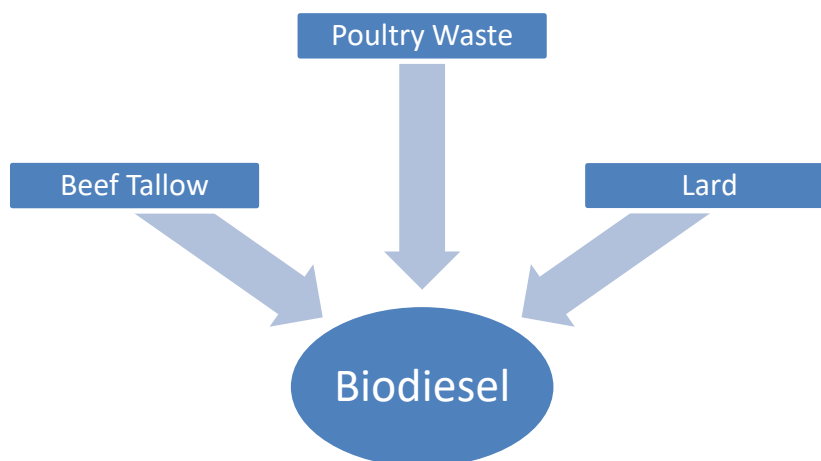


Fig.2. Production of Biodiesel by various animal sources

**5. LIMITATIONS OF BIOFUEL PRODUCED BY ANIMAL WASTES**

The esters which are required for production of fuel are found as less stable for oxidation as compared to other plant wastes.

It contains sulphur which minimizes quality of biodiesel.

Presently production of biodiesel from animal waste is slightly costly than fossil fuels.

It may lead to production of more CO<sub>2</sub> and NO<sub>x</sub>.

**6. CONCLUSION**

Biofuel production through animal wastes is one of the best substitute to overcome energy crisis. Biodiesel produced by animal waste contain high cetane number and low rate of emission of nitrous oxides thus prevents pollution. Oxidative properties of fuel can be stabilized by antioxidants. Animal fat contain sulphur can be removed by using efficient techniques like vacuum distillation. Impurities mixed with animal product also creates problem that can be overcome by eliminating them. Carbon dioxide produced by biofuels can be captured and stored in the form of sediments in deep sea or in the form of carbonates. Thus by proper management and operation, biofuels can be efficiently used in various forms of energy. It is renewable and less pollution causing fuel. Conversion of animal waste into fuel is best alternative for disposal of animal garbage. It also reduces contamination of ground water and minimizes odour. It is an effective way to convert

waste into best. It can be the better source of alternative energy.

**REFERENCES**

[1] M.V. Rodionova, R.S. Poudyal, I. Tiwari, R.A. Voloshin, S.K. Zharmukhamedov, H.G. Nam, et al. "Biofuel production: challenges and opportunities". International Journal Hydrogen Energy, 42(12):8450-8461, 2017

[2] S. Lebedevas, A. Vaicekauskas, G. Lebedeva, V. Makareviciene, P. Janulis, and K. Kazancev. "Use of waste fats of animal and vegetable origin for the production of biodiesel fuel: quality, motor properties and emission of harmful components". Energy and Fuels, 20(5):2274-2280, 2006

[3] M. Guru, B.D. Artukoglu, A. Keskin, and A. Koca. "Biodiesel production from waste animal fat and improvement of its characteristics by synthesized nickel and magnesium additive". Energy Conservation & Management, 50(3):498-502, 2009

[4] E.G. Varuvel, N. Mrad, M. Tazerout, and F. Aloui. "Experimental analysis of biofuel as an alternative fuel for diesel engines". Applied Energy, 94:224-231, 2012

[5] A. Cunha, V. Feddern, M.C. De Pra, M.M. Higarashi, P.G. Abreu, and A. Coldebella. "Synthesis and characterization of ethylic biodiesel from animal fat wastes". Fuel, 105:228-234, 2013

- [6] E. Alptekin, M. Canakci, and H. Sanli. "Biodiesel production from vegetable oil and waste animal fat in pilot plant". *Waste Management*, 34(11):2146- 2154, 2014
- [7] T.M. Mata, A.M. Mendes, N.S. Caetano, and A.A. Martins A. "Properties and sustainability of biodiesel from animal fats and fish oil". *Chemical Engineering Transactions*, 38, doi, 10.3303/CET1438030, 2014
- [8] P. Adewale, M.J. Dumont, and M. Ngadi. "Recent trends of biodiesel production from animal fat wastes and associated production techniques". *Renewable and Sustainable Energy Reviews*, 45:574- 588, 2015
- [9] R.V. Marques, M.F.D. Paz, E.H. Duval, L.B. Correa, and E.K. Correa. "Staphylococcus xylosus fermentation of pork fatty acid: raw material for biodiesel production". *Brazilian Journal of Microbiology*, 47(3), doi.org/10.1016/j.bjm.2016.04.018, 2016
- [10] D. Yuvaraj, B. Bharathiraja, J. Rithika, S. Dhanasree, and V. Ezhilarasi, A. Lavanya, and R. Praveenkumar. "Production of biofuels from fish wastes: an overview". *Biofuel*, doi.10.1080/17597269.2016.1231951, 2016
- [11] E.A. Sales, M.L. Ghirardi, and O. Jorquera. "Subcritical ethylic biodiesel production from wet animal fat and vegetable oils: A net energy ratio analysis". *Energy Conversation and Management*, 141:216- 223, 2017
- [12] N.S. Shamsul, S.P. Ramli, and S.K. Kamarudin. "Bio- Alcohol from anaerobic co-digestion of agriculture and animal wastes". *Indian Journal of Science and Technology*, 9(21), doi. 10.17485/ijst/2016/v9i21/95233, 2016
- [13] M. Belgharza, E.H.E. Azzouzi, M. Kitane, H.I. Bouzaidi, Y. Idrissi, and M.A. Belghiti. "Study of manufacturing biodiesel from animal fats (chicken) in Morocco". *Journal of Chemical and Pharmaceutical Research*, 6(12):844-849, 2014
- [14] J. Abraham, R.S. Kumar, F. Xavier, and D. Mathew. "Biodiesel production from broiler chicken waste". *International Journal of Agricultural and Biosystems Engineering*, 9(12):1190-1193, 2015
- [15] A.P. Karlapudi, V.P. Kodali, I. Mikkili, K. Srirama, M. Shaik, and R.K. Kota. "Biodiesel from chicken feather meal". *Journal of Pharmaceutical Science Research*, 7(12):1073-1075, 2015
- [16] J. Lundgren, and E. Pettersson. "Combustion of horse manure for heat production". *Bioresource Technology*, 100(12):3121-3126, 2009
- [17] M.M. Tegeder, A. Lemmer, and H. Oechsner. H. "Enhancement of methane production with horse manure supplement and pretreatment in a full- scale biogas process". *Energy*, 73:523-530, 2014