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Review Article

Gomeya- A Multifaceted Biomass

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Abstract: Cow dung obtained from *Bos indicus* have been long recognized as multifacted biomass that serve not only as conventional combustion material but also a modern day fuel. Apart from being an essential part of ayurvedic formulations it finds application in healthcare management by virtue of it's antibacterial activity. This article addresses the even more recent application of gomeya or the cow dung in various aspects including bioremediation. This implies that conservation of indigenous cattle is very crucial in order to make use this 'gold mine' and further explore it's hidden qualities.

Keywords: *Bos indicus,* cow dung, antibacterial activity.

INTRODUCTION

Cow has been an integral part of human life and regarded as 'the foster mother of human race'. In India there has been a long tradition of worshiping cow. Apart from the ethical side, the cows plays a huge role in balancing agro-ecosystem. Cows are also the inevitable component of rural as well as nation's economy. Not only the milk and dairy products but also several other products are obtained from cow including urine and cow dung. Although urine and dung are generally considered as waste product, but in India the cow dung or *go-var* (translated as cow-boon) obtained from the indigenous cattle has been considered auspicious. The cow dung find application as fertilizer, bio fuel, housing material and also as a part of panchagavya in Ayurveda.

In the modern time primarily the cows are being domesticated to fulfill the milk requirement and as soon as the animal stops lactating, it is considered as useless. Non realization of importance of these indigenous cattle has led to increase in estrayed cattle, thus *goshallas* or cow nursing home are being run by government agencies to offer shelter for old and infirm cows. The primary aim of this review is to summarize the multidimensional applications of cow dung or gomeya.

A) Gomeya

Cow dung or gomeya is basically fecal matter of cow. Basically cow dung contains a variety of different substances including microorganisms, products of digestion and secretions from different parts of the digestive tract and the stomach chambers, and water. Cow dung is also high in organic materials and rich in nutrients. Interestingly, the dung composition varies in indigenous cattle and exotic breeds [1] (Table.1).

Table 1: Adapted from Garg and Mudgal [1]

Nutrients (on dry matter basis)	Indigenous cow	Crossbred cow
Ash (%)	14.62	14.46
Acid insoluble ash (%)	10.49	10.43
Nitrogen (%)	01.848	01.826
Calcium (%)	00.72	00.65
Phosphorus (%)	00.52	00.48
Zinc (ppm)	27.80	15.10
Copper (ppm)	07.15	05.60
Manganese (ppm)	112.00	111.00

B) Gomeya- as a clean fuel

On average a cow produce 9-15 kg dung per day [2]. Thus, the total production of manure from cattle in India is 800 million tons of manure every year [3]. The increase in population has also increased the required to available ratio for non-renewable resources, since those are present in limited number. Due to limitation factor the cost of that particular product increases. For example fuel cost is one of the rising problems now a days, fuel costs as well as the taxation burden have been rising steadily for a number of years, leading to a dual load to the end user to bear.

In order to get rid from these major problems viz. increasing fuel cost, pollution, and shortage of electricity, cow dung as a biomass is a very good alternative in daily routine to get a pollution free environment. Making cow pats is one of the conventional strategy to use the gomeya as fuel. But, use of gomeya as cow dung cake is an inappropriate practice, since there are even more effecient non-conventional mode to utilize the dung as fuel. Biogas or gobar gas is a by-product of the decomposition of organic matter present in gomeya by anaerobic bacteria. This way of using cow dung is in itself more efficient and economical.

Biogas is a clean and renewable energy that may be substituted to natural gas to cook, to produce vapor, hot water or to generate electricity. At room pressure and temperature biogas is in gaseous form, not liquid like LPG (propane). To produce biogas, simply the organic waste or cow dung slurry is kept into a sealed tank called a digester (or bioreactor), where it is heated and agitated. In the absence of oxygen anaerobic bacteria consume the organic matter to multiply and produce biogas.

Gas produced from cow dung is 55-65% methane, 30-35% carbon dioxide, with some hydrogen, nitrogen and other traces. It's heating value is around 600 B.T.U. per cubic foot. The calorific value of bio gas is even higher than fossil fuel and fire wood (table.2). One kilogram of cow manure can produce 35–40 l of biogas when mixed with equal amount of water with hydraulic retention time (HRT) of 55–60 days maintained at an ambient temperature of 24–26 °C [4]. So, total production that India could achieve if all the dung from cattle is utilized is 0.2904 billion cubic metre.

Table 1: Thermal efficiency of Bio-gas and various other fuels

Fuels	Calorific values (KCal)	Thermal efficiency
Bio-gas	4713/M^3	60%
Dung cake	2093/Kg	11%
Firewood	4978/Kg	17.3%
Diesel	10550/Kg	66%
Kerosene	10850/Kg	50%

Biogas energy is considered carbon neutral, since carbon emitted by it's combustion comes from carbon fixed by plants (natural carbon cycle). When we convert biogas to electricity, in a biogas powered electric generator, only 2 kWh instead of 6 kWh and the rest of the 4 kWh is converted into heat which can be further utilized. This 2 kWh could power a 100 W light bulb for 20 hours or a 2000W hair dryer for 1 hour. Thus, we could say that biogas has more thermal efficiency than conventional fuels (Table 2). Waste coming out of the digester can be separated (solid/liquid). The solid part can be composted and the liquid part can be used as liquid fertilizer.

Advantages of Biogas

1. Production of energy-heat, light, and electricity
2. Transformation of organic wastes into high quality organic fertilizers
3. Improvement of hygienic conditions through reduction of pathogens, worm eggs and flies
4. Reduction of workload, mainly for women, in firewood collection and cooking
5. Environmental advantages through protection of soil, water, air and woody vegetation
6. Micro-economical benefits through energy and fertilizer substitution and additional income sources

C) Bioremediation by use of *Gomeya*

An age old tradition of performing *havana*, is a method for cleansing environment. Havana involves burning the cow dung cake. And in modern period the cow dung/gomeya has found application in myraids of bioremediation including medical waste, pesticides, heavy metal and even hydrocarbon residues.

C.1) Agnihotra

Agnihotra is a simple fire ritual mentioned in ancient *Vēdic* scriptures which is performed to reduce pollution and spiritually purify the atmosphere. Cow dung cake are used to lit the fire and start the combustion of other ingredients added to the fire like rice, ghee and other herbs. The temperature attained varies between 250°C and 600°C, while in actual flames it can go as high as 1200°C to 1300°C. A study conducted by Sharma et al. [19] showed that that Sox, Nox were considerably reduced by almost 51%, 60% respectively more by *yagya* when compared without yagya and both RSPM & SPM were also found to be

reduced by 9% & 65% more respectively as compared to the condition without yagya.

C.2) Bioremediation of drugs and biomedical waste

Cow dung has been showed to degrade antibiotics. Wicklow *et al.* [5] has reported isolation of *C. Stercoreus* from cow dung that has the ability to degrade enrofloxacin.

C.3) Bioremediation of Pesticides

The cow dung microbiota iscomposed of bacteria, fungi and actinomycetes. *Pseudomonas plecoglossicida* and *Pseudomonas aeruginosa* present isolated from dung have also been shown to completely degrade hazardous chemicals like cypermethrin and chlorpyrifos [6, 7]. The cow dung slurry in the ratio of 1:10 could bioremediate pesticides namely chlorpyrifos, cypermethrin, fenvalerate and trichlopyr butoxyethyl ester into some intermediate or less harmful compounds as shown by the study conducted by Geetha and Fulekar [6, 8].

C.4) Bioremediation of heavy metals

The heavy metals have posed threat to environment as well as to human health in recent century due to industrialization. The heavy metals disturbs the food chain and accumulates in living tissues, ultimately destroying organs, metabolism and even DNA damage, Gomeya has been proved to be a cost effective way to bioremediate the heavy metals in comparison to the conventional method like electrolytic deposition, electrodialysis, electrochemical, evaporation, precipitation, ion exchange, reduction, reverse osmosis, filtration, adsorption, chemical precipitation and distillation [9]. A study conducted by Mohopatra *et al*. [10] has demonstrated volatization of arsenic by bacteria in the presence of cow dung as substrate. Even radioactive toxic metals like strontium has been shown to be removed by cow dung by absorbtion. As well as another study conducted by Gupta [9] used cow dung powder to remove chromium from aqueous solution.

C.5) Bioremedaiation of oil spoilage

Akinde and Obire, [11] isolated petroleum utilizing bacteria from cow dung. *Acinetobacter spp*, *Alcaligenes spp*, *Serratia spp*, *Pseudomonas spp* and *Bacillus species* were identified as petroleum utilizers in cow dung.

C.6) Bioremedaiation of petrochemical and chemical industry waste

The wastes generated by petrochemical and chemical industries are not only non- biodegradable but also highly carcinogenic. Gomeya have great potential to detoxify these wastes thus with the help of Gomeya we can also to get rid from these highly toxicable wastes or by degrading them into nontoxic or very less toxic compounds. The *Pseudomonas putida* was isolated by Singh and Fulekar [12] from cow dung and it was demonstrated to degrade benzene at various concentrations. Another study have demostrated degradation of phenol by bacteria, fungi, and actinomycetes isolated from cow dung slurry [13].

D) Gomeya and human health

Vedas have illustrated Indian cows as unique for having the surya ketu nadi, claimed to be having ability to interact with solar rays and secrete gold nano-particles into the milk. However there are no scientific evidence for such claims. The proven health prospecteus of gomeya includes several ayurvedic formulation including the Panchagavya or panchakavyam. Cow dung has been narrated the important component of panchagavya.

'Panchagavya' is term used in "Ayurveda" to describe five major products obtained from cow, these products include cow's dung, urine, milk, ghee and curd. All the five products have medicinal properties against many disorders and are used for the medicinal purpose separately or with the combination of some other herbs. The term 'cowpathy' has been coined for panchagavya therapy. It is a very important part of ayurveda in which the importances of cows are mentioned in detail.

A recent syudy by Gosavi *et al*. [14] has shown the panchagavya to be an anti convulsant. Other studies have shown the panchagavya to be effective cancer [15], acquired immunodeficiency syndrome (AIDS) and diabetes. Immunomodulatory effects of panchagavya have also been demonstrated in various studies [16, 17]. Few innovative products have also been developed using gomeya, one of it is mosquito repellent developed by Mandavgane *et al*. [18].

CONCLUSION

The estrayed cattle in India are the real treasure for sustained development at both rural and urban level that is evident from the cow dung, which unlike other metabolic waste product serve as a boon for mankind and environment. The varied application of gomeya or with other components exert it's effect on bioremediation, conditioning soil, producing energy, degrading petrochemicals and also as a component of ayurvedic preparation. Further, the gomeya claimed to be absorber of radioactive, has opened new possibilities in this direction.

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