

Crude glycerol

bridging biofuel and livestock sector

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Awareness of the negative impact of greenhouse gas (GHG) emission from transportation vehicles forcing developing countries to look for the alternative source of energy such as biofuel production. India contributes about 1% of global biofuel production. Bioethanol and biodiesel are two biofuels that are commercially produced from biomass such as plant and organic wastes.

Key words: Biofuel, Crude glycerol, Livestock

BIOETHANOL produced by use of starch sources such as molasses, maize, sugarbeet, cassava etc. Biodiesel produced from the triglyceride sources such as edible, non-edible oilseeds and also from the animal source of fat and fish oil (Fig 1).

During the extraction of biodiesel, 10% of crude glycerol (60 to 80%) is obtained by trans-esterification process as a byproduct. Purification of crude glycerol to pharmaceutical grade (99.8%) is not cost effective (24.05 ₹/litre) as the prices of glycerol is dropped globally. Drop in prices of glycerol is impending issue for the biodiesel industry which is entering a new era of transition with anticipated entry of 200 nations by 2020 compared to just 20 nations in 2007. India also made a policy to replace 20% of diesel demand with biofuel.

The aim of the present communication is highlighting the alternative usage of crude glycerol as livestock feed to reduce burden of purification costs of glycerol in biofuel units.

Changing trends of biofuel industry

Biofuel industry needs a turn around policy to minimize utilization of crops that can be used for food production viz., corn, wheat, sugarcane, sugarbeet, palm oil, rapeseed etc., as feed stocks for biofuel production and encourage using non-food feed stocks viz., jatropha, pongamia, neem, mahua, simarouba, food processing wastes, waste oils, crop residues, algae etc. However, biofuel produced from non-food feedstocks may contain toxic principles, secondary plant metabolites and other crude substances amalgamated in crude glycerol which

needs scientific considerations for their alternate usage.

Digestible and metabolizable energy value of glycerol in different livestock feeding ranges from 14.9 to 15.3 MJ/kg and 13.9 to 14.7 MJ /kg respectively indicates that it is a good source of energy to comparable with most commonly used cereals in animal feeding. Currently Livestock Sector in India facing deficit of 27.15% and 23.41% of crude protein and energy, respectively Further, it is predicted that the global annual demand for coarse grains increase over the period by 553 million tonne. Effective utilization of crude glycerol in livestock feeding as an alternative energy source will help to overcome the energy deficit thus, providing a solution for two important sectors in the economy of India; livestock and biofuel.

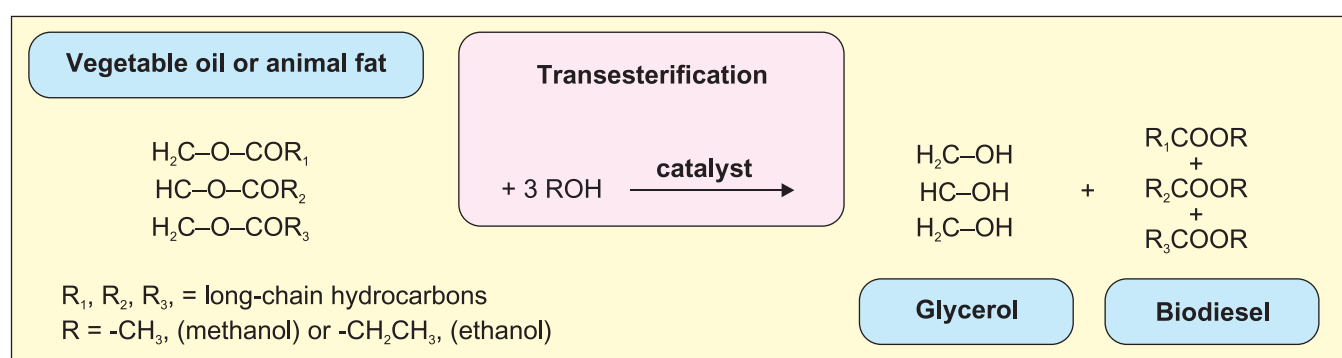


Fig. 1. Biodiesel produced from the triglyceride sources such as edible and non-edible oil seedlings

Scope for feeding of glycerol as an energy source

India producing 135 million litres of biodiesel and 2,219 million litres of bioethanol per year from which 13.5 million litres of crude glycerol available as byproduct. India requires around 88,807 million litres of total diesel and 28,252 million litres of petrol. National Biofuel Policy decided to blend 20% of bioethanol and biodiesel with petrol and diesel respectively for the end of XII Five-Year Plan i.e., 2017 to decrease GHG emission. Hence, about 23,412 million litres of crude glycerol will be obtained as a byproduct. Since value of crude glycerol (14.3 MJ/kg) can be comparable with the metabolizable energy value of maize (13.5 MJ/kg), it can be used as alternative glucogenic energy substrate in animal feeding. Currently, in India around 4.5 million tonne of maize is used in the animal feeding putting heavy demand on maize cultivation, an increase in price during the lean season is not affordable. These situations can be effectively handled by the inclusion of crude glycerol in the ration of the animals.

Composition of crude glycerol

Biodiesel derived from the natural triglycerides such as vegetable oil or animal fats through the trans-esterification process, where glycerol content of these triglycerides replaced by an alcohol molecule either ethanol (ethyl route) or methanol (methyl route) with catalytic base (NaOH, or KOH). Alcohol is removed from biodiesel and glycerol phases by flash evaporation or distillation and reused. The resulting glycerol contains unused catalyst and soaps which are then neutralized by the addition of acid to produce crude glycerin containing 76 to 90% glycerol. Crude glycerol pH may vary from 4.5 to 7.4. Methanol content in crude glycerol may vary from 0.01 to 13.5% and on which safety of supplementation of crude glycerol for livestock is dependent. Non-glycerol organic matter content will be 1.6 to 7.5% and inorganic ash content may vary from 3.5 to 7%. Inorganic ash part of crude glycerol contains

calcium, magnesium, sodium, potassium, iron and manganese 0.1 to 65, 0.02 to 55, 400 to 2 000, 30 to 4 000, 0.1 to 30, less than 0.5, respectively apart from 0.02 to 1.45 % of phosphorous.

The chemical composition of crude glycerol in biodiesel extraction varies mainly with source used for extraction, type of catalyst used, recovery and trans-esterification efficacy and presence of impurities in feedstock and methanol recovery. Simple exposure of crude glycerol to sunlight and air will increase the glycerol content from 80 to 85% by water and methanol evaporation. Currently, in India, non-edible oilseeds for biodiesel production such as jatropha (*Jatropha curcas*), pongamia (*Pongamia pinnata*), neem (*Azadirachta indica*), kusum (*Schleichera oleosa*) and mahua (*Madhuca longifolia*) are encouraged to use as substrates. Among these *Jatropha* is most commonly used because of better drought resistance property. Glycerol harvested during the biodiesel production using non-edible oilseeds contains contaminants whose purification process is not cost effective at the existing market prices for purified glycerol.

GLYCEROL IN ANIMAL FEEDING

Glycerol is a source of carbohydrates having high absorption rates. Absorbed glycerol converted to glucose in the liver of animals by the enzyme glycerol kinase. Glycerol enters the metabolic pathway to glucose at a different step than other glucogenic precursors. The glycerol component can be converted to glucose by the liver or kidneys to provide energy for cellular metabolism.

Non-ruminants

Crude glycerol inclusion in non-ruminants such as pig and poultry has been studied more extensively, metabolizable energy values estimated in broilers, layers and swine were 15.2, 15.9 and 13.4 MJ/kg respectively. Earlier research suggesting up to 10% and 9% inclusion in the weaned pigs and lactating sow diet with the similar

growth rate and performance compared to standard corn-soybean meal fed diet. Laying hen diet with 6% crude glycerol did not affect the egg quality, egg number, and nutrient digestibility.

Ruminants

Feeding of glycerol in complex ruminants subjected to fermentation, being the glucogenic substance glycerol increases total volatile fatty acids by increasing individual propionate and butyrate concentrations. *In vitro* experiment with crude glycerol showed decrease in methane (CH₄) production. Use of crude glycerol *in vivo* trial in large ruminants is less available. Purified glycerol up to 15% in dairy cows ration replaced with corn grain diet showed no adverse effect on feed utilization and milk yield. Meat goats and finishing lamb's diet fortified in the range of 5-15% of glycerol had no adverse effect on carcass characteristics. Recently Brazil government fixed the standards for the use of crude glycerol in animal feeding in the proportion of 10% of the ration and must have 80% of glycerol and up to 150 ppm of methanol is allowed.

SUMMARY

Biofuel production meets the deficit of fossil fuel sources, the government also interested in the promotion of biofuel production by giving incentives for effective utilization of low rainfed and drought prone areas for *Jatropha* sp. growing. Crude glycerol production in near future is expected to be high. Purification of crude glycerol is a costlier process instead of addition in animal feeding up to 10% will decrease the concentrate usage, which will be economical for the dairy farmers and environmental friendly also. Research regarding usage of crude glycerol in large animal feeding needs to be done to fix the particular standards for the impurities for the safety point of view.

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