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Glycerol as an alternative feed additive in the ration of Dairy cattle regarding to its blood constituents, anti-coccidial and anti-microbial effect: Impact on health, performance, milk yield and meat quality

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Abstract

One of the end-product of related biodiesel material is glycerol. Glycerol has been shown to possess properties that modulate the immune system, including decreasing bacterial colonization, regulating immunity and subsiding inflammation. The characteristic features of using glycerol in cattle feed can be summarized as following: i- decreasing the milking barn's concentration. ii) raising the yields of milk, protein, and lactose in a slight proportional glycerol use. Holstein cows' blood cholesterol levels are lowered when glycerol is added to their feed. Glycerol has an impressive effect on glucose production and improving the animal's energy, which results in a reduction in the breakdown of fats from tissues. The action of glycerol on Eimeria spp is through a positive effect on coccidia infection by suppressing infectivity level, and preventing oocyst sporulation. animals receiving diets containing Glycerol showed Low total bacterial counts. In conclusion, Glycerol is one of the most beneficial alternative feed additive that enhances growth promoters, ameliorates energetic value, health, body weight performances in and animal farms, improves milk and meat quality and finally valuable anti-coccidial and anti-microbial effector.

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Introduction

One of the end-product of related biodiesel material is glycerol. Recently industrialists directed for using a glycerol as a substitution economic material in animal ration either in cattle farms **(Bergner *et al*., 1995)**. The metabolic pathway of glycerol is via hepatic and renal systems ended by ATP providing a high energy level for animals. Renewably, industrialists take glycerol in their livestock fed as a main feed source for its cheapness and abundant sources. **(Bodarski *et al*., 2005)**. By lowering bacterial colonization, modifying immunity, and reducing inflammation, glycerol has been demonstrated to have immunomodulatory effect. It also enhances animal growth **(Smulikowska *et al*., 2009)**.

Chemical composition of Glycerol:

Glycerol is one of the chemical components of glycerin, a key ingredient made from triacylglycerols, which are fatty acids, and the origin of energy that can be stored chemically since it serves as a precursor to the breakdown of glycerol-3-phosphate, a common molecule in the glycolytic pathway. That is where glycerol is then converted into glucose, participating in the Krebs cycle or via gluconeogenesis, affecting the energy provision to the animal's system **(Ustundag *et al*., 2013).** Following absorption, aquaglyceroporins carry it to the liver in the circulation **(Guerra *et al*., 2011)**. To prevent loss in the urine, the kidneys also reabsorb and metabolize **(Leite *et al*., 2017 and Guerra *et al*., 2011)**.

As a result, glycerin is essential for both animal and human energy production. It serves as an essential structural element in both triglycerides and phospholipids. Glycerol, which comes from the dietary intake of glycerin, is metabolized in the liver through the pathways of lipogenesis or gluconeogenesis. When energy levels are adequate, Triglycerides are formed using glycerol as a building ingredient; conversely, during periods of energy scarcity, glycerol is utilized to form carbon backbones for gluconeogenesis or to generate energy via the Krebs cycle and glycolysis

Glycerol is used either to form carbon backbones for gluconeogenesis or to produce energy through glycolysis and the Krebs cycle. **(Arif *et al*., 2017 and Verrusa *et al*., 2017).**

Glycerol and its effect on livestock farms:

The characteristic features of using glycerol in cattle feed can be summarized as following: i) decreasing the milking barn's concentration. ii) raising the yields of milk, protein, and lactose while using glycerol in a somewhat proportionate manner **(Defrain *et al*., 2004)**. iii) indeed slight proportional glycerol intake will slightly upset the levels of fatty acids in milk yield including conjugated linoleic, palmitic, oleic and linoleic acids. **(Defrain *et al*., 2004)**.

Researchers reported the impact of different levels of glycerol in non-ruminant animal feed; for instance, in pig farms, the implying of 2.76% crude glycerin was recorded as a precursor factor in body weight gain in piglets during the nursery phase **(Da Rosh *et al*., 2016)**. The ideal recorded levels was between 5% and 10% **(Garcia *et al*., 2018; Romano *et al*., 2014)**.

There are several beneficial effects of glycerol usage in animal nutrition, **(Barros *et al*., 2020)**. In assessing the feeding habits of sheep given varying amounts of glycerol, it was found that adding up to 12% would not notably disrupt nutrient consumption, feed conversion efficiency, or the rumination of ingested fiber and dry matter.

Effect of glycerol substitution on dairy cattle:

A trial was conducted using forty Holstein dairy cattle milked in an automated milking

system, in which crude glycerol (Gly) was incorporated into the cows' partially mixed ration (PMR) as a replacement for barley at dietary dry matter (DM) inclusion levels of 0% (Gly0), 6% (Gly6), 12% (Gly12), and 18% (Gly18) **(Defrain *et al*., 2004 and Food and Drug Administration, 2006)**.

For lactating cows in the middle or terminal phases of lactation, the study demonstrated that glycerol, serving as an energy feed, is capable of replacing barley at inclusion rates of up to 18% of dietary dry matter without compromising the quality of the milk. As anticipated given the change in the dietary FFA profile brought about by the addition of glycerol to the diet, the milk's FFA profile underwent a minor modification. Glycerol inclusion was thought to have negligible effects on the flavor of both fresh and preserved milk. But adding more than 12% dietary glycerol could reduce the output of Energy Correct Milk (ECM) **(Defrain *et al*., 2004)**.

Glycerol and Blood contituents:

Ezequiel *et al* (20) reported that adding glycerol to the diet of Holstein cows lowers blood cholesterol concentration. The inclusion of glycerol supports glucose generation and energy improvement in animals, which consequently diminishes the in tissue fat catabolism **(Kupczynski *et al*., 2011).** A decrease in the concentration of non-esteratified fatty acids (NEFA) and β-hydroxybutyric acid (βHBA) and an increase in the serum concentration of triglycerides are characteristic features in glycerol effect. The rise in triglyceride indicates the positive impact on lowering the levels of NEFA and βHBA **(Kupczynski *et al*., 2011)**. According to **Torres *et al*. (2021)**, glycerol lowers the blood's NEFA content by 5.6% and raises the blood's serum glucose concentration by 2.5%.

The dietary glycerol is predominantly taken up directly via the rumen epithelium or the small intestine, then it is carried via the bloodstream to the liver. In the liver, the enzyme glycerol kinase transforms glycerol into glycerol-3-phosphate, which is utilized to promote glucose production through gluconeogenesis. This could explain the high concentration of glucose that results from glycerol intake **(Kupczynski *et al*., 2020)**, or as a result of rumen bacteria fermenting glycerol to propionate, which is then transported to the liver and transformed into succinyl-CoA, which then enters the Krebs cycle and transforms into pyruvate phosphoenol during the gluconeogenic process to produce glucose **(Osman *et al*., 2010)**.

Glycerol-fed animals had higher plasma concentrations of glucose, uric acid, globulins, and total protein compared to the control group **(Fortuoso *et al*., 2019)**.

Glycerol and anti-coccidial effect:

Fortuoso *et al*. (2019) found that animals fed diets with Glycerol had reduced levels of Eimeria spp. oocysts on day 42 when compared to the control group**.**

Glycerol and antibacterial effect:

The creation of natural substitutes for growth boosters and antibiotics is appealing to both producers and consumers in the age of rising antibiotic resistance brought on by the use of antibiotics in animals raised for food. One feed additive that can be used in place of antibiotic growth promoters is glycerol. It can also be utilized as a modulator of the gastrointestinal tract's microbiota and to lessen the negative impacts of certain disorders, like coccidiosis. Dietary butyrate glycerides have been shown to alter gut flora in the past **(Yang *et al*., 2018).**

Fortuoso *et al*., 2019 reported that animals receiving diets containing glycerol had low overall bacterial counts in the tested groups on day 21 of the experiment.

Conclusion

In conclusion, Glycerol is one of the most beneficial alternative feed additive that enhances growth promoters, ameliorates energetic value, health, body weight performances in animal farms, improves milk and meat quality and finally valuable anti-coccidial and anti-microbial effector.

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