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Review Article

Effects of Supplementation of Acidifiers in the Diet of Poultry

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Abstract

The paper presents a literature review of effects of the acidifiers (the substances which are put into an animal body to produce or become acid) when they are supplemented in poultry rations. An overview of their effects on poultry's growth performance and immunity along with the effect of supplementation on nutrient digestibility is presented. The literature on antimicrobial activity of organic acids has also been reviewed.

Keywords: Acidifiers; Poultry; Growth; Immunity; Review Paper

Introduction

Antibiotics and their use have a significant impact on animal health and welfare [15]. Also, antibiotics promote the growth of livestock and poultry by at least three effects: modulating metabolism, improving nutrients efficiency and preventing diseases. Antibiotics in the diet enhanced body weight and feed intake in broiler hens, according to Afsharmanesh., *et al.* [2]. Antibiotics have been used for over half a century to improve livestock production in feed. Increases in poultry performance and feed utilisation by about 3-5% have been reported [35]. But, the use of antibiotics in livestock and poultry farming has been debated, as side effects may occur with long-term usage, such as the development of microbial resistance and residues in meat [28]. As a result, numerous European governments have restricted or outlawed the use of antibiotics as growth promoters in reaction to the spread of antibiotic resistance and the inappropriate use of antibiotics [12,21]. Unfortunately, the use of antibiotics is prohibited, which may raise production costs, reduce growth and feed efficiency, and raise morbidity and mortality rates [35]. As a result, numerous alternatives to using antibiotics in chicken are being researched [18,37]. This prompted the researchers to investigate the use of non-therapeutic feed additives in poultry production, such as organic acids, enzymes, probiotics, prebiotics, herbs, essential oils, and immunostimulants. Organic acids (or simply acidifiers) are one of these options, and they play an essential role in animal gastrointestinal health as well as nutritional digestion.

Organic acids are naturally occurring components in a variety of feeds, are frequently employed in feed acidification, and are created during animal metabolism. They've been used as an in-feed preventive approach to combat diseases in the feed industry since they contain antibacterial, antifungal, and antimicrobial properties [13]. Organic acids like fumaric, formic, lactic (LA), and citric acids, as well as their salts, provide performance and health benefits [47]. Lactic acid research has become one of the hottest topics in animal husbandry. It is an essential energy carrier with no pollution, no residue, quick absorption in the body, participation in metabolism [9,25], and participation in the tricarboxylic acid cycle [20].

Organic acid therapies containing single acids and mixtures of multiple acids have been shown to exhibit antibacterial properties comparable to antibiotics [43]. Because organic acids and their salts are generally deemed safe, the European Union permitted their use in poultry production [1]. Any organic carboxylic acid with the generic structure R-COOH is termed an organic acid (including fatty acids and amino acids). Antimicrobial action is linked to short-chain acids (C1–C7). Simple mono-carboxylic acids like formic, acetic, propionic, and butyric acids, carboxylic acids with the hydroxyl group like lactic, malic, tartaric, and citric acids, and short-chain carboxylic acids with double bonds like fumaric and sorbic acids are all examples [38]. Organic acids are effective not only as a growth stimulator, but also as a control tool for all intrinsic bacteria, whether pathogenic and nonpathogenic [29,44]. They alter the pH of digesta, enhance pancreatic output, and have trophic effects on the mucosa of the gastro-intestinal tract, in addition to their antibacterial action [10]. Inorganic acidifiers, such as hydrochloric, sulphuric, and phosphoric acids, are underutilised while being less expensive than organic acids. Phosphoric acid, the most common inorganic acidifier, serves as both an acidifier and a source of phosphorus for the body. It has the ability to liberate up to 3 H^+ while also slowing down the pace of H^+ release, allowing it to play a long-lasting and effective role [3]. It is also useful for young fowl with an undeveloped digestive system [3]. Acidifiers in cattle nutrition are thus a cost-effective performance-enhancing option, acting on animals via their feed, gut, and metabolism [36]. However, organic and inorganic acidifiers are not the same, and organic acidifiers are more expensive. Although organic acidifiers have a superior flavour and stronger bacteriostatic effects, inorganic acidifiers have a high degree of dissociation and a fast rate of dissociation, allowing them to swiftly lower the pH of feed in the stomach. However, a rapid drop in pH may prevent gastric acid release, burn the oesophagus and stomach, and prevent normal gastric function development [46].

Effect on growth performance

Panda., *et al.* [33] noticed that 0.4% butyrate in the diet of broiler was similar to antibiotics in maintaining body weight gain (646 and 642 g, respectively) but superior for FCR. There was no added advantage obtained on these parameters by increasing the butyrate from 0.4% to 0.6% in the diet. Contrary to the findings of the above study, Antongiovanni., *et al.* [4] and Leeson., *et al.* [24] suggested a lower level (0.2%) of butyrate to maintain the performance of broiler chickens. Chowdhury., *et al.* [7] reported the highest body weight was attained in 0.5% citric acid-fed chicks (1318 g), which was significantly ($P < 0.05$) higher than control chicks (1094 g) or 0.001% avilamycin-fed chicks (1217 g). Broiler chicken fed diets supplemented with organic acids (2 percent butyric acid, 3 percent butyric acid, 2 percent fumaric acid, 3 percent fumaric acid, 2 percent lactic acid, and 3 percent lactic acid) had significantly ($P < 0.05$) improved body weight gains and feed conversion ratio when compared to control, according to Adil [3]. On cumulative feed consumption, there was no effect ($P < 0.05$). The increase in FCR could be related to greater nutrient utilisation, resulting in enhanced body weight gain in the birds fed organic acids in their diet. Azza., *et al.* [5] discovered that broiler chicken diets enriched with organic acids (3 percent butyric acid, 3 percent fumaric acid, and 3 percent lactic acid) enhanced body weight growth and feed conversion ratio significantly ($P < 0.05$). On cumulative feed consumption, there was no effect ($P < 0.05$). Khooshechin., *et al.* [19] discovered that at 3 g/kg of organic acid inclusion, body weight, average daily gain, and average daily feed intake increased (linear effect, $P < 0.05$), whereas feed conversion ratio was negatively affected by dietary treatments (quadratic, $P < 0.05$) as organic acid inclusion increased to 2 g/kg and then decreased with further inclusion. Vinolya., *et al.*[42] reported that groups of broilers those supplemented with combination of organic acids @ 1kg/MT of feed and organic acids with essential oil@ 1kg/MT of feed had shown significantly ($P < 0.05$) improved body weight and average daily gain over control group (without acidifier) at 42 days of age. Broilers treated with a combination of organic acids @ 1kg/MT of feed also exhibited a 5 point increase in feed conversion above control ($P < 0.05$).

Organic acid supplementation in broiler chicken enhanced body weight gain when compared to the unsupplemented group, according to Owens., *et al.* [32]; Sheikh.,*et al.* [39] and Ghazalah., *et al.* [14]. The favourable effect of organic acids on the gut flora is most likely responsible for the improvement in body weight gain. Organic acids may disrupt the integrity of microbial cell membranes or macromolecules, as well as nutrient transport and energy metabolism, resulting in a bactericidal effect. Organic acid is thought to promote growth rate by managing the intestinal microbial ecology in the digestive organs, allowing commensal bacteria to flourish while reducing pathogenic bacteria that can create poisons [45,27]. The favourable effect of acidifiers, such as organic acid, on performance is linked to increased nutrient efficiency and improved digestibility [31].

Impact of acidifier on immunity

Chowdhury., *et al.* [7] observed an improvement in the immunological status of broiler chickens those fed 0.5% citric acid. Houshmand., *et al.*. [17] discovered that adding organic acids (Sunzen Corporation SdnBhd, Malaysia; 0.15 percent in a beginning diet) to broiler chicken diets resulted in significant increases in antibody titers against Newcastle disease at 21 days of age. However, by 42 days of age, there was no significant difference between treatments ($P > 0.05$). Emami., *et al.*. [11] discovered that adding phytase and organic acids to broiler diets lacking in accessible phosphorous improved intestinal integrity and immunological response. They discovered that broilers given a phytase+organic acid diet had higher ($P < 0.001$) immunoglobulin G (IgG; 2.27) in the primary and secondary responses, as well as higher ($P < 0.001$) total immunoglobulin (7.84) and IgG (5.74) in the primary response. Hedayati., *et al.* [16] found no significant difference between the dietary treatments for all antibody titers against Newcastle Disease (ND), Infectious Bursal Disease (IBD), and Avian Influenza when broiler diets supplemented with 0.025 percent, 0.05 percent, and 0.1 percent acidifier agent.

Totacid was the natural acidifier employed in this investigation (containing citric acid, acetic acid, propionic acid, lactic acid and mannan oligosaccharides from natural sources). Yang., *et al.* [47] reported birds those consumed 0.30 g/ kg of sorbic acid, fumaric acid and thymol throughout the grower and finisher period has significantly higher spleen index as compared to control group. Further, the secretory level of immunoglobulin A in duodenal and ileal mucosa was increased ($P < 0.05$) at day 42. Lee., *et al.* [23] found the beneficial effects of organic acids on immune responses against viral antigens (H9N2) in broiler chickens and they reported that group of birds those supplemented with organic acids and administered a H9N2 vaccine had higher $CD4^+$ $CD25^+$ T-cell percentage than in the control.

Antimicrobial activity of organic acids

Salmonella, Campylobacter, and Escherichia coli are the most prevalent bacteria that impact poultry intestinal health, and they can be controlled by taking an organic acid supplement [30,41]. Poultry is known for being one of the most important Salmonellae reservoirs in the human food chain [8]. Against Salmonella typhimurium that was loosely or firmly attached to broiler chicken skin, bactericidal activity (mean reduction log CFU per skin) of all acids increased linearly with increasing concentration (0.5, 1, 2, 4, and 6 percent acetic, citric, lactic, malic, mandelic, propionic, or tartaric acid) [40]. A study showed that dietary supplementation of organic acid reduced cecal E. coli numbers at 10 day of age compared to Escherichia coli K88-challenged (ETEC) broiler chickens ($P < 0.05$) [11]. But how organic acid affect (particularly more distal) GIT microbial populations remains unclear, particularly as organic acid should have lower direct antimicrobial activity in the higher pH environment of distal sites [6]. This suggests that organic acid initiatetheirmicrobiota-modifying effects in more proximal GIT regions. Organic acid salt (ammonium formate or calcium propionate; 3 gm/kg diet) reduced coliform count in broiler feed compared to control, but had no effect on clostridium count, according to Paul., *et al.* [34]. The results also demonstrated that supplementing with ammonium formate reduced the number of E. coli in the stomach, but had no effect on the number of clostridium. Calcium propionate, on the other hand, may suppress fungal count in the feed more effectively than ammonium formate. This could be owing to propionic acid's or propionate's anti-mould properties [48]. Mikkelsen., *et al.*[26] discovered that 0.45 percent potassium diformate reduced necrotic enteritis-related mortality (Clostridium perfringens). Potassium diformate significantly reduced the amount of C. perfringens in the jejunum after the outbreak of necrotic enteritis (day 35 of the trial period).

Effect of organic acids on nutrient digestibility

Nourmohammadi., *et al.* [31] reported that supplementation of 3% citric acid along with microbial phytase enzyme caused better ileal nutrient (CP, apparent metabolisable energy (AME), Ca and total P) digestibility and increased mineral retention in broiler chicken. It was found that lower pH facilitates the P solubility and the microbial phytase was more active through acidification resulting in improved P absorption. Supplementation of organic acid together with the developing desirable gut microflora was found to contribute for mineral retention and bone mineralization through increased digestibility and availability of nutrients as stated by Ziaie., *et al.* [49]. Ghazala.,*et al.* [14] discovered that supplementing broiler diets with 0.5 percent fumaric or formic acid, 0.75 percent acetic or 2 percent citric acid, and 0.75 percent acetic or 2 percent citric acid improved both metabolisable energy and nutrient digestibility, as measured by crude protein (CP), ether extract (EE), crude fibre (CF), and nitrogen-free extract (NFE). According to Van Der Sluis [41], the beneficial effects of organic acids on digestion are associated with slower feed passage through the digestive tract, improved nutrient absorption, and fewer moist droppings. Emami., *et al.*[11] discovered that broilers fed the control diet (without microbial phytase enzyme and organic acid) had the lowest CP and EE digestibility (0.7751 and 0.7949, respectively), which was improved ($P < 0.001$ and $P = 0.01$) by adding Phytase+organic acid (0.8858 and 0.8561, respectively).

Conclusion

Organic and inorganic acidifiers have an overall positive impact on growth performances of poultry along with increasing the antibody titer in their blood, thus increasing the disease resistance. Lowering of E. coli count in poultry gut, which improves gut health, is another beneficial effect of their supplementation in poultry ration. Improvement in digestibility of nutrients (CP, CF, NFE and EE) and absorption of calcium and phosphorous in the gut is also evident. The acidifiers are safe for long term use as compared to antibiotics which could cause microbial resistance and leave their residues in poultry meat. Hence, we can conclude that acidifiers can be supplemented in the poultry rations to upgrade health of a flock and significantly increase the production obtained from it.

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