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A review on recent advances in uses of organic acids in poultry production

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Abstract
The use of organic acids in poultry production is increasing day by day due to its beneficial effect. This review explain the effect of organic acids on the performance, gut health, nutrient digestibility, egg production, Carcass, biochemical and haematological status of birds. Due to demand of meat and eggs, production should be increased so antibiotics were used to prevent birds from diseases. Antibiotics use in poultry production is prohibited since 2012. Therefore, search for its alternative was start and essential oil, probiotics and organic acids give good results. Organic acids act as antifungal and anticoccidial agent which inhibit growth of pathogenic organisms and increase the digestibility. Organic acids in proper dose rate improve growth, health status and decrease mortality.

Keywords: Organic acids, poultry production, eggs

1. Introduction
Poultry is one of the fastest growing industry in India as well as in the world. India is ranking third in egg production and fourth in meat production which indicates the need for increasing production to combat the problem of malnutrition (Poultry Sector in India 2017) [33]. The poultry sector is continuously in look for new feed additives in order to improve the feed efficiency and health of poultry birds. The ban on the use of antibiotics as growth promoters in EU since 2006 permitted the finding of alternative to antibiotics in farm animal nutrition (Attia *et al*., 2006; 2012) [2, 3]. Alternative strategies comprising of organic acids and their salts, probiotics, prebiotics and enzymes were developed to cope up with antibiotic residual problem in meat which can ultimately give rise to antibiotic resistance issue. One such substitute was the use of organic acids as a feed additive in the animal production. Organic acids stimulate the epithelial growth of the intestinal wall (Langhout and Sus, 2005) [24]. Dietary organic acids and their salts are able to inhibit the growth of detrimental microbes in the feed and subsequently maintains the level of beneficial bacteria in the gastrointestinal tract. In addition, they not only decrease the pH of the gastro-intestinal tract but also increases the solubility, digestion and absorption of the nutrients (Vogt *et al*., 1981; Patten and Waldroup, 1988 and Skinner *et al*., 1991) [47, 31, 42]. These studies would be related to the source, the amount of organic acids used, location, environmental condition and the composition of the diets (Gama *et al*., 2000) [16].
Gut health is one of the major factors upsetting the performance of birds and thus the economics of poultry production and hence the profitability of an enterprise (Samik *et al*., 2007) [40]. Gut microflora has a noteworthy effect on gut health, host nutrition and growth performance by intermingling the nutrient utilization and development of gut system of the host (Barrow, 1992) [5]. Broilers are always under the threat from pathogens like *Escherichia coli, Salmonella, Clostridium* spp. etc., so, the practice of addition of sub-therapeutic dosage of antibiotics in feed as additives to achieve protection from specific intestinal pathogens and as growth promoter is increasing day by day though there is a ban on use of it (Dibner and Richards, 2005) [10]. Organic acids are either simple monocarboxylic acids (formic, acetic, propionic and butyric acid) or carboxylic acids with hydroxyl group (lactic, malic, tartaric and citric acid). In undissociated form, they penetrate the semi-permeable membrane of bacterial cell wall, enters the cytoplasm and decrease the internal pH affecting the enzyme system

(e.g. decarboxylases and catalases) thus, inhibiting glycolysis, preventing active transport and interfering with signal transduction. Hence, the supplementation of organic acids in feed instead of sub-therapeutic dosage of antibiotics is being seriously considered, particularly in the context of reservations in using antibiotic as a feed additive. The use of organic acids has been reported to protect the young chicks by competitive exclusion (La Ragione and Woodward, 2003) [23], enhancement of nutrient utilization, growth and feed conversion efficiency (Denli *et al*., 2003) [9]. They can also stimulate pancreatic juice secretion and modifies the gut morphology in terms of villi height thus increasing the area of absorption of the nutrients (Dibner and Buttin, 2002) [11]. On the other hand, it stated that diet palatability and appetite can be influenced by organic acids (Cave, 1982) [8].

2. Effect of OA on Performance

High production and better FCR is key to develop the poultry industry. Many works were done to achieve it. To increase the production rate, Antiobiotics were used but due to their harmful effect they are prohibited and alternatives are used like organic acids. Elnesr *et al*. (2018) [12] conducted an experiment to investigate the effect of sodium butyrate (SB) supplementation on growth of Japanese quail and it was observed that there is better FCR and high body weight as compare to control group. Vinus *et al*. (2017) [46] reported that basal diets containing sodium butyrate and calcium propionate @ 0.5% and 1.0% respectively showed high body weight and FCR than control group. Tomar *et al.* (2017) [45] conducted a study to know the effect of organic acid supplementation on performance of broiler chicken and Results indicated better (P<0.05) performance in terms of body weight gain and feed efficiency ratio in treatment group where there was 3% sorbate dietary supplementation. Fouladi *et al*. (2017) [14] conducted a research trial to evaluate the effects of acetic acid, lactic acid and butyric acid on the production performance of female Japanese quails and it was observed that the diets containing Basal diet +Lactic acid +Butyric acid+Acetic acid and Basal diet +Acetic acid alone considerably increased feed intake and feed conversion) and improved performance of Japanese quails. Emami *et al*. (2017) [13] performed an experiment to know the effects of commercial organic acid blend on male broilers challenged with E. coli K88 on performance of broilers and observed that addition of Organic acid to the diets of ETEC challenged birds either numerically or significantly improved growth performance. Ishfaq *et al.* (2015) [18] determined the efficacy of Acipure (citric acid, formic acid, lactic acid, propionic acid) supplementation on the performance of unsexed broiler chicken which showed that A significant (P<0.05) increase in body weight gain was observed in the group of birds fed with acidifier when compared with the group of birds fed untreated diets. The feed conversion ratio was improved and mortality reduces. The growth promoter effects of acidifiers are attributed to their ability to limit the growth of potential pathogens in the digestive tract of animals (Luckstadt *et al*., 2004; 2008) [26, 27]. Thus, the digestive tract remains healthy, functions more efficiently and more nutrients are available for absorption. OAs' enhances the digestibility of protein and amino acid by increasing gastric proteolysis. They reduce gastric pH which may boost the action of pepsin (Kirchgessner and Roth, 1988) [22] during proteolysis which activates the release of gastrin and cholecystokinin hormones and regulate the digestion and assimilation of protein (Hayat *et al*., 2014) [17] and play a significant role in better utilization of the available nutrients resulting in improved growth rate and feed conversion efficiency (Denli *et al*., 2003) [9].

3. Effect of OA on Gut health

Elnesr *et al*. (2018) [12] determined the effect of dietary sodium butyrate (SB) supplementation on histomorphometry of intestine and immune organs of Japanese quails and significantly improve villus height and width of intestine and morphometry of immune organs in organic acid supplemented group. Vinus *et al*. (2017) [46] evaluated the effect of dietary supplementation of salts of organic acids on gut health of broilers and result showed that, pH was reduced significantly (P<0.05) in treatment groups where diet supplemented with organic acid. There was significant improvement was observed in villus height and crypt depth in all treatment groups and Lowest Coliform bacteria (log CFU/g.) was recorded in treatment group. Higher duodenal villi height and crypt depth observed in of organic acids or probiotics alone or in combination on gut health of broiler chickens when diet was supplemented with acidifiers and the dietary treatment dramatically improved gut microflora by decreasing the population of *Escherichia coli* and increasing the *Lactobacillus* spp.:*E. coli* ratio. (Rodjan *et al*. 2017) [37]. Nicodeme *et al.* (2017) [29] studied the effect of organic acids and multispecies probiotic on gut microbial load (*Campylobacter*) in broilers and led to a slight but reduction of pathogenic microorganisms. Kazempour and Jahanian (2017) [21] evaluated the effect of dietary supplementation of organic acids (OA) on gut microbiota and concluded that dietary supplementation of OA reduced (P<0.01) ileal enumeration of *Salmonella* and the lowest (P<0.05) *Escherichia coli* count. Fouladi *et al*. (2017) [14] investigated the effect of organic acids supplement on gut microflora in female Japanese quails (*Coturnix coturnix japonica*) and results showed that the diets containing BD+LA and BD+BA significantly decreased the *E.Coli* and *Salmonella* population in the gastrointestinal tract. Awaad *et al*. (2016) [4] studied the effect of Na-butyrate supplementation on gut integrity of experimentally induced *salmonella enteritidis* in broiler chicks and Gut integrity of NaB supplemented groups showed significant increase in villi height, crypt to depth ratio and had positive effect in maintenance of healthy intestinal epithelial cells. The organic acids in their un-dissociated form are able to pass through the bacterial cell membrane into the cell, where they dissociate in H+ ions which lowers the pH of the cell and RCOO- ions that can disrupt normal cell function and protein synthesis. (Luckstadt *et al*., 2004; Luckstadt, 2008) [26, 27]. Adding OAs to feed can lower gastric pH which accelerates the conversion of pepsinogen to pepsin, thereby improving the absorption rate of proteins, amino acids and minerals (Park *et al*., 2009) [30].

4. Effect of OA on Biochemical and haematological parametrs

Elnesr *et al*. (2018) [12] showed the effect of dietary sodium butyrate (SB) supplementation on blood biochemistry and haematology where there is significant change observed in case of total protein and cholesterol. Supplementation of organic acids reduced meat cholesterol level when Vinus *et al*. (2017) [46] studied the effect of dietary supplementation of salts of organic acids on biochemical parameters of broilers. Fouladi *et al*. (2017) [14] performed an experiment to evaluate the effects of acetic acid (AA), lactic acid (LA) and butyric acid (BA) on the serum biochemical parameters on female Japanese quails and observed that diets containing BD+AA

and BD+LA alone increased serum cholesterol, HDL, albumin, globulin and total protein and the groups containing BD+AA and BD+LA decreased triglyceride contents in serum. Seifi *et al*. (2015) [41] investigated the impacts of acetic acid on blood biochemicals of broiler chickens and increased the blood urea but other serum components did not influenced by addition of acetic acid to the ration. Ramigani *et al*. (2015) [35] determined the effect of dietary supplementation of organic acids on serum biochemical profile of broiler birds where higher serum total protein, albumin, globulin levels and decreased cholesterol level were recorded in organic acid supplemented groups. The effect of organic acid supplementation on protein metabolism may be related to improvement of intestinal amino-acids absorption in acidic conditions that consequently enhances protein synthesis (Yesilbag and Colpan, 2006) [48].

5. Effect of OA on Nutrient digestibility

Tomar *et al.* (2017) [45] evaluated the effect of organic acid supplementation on nutrient digestibility. The retention of DM, CP and GE improved on supplementation of organic acids @ 3% of the diet and the highest (P<0.05) retention of protein was observed in broilers assigned diet supplemented with calcium sorbate @ 3% of the diet. Rodjan *et al*. (2017) [37] evaluated the effect of organic acids or probiotics alone or in combination on nutrient digestibility in broiler chickens. the crude fiber digestibility was found to be increased in chicks supplemented with CDOA or CDOAP relative to CD (P<.05). Ndelekwute *et al*. (2017) [28] evaluated the effect of organic acids (acetic, butyric, citric and formic acids) on growth and nutrient digestibility of broilers. From the study, it was concluded that 0.25% formic acid could be added to broiler diets to improve the digestibility of nutrients. Thirumeignanam *et al.* (2006) [44] studied the effect of dietary supplementation of organic acids on nitrogen retention. The increased nitrogen retention in organic acid treated groups was attributed to the increased digestibility of crude protein.

As pH reduces in the upper part of the GIT, there may be increase in nutrient digestibility. Due to reduced pH in the stomach, pepsinogen and other zymogens get activated by adjusting gastric acidity closer to that required for optimal activity resulting in increased enzyme activity and improve the digestion of proteins (Jongbloed *et al*. 2000) [19]. OAs raised gastric proteolysis and improved the digestibility of protein and amino acids by reducing pH of the chime and thus enhanced the digestibility of protein (Samanta *et al.*, 2010) [39].

6. Effect of OA on carcass production

Peyman *et al*. (2014) [32] conducted an experiment to evaluate the effect of organic acids supplementation (acetic, lactic and butyric acids) in the basal diet and their effects on carcass parameter on male Japanese quails. increase in the intestinal weight. Bonos *et al*. (2014) [6] studied the carcass characteristics of Japanese quails as affected by sex or mannan oligosaccharides and calcium propionate. Results of the study revealed that the female quails showed increased carcass weight and liver to live weight percentage. Salmanzadeh *et al.* (2013) [38] evaluated the effect of dietary supplementation of butyric acid on carcass traits of Japanese quails. it was found that dietary supplementation with high level of butyric acid improved carcass traits by increasing surface absorptive area which promoted nutrient assimilation sustained performance of Japanese quails. Abdel-Mageed (2012) [1] revealed the effect of using organic acids on carcass parameters of Japanese quails fed optimal and sub-optimal energy and protein levels. It was observed that using dietary butyric acid at a level of 0.2% in Japanese quail diets containing sub-optimal energy and protein levels helped in improving quail performance and carcass yield. Leeson *et al*. (2005) [25] conducted an experiment to study the effect of butyric acid on the carcass yield of broiler chickens. The results showed that 0.2% of butyric acid could maintained the performance and carcass quality of broilers, especially in vaccinated birds challenged with coccidiosis.

7. Effect of organic acids on egg production

Ravinder *et al.,* (2016) [36] was conducted an experiment to evaluate the effect of supplementing different levels of salts of organic acid in the laying hen's diet on egg quality parameters. Egg production was more profitable at 0.5% level of sodium butyrate and 0.5% level of calcium propionate which reduced the feed cost per dozen eggs and per kg egg mass production without affecting the egg quality. Effect of dietary available phosphorus and organic acids on the performance and egg quality of laying hens was studied by Park *et al*, (2009) [34]. Hen-housed egg production was highest in the Available Phosphorous 0.3 + Organic Acid 0.2 treatment group. Effect of supplementation of organic acids on laying Performance, body fatness and egg quality of hens was studied by Rahman *et al*., (2008) [34] and results indicated that Inclusion of organic acids improved egg shell thickness (P<0.05) while significantly reduced albumen index (P<0.05). Incorporation of organic acids attributed to significant increase per cent albumen (P<0.01) and significant decrease in yolk per cent (P<0.05). Soltan, M. A.(2008) [41] evaluated the effect of dietary supplementation of organic acid in laying hens and observed that organic acid supplentation at the level of 780 ppm of laying hens improve persistence of laying eggs and shell quality.

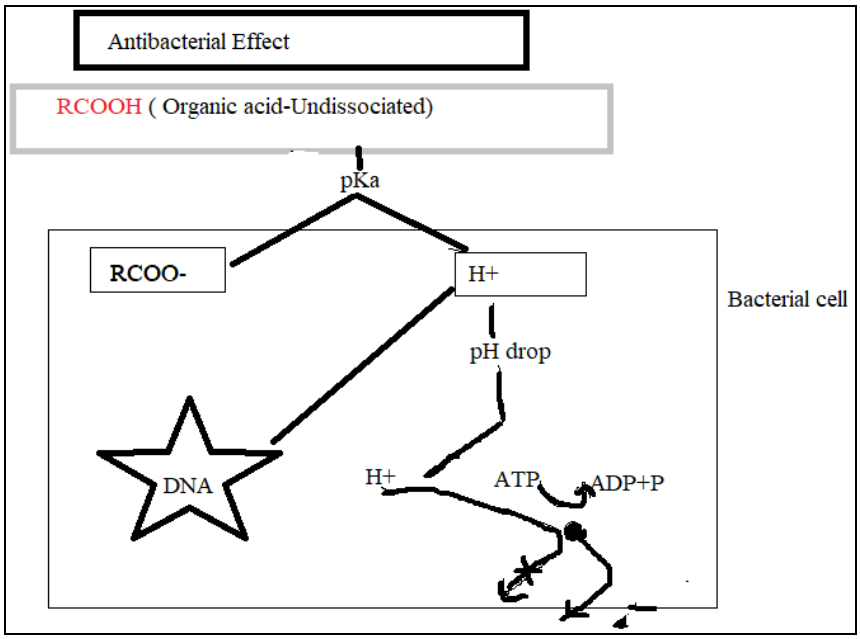

Fig 1: Antibacterial effect

8. Conclusion

The results from the cited literature showed that organic acids at different dose rate and different form have beneficial effect on poultry species like chicken, Quail, etc. OAs' increases the gastric proteolysis by enhancesing the digestibility of protein and amino.), enhancement of nutrient utilization, growth and feed conversion efficiency). They can also promote pancreatic juice secretion and modifies the gut morphometry by increasing villi height and decreasing intestinal thickness and therefore increasing the area of absorption of the nutrients which improve performance of birds by improving FCR, Body weight and Body weight gain. Due to decrease in pH in Upper part of GIT and reducing microbial competition with the host for nutrients and endogenous nitrogen losses, there is increase in nutrient absorption. Among various alternatives, organic acid considered as most promoising growth promoter which improve poultry production.

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