



Effective role of aloe Vera as a feed additive and controlling diseases in broiler chicken diets

Keshamma E¹, Sumia Fatima²

¹ Department of Biochemistry, Maharani Cluster University, Bangalore, Karnataka, India

² Dr. Rafiq Zakaria College for Women, Aurangabad, Maharashtra, India

Abstract

There has been a paradigm shift in the use of plant-derived feed additives in the diets of poultry, specifically broiler chicken, replacing the traditional use of antibiotic growth promoters (AGPs). The use of natural alternatives such as photogenic products has gained value in recent years. They also have beneficial effects as growth promoters, immunity boosters, and therapeutic agents for various diseases. Aloe vera is a renowned medicinal plant known for its industrial and therapeutic use owing to its properties such as antimicrobial, anti-inflammatory, anti-tumor, anti-oxidant, immuno-modulator, wound healing, and antiprotozoal agent. Aloe vera has been increasingly used as a natural component of broiler diets as of the last few decades. According to recent studies, Aloe vera was found to enhance the immune system and growth performance in broilers, and also serves as a good alternative to anticoccidials and AGPs. Various formulations are available for use in broiler diets, including powder, gel, aqueous and ethanolic extracts. This review provides deep insight into the effective role of Aloe vera as a feed additive and its impact on growth improvement, immunity enhancement, maintenance of microflora, and control of diseases like coccidiosis.

Keywords: aloe Vera, feed additive, controlling diseases, chicken diets

Introduction

Broiler farming aims to achieve faster growth, the higher conversion efficiency of feed, and a more livable product. A lot of broiler production depends on economics, as feed is one of the most important factors affecting productivity and profitability. Feed additives and feed supplements have been introduced to attain a higher net return and to minimize high feed expenditure ^[1].

To enhance feed conversion efficiency and increase the body size in poultry, growth promoters are added to the diet and can be divided into non-antibiotic growth promoters (NAGP) or antibiotic growth promoters (AGP). In the past, antibiotics played a significant role in growth promotion. Poultry growth and feed conversion ratio have been improved using antibiotic growth promoters. Treatment of poultry with antibiotics, on the other hand, leaves residues in poultry products and causes bacteria to develop resistance to the treatment ^[2]. Antibiotics are prohibited in many countries because they pose such a threat to human health. The use of NAGP in poultry production, on the other hand, is generally considered to be a better alternative to AGP. NAGP has a number of advantages over AGP, including the fact that they do not carry any potential risk of harmful traces in the meat or the development of bacterial resistance. A number of benefits may be derived from NAGP addition to poultry feeds, including increased gut health, improved digestion, and feed efficiency. Organic acids, prebiotics, probiotics, phytonics, enzymes, nutrition, and immune stimulators are the most common forms of NAGPs. However, phytonics are gaining more popularity ^[3].

The phytonic products come from plants or herbs and may exhibit antioxidant, antimicrobial, antiviral, antifungal, or sedative effects. Compounds present in them are known to increase palatability and stimulate the digestion of feeds since they act as bioactive agents. In addition, phytonics impact gut bacteria in a profound way. It has been shown that adding herbs to poultry products, as alternatives to antibiotics, affects the microbiome either directly or indirectly ^[4]. It has been demonstrated that herbal extracts have antimicrobial properties that can enhance the population of intestinal microflora and increase the digestive health of birds by reducing the number of pathogenic bacteria. Modified microbe populations in the intestine will also alter the morphology of the intestine. It is of great importance that poultry has a healthy digestive system to ensure that they are performing at their best and consuming a lower proportion of feed. Herbs also possess other properties such as antioxidants, antivirals, and immunomodulators that play an eminent role in body function and digestion ^[5]. Aloe vera features a great therapeutic potential. There are more than 70 biologically active compounds in Aloe vera, widely cultivated in China, Egypt, and India. Aloe vera has been found to possess antibacterial properties, antiseptic properties, anti-inflammatory properties, and immune-modulating abilities. Several studies have demonstrated Aloe vera's antioxidant and anti-cancer properties as well. Researchers have also reported that Aloe vera has antimutagenic and anti-hypersensitivity effects ^[6, 7].

Aloe vera is one of the most popular herbs due to its numerous beneficial properties. Mostly found in arid regions of Asia and Africa, this Liliaceae member looks like a cactus^[8]. Aloe vera is composed of saccharides, enzymes, anthraquinones, vitamins, and compounds of low-molecular weight that result in its unique role as an antimicrobial, antiviral, antifungal, antitumor, anti-inflammatory, wound healing, immunomodulatory, anti-diabetic agent. The polysaccharides that compose a large portion of the dry matter in Aloe vera gel may be responsible for many of its physiological benefits^[9]. Polysaccharides constitute almost 60% of the dry matter of aloe vera gel. The polysaccharide acemannan is a compound that researchers often examine since it has antimicrobial, immunomodulatory, and anticancer properties^[10].

Aloe vera leaves are primarily composed of gel in the middle. The Aloe vera gel has many beneficial properties as reported by recent studies, such as healing wounds, anti-parasitic, anti-bacterial anti-fungal, and anti-viral properties. Researchers have focused attention on the mannose polymer acemannan, a polysaccharide found in Aloe vera gel. Researchers have concluded that the healing properties, immunomodulatory properties, and antibacterial properties of Aloe vera are connected to acemannan^[10]. Researchers have found that Aloe vera gel improves the immune response of broilers when given polysaccharide (acemannan) contained in Aloe vera gel. The treatment of broilers with acemannan also improved intestinal microflora. *E. coli* counts were reduced, and lactobacillus counts increased. For reasons of preserving human health and producing healthy foods, it is imperative that AGP is not used as an additive in poultry feed^[11]. Aloe vera is a natural feed additive that has effects on broilers, which is what the article aims to showcase. There are numerous studies on Aloe vera which mostly discuss its immune responses in poultry however we will summarize its other aspects also such as its influence on growth, impact on intestinal microflora, cost of production, anti-coccidial effects, haemato-biochemical properties, etc.^[12].

Role of Aloe vera in Growth Promotion

Improved feed conversion ratio (FCR) and greater body weight are among the most important parameters to evaluate broiler production. As a result of the ban on AGP applications, broilers have been unable to attain this goal. In several research, different forms of feed additives have been examined, such as probiotics, prebiotics, herbs, and organic acids to determine whether they have a greater impact on growth than antibiotics^[13]. Experimentally, Aloe Vera gel (as feed additive) was compared with Virginiamycin (AGP). There was a significant improvement in growth after AGP (virginiamycin) was administered to the groups compared to Aloe Vera gel (at 1.5, 2, and 2.5%). There were no significant differences in body weight gain or FCR between the control group and the 2% Aloe vera gel group ($P > 0.05$)^[14]. Aloe vera leaf powder (1%), as suggested by Mmereole *et al.*, might prove to be a suitable alternative to AGP (Teramycin). As a result of feeding the birds a diet containing Aloe Vera supplement, body weight and body weight gain were significantly ($P < 0.05$) higher than for the birds given the control diet^[15]. In a study by Wang *et al.*, aloe vera extract and powder were found to improve broiler chicken performance and immunity. Treatment group results revealed higher body weights, feed conversion ratios, immunity index of spleens and natural killer cell activity as compared with the control group^[16]. According to Darabighane *et al.* Aloe vera gel treated groups demonstrated better performance and heavier dressing percentages when compared with control groups. As a result, the antibiotic group gained more weight, had a better feed conversion ratio, and had a higher dressing percentage than other groups compared to the 2% Aloe vera gel group, though their feed consumption was greater. In contrast, the increased villus height, the reduced crypt depth, and the improved villus height/crypt depth ratio demonstrated with Aloe vera gel at the 2% level suggests that Aloe vera gel can be a good alternative to virginiamycin as a supplement to broiler's diet for increasing performance^[17]. Bolu *et al.* observed that mortality, daily growth rate, and feed conversion efficiency were quite higher ($P < 0.05$) among poult provided with 30 ml/l Aloe vera gel (0.5% mortality, 17.18g/day, and 2.89) than those given a control diet. According to histological examination of the organs (breast muscles, liver, spleen, and ileum), poult exposed to 20 g/l Aloe vera gel showed normal morphological patterns while those exposed to 30 g/l Aloe vera gel showed normal morphological patterns for breast muscles, spleen and ileum however not livers. The organ morphology of birds raised with commercial antibiotics was also normal in comparison to the control birds. All the organs examined were abnormally morphologically altered in the birds which had been challenged with *E. coli* without the use of aloe gel (negative control). Various haematological parameters and metabolites of serum were analyzed, and it was determined that Aloe vera gel had no adverse effects on the health of turkey juveniles. Using 20 ml/l of Aloe vera gel in drinking water for turkey poult rearing demonstrated that antibiotics could be successfully replaced^[18]. Moonthy *et al.* reported 0.1 percent Aloe vera fed chickens produced significantly more eggs, had a better feed conversion ratio, and had a positive return over feed cost compared to other treatment groups. The feed consumed, the percentage of hens producing day-old eggs, and the percent of unbroken eggs did not differ significantly^[19]. We conclude that adding 0.1% Aloe Vera to the White Leghorn diet with turmeric and probiotics at 0.1 percent level is more economical. In an experiment conducted by Singh *et al.* in 2010 they evaluated the potential use of Aloe vera as a growth promoter in broiler chicks. They concluded that Aloe vera's effects are comparable to those of antibiotic growth promoter (AGP)^[20]. The effect of Aloe vera powder on broiler growth has been examined in several studies. In a study conducted by Mehala and Moorthy, they gave broilers curcuma and aloe vera powder, together with a mixture of these powders, and found no significant difference in body weight gain and FCR, with the exception of the first week. Furthermore, no difference in feed intake was observed. 0.75% and 1% Aloe vera gel powder were found to improve growth performance in broilers when compared to broilers in the control and 0.5% Aloe vera gel

powder groups ^[21]. In addition, broilers treated with aloe vera showed an improvement in FCR compared with the control group, although the difference was not statistically significant. A study conducted by Hassanbeigy-Lakeh *et al.* administered Aloe vera gel to broiler water (0.6, 1.2, 1.8, 2.4, and 3 ml per liter). During the experimental period, Aloe vera gel had no effect on feed intake, and the group that received 1.8 (ml per liter) Aloe vera gel showed the greatest gain in body weight and the smallest feed conversion ratio ^[15]. Additionally, Sinurat *et al.* found that fresh and dry gels of Aloe vera added to broiler feed improve feed conversion rates when compared to 0.1 and 0.25 g of dry gel ^[22]. Aloe vera, which is a natural antioxidant, was found by Eevuri and Putturu to increase body weight gain, conversion efficiency of feed, and decrease feed intake in broilers when it was supplemented in their rations ^[23].

Using Aloe vera instead of an antibiotic growth promoter (Enramycin) in the diet, Amaechi and Iheanetu evaluate the impact on the performance, carcass characteristics, and intestinal flora of broiler chicks. In the study conducted, we found that animals of the Aloe vera powder and antibiotic groups gained more weight and consumed more feed compared with those of the control group. On the other hand, there was a significant difference in feed conversion ratio between the control group and the groups treated with Aloe vera powder and antibiotic Enramycin ($P < 0.05$) ^[24, 25].

Role of Aloe vera as Immunity Booster

For poultry, improving the immune system against disease is an important factor that could help enhance consistency, growth performance, and longevity. This can be done by strengthening the immune response against infectious agents. Previous studies have demonstrated that certain herbs and mushrooms contain polysaccharides that improve the immune system ^[26, 27].

According to numerous studies, Aloe vera is immunomodulatory primarily because of its macromolecular glycoproteins and polysaccharides. Aloe vera possesses good antibacterial properties that could contribute to the growth of beneficial bacteria in the intestines of birds and their immune responses ^[26]. Accompanied by its presence of acemannan, aloe vera is believed to improve the immune system. The activation of macrophages is part of the immunoregulatory programme of acemannan. Immune cells are activated, cytokines released, IL-6, TNF, and NO are produced, and surface antigens are expressed. This acemannan of AV is responsible for activating macrophages mainly because it contains a mannose-containing acetylated mannan, which attaches to the receptors on macrophages for mannose. An extract of AV gel which has been shown to modulate DNA-damage activated signal transduction pathways could possibly reduce immunosuppression caused by UV rays and the risk of skin cancer ^[11].

Through a variety of experiments, it has been demonstrated that acemannan of AV enhances macrophage activity in the chicken. Antibodies to Newcastle disease virus (NDV) were elevated on days 24 and 38 after AV gel addition to broiler diets (1.5%, 2%, and 2.5%). The same results were obtained by using 2% AV gel with broilers fed on days 37 and 52 when mixed with drinking water (mixed with AV gel) ^[28]. Adding AV gel powder (0.5%, 0.7%, and 1%) to broiler feeds increased the titre of antibodies against NDV. According to results reported in the literature, the addition of polysaccharides (0.1% and 0.05%), acemannan (0.1% and 0.05%), and AV gel (0.1%) to broiler feeds significantly increases antibody titers. As a result of the use of Aloe secundiflora in broilers, losses have been reduced and clinical signs of NDV infections have been reduced ^[29]. In addition to the overall effect of AV on antibody titers against NDV, the researchers assessed antibody titers against sheep red blood cells (SRBC). The AV gel group, for example, showed a significant increase in antibody titer against SRBC in comparison to the control group. In comparison to a control group, it is found that broilers treated with ethanol and aqueous extracts from AV pulp for a period of three consecutive days have developed antibody titers to SRBC in comparison with the control group ^[30]. Additionally, the addition of aqueous extract of AV in feeding water and 0.5% and 1% mixes of AV leaf powder in feed as well as 15 and 30 ml/l of AV leaf powder in feed resulted in an increase in total immunoglobulin, which was previously reported in a report on antibody titers against SRBC. It is reported that AV gel supplementing birds' diet with 0.75 and 1% increased antibody responses to SRBC compared to 0.5% AV control groups. AV gel applied intermittently at 1% also contributed to a significant increase in antibody titer. The total count of white blood cells in broilers is greatly increased after the addition of AV gel to broiler feeds ^[31].

It an increase in the WBC, WBC count, and lymphocyte count was observed in broilers that were given 2% AV gel mixed with drinking water on days 37 and 52. In addition, haemoglobin, RBCs, and WBC count were higher in the 1% AV gel powder group than in the control group. Additionally, there was significant immunity against *B. avium* inactivated vaccine among the birds treated with the polysaccharides contained in AV ^[32].

Role of Aloe vera in Disease Prevention & Control

Among the most prevalent protozoal diseases in the poultry industry, coccidial infections cause raised mortality and morbidity in the infected flocks. Familie Eimeriidae, which includes various species of Eimeria, causes this disease. The most important predisposing factors for this disease in intensive poultry production are damp litter, high stock density, feed and drink contamination, and inefficient ventilation system. According to the experts, approximately three billion dollars is lost every year due to it globally ^[20].

Poultry coccidial infections pose a significant economic challenge as they negatively affect the growth efficiency and, therefore, the profitability of poultry farms. Medications and vaccinations are traditionally used to control diseases, but there are some constraints. Modern approaches are shaping towards treating various afflictions in

both humans and animals with native biomolecules extracted from medicinal plants. There are numerous immunoregulatory and immunostimulatory effects of Aloe Vera in different animal models, primarily antioxidant activities, such as enhancement of humoral immunity and phagocytic activity [33].

There is evidence that aloe polysaccharides like Acemannan can stimulate immune responses in chickens. Acemannan has been reported to prevent wound infections and accelerate wound healing (up to 70%). Furthermore, previous studies have demonstrated that the carbohydrates found in Aloe Vera (glucomannans) are important in the healing process. They decrease prostaglandin production from arachidonic acids by inhibiting the cyclooxygenase pathway [11].

In addition to increasing the production of T-lymphocytes and cytokines, Aloe Vera polysaccharides are believed to stimulate the cellular and humoral immune response, which could neutralize pathogenic organisms such as *Eimeria* species. Different dosage rates of Aloe Vera extracts significantly elevate the count of macrophage and white blood cells (WBCs) in chickens. Also, Aloe Vera polysaccharides play an important role in the protection of cells against viruses, bacteria, and tumors by increasing their activity by up to 50 percent [34, 35].

Role of Aloe vera in Improving the Gut Microflora

Creating tranquility and maintaining a stable balance of microflora in the intestine is essential. The result could be a better immune response and growth performance in poultry. After applying Aloe vera gel (1, 2, 2.5%) to broiler feeders, an increase in *Lactobacilli* and a decrease in *E.coli* were observed. *Lactobacilli* are able to grip the digestive system and compete with infectious agents for nutrients. Inhabitants of the gastro-intestinal tract find *Lactobacilli* favorable since lactic acid is created after the fermentation of acetic acid, which inhibits the growth of microorganisms. Compared to the control group that received 0.5% of Aloe vera gel with drinking water, broilers given 0.75% or 1% of Aloe vera gel tend to have a higher level of *Lactobacillus* [36]. In the presence of 4.5 mg flavophospholipol per kilogram of diet, *Lactobacilli* were significantly increased in broilers. Acemannan and polysaccharides when combined with Aloe vera gel also resulted in increased bacteria such as *Lactobacillus* and *Bifidobacterium* and a reduction of *E. coli*. Aloe vera extracts are also present in all the herbal products, polysaccharides, which prevent *E. coli* from growing and promote the growth of *Lactobacillus* and *Bifidobacteria*. However, the manner in which Aloe vera works upon intestinal microflora is not known, and its effects are only determined by its positive influence on gut microflora [37, 38].

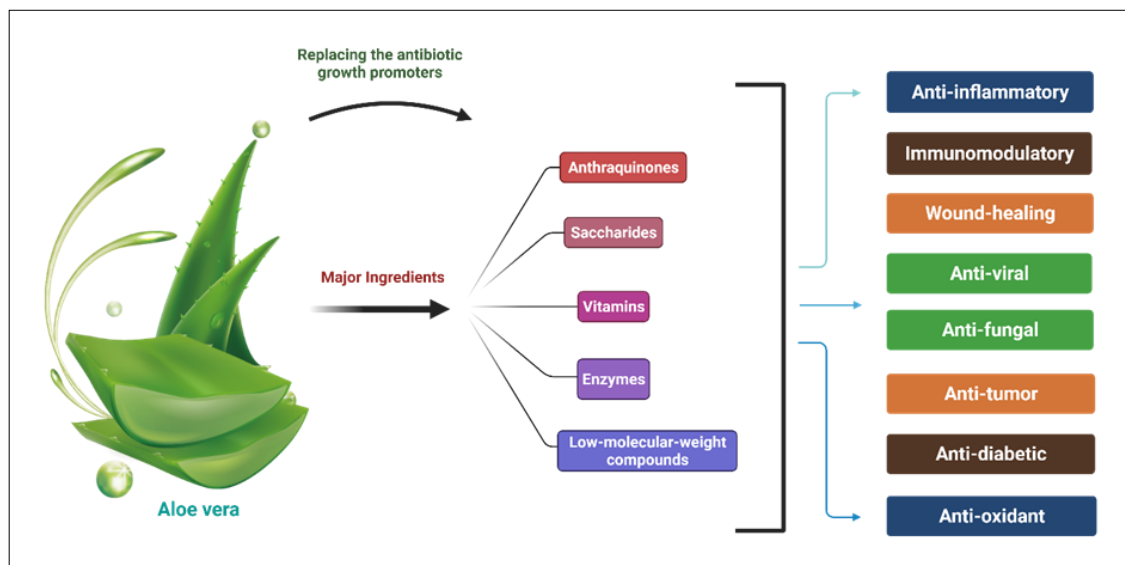


Fig 1: Graphical representation of the role of Aloe vera as a feed additive.

Conclusion

The Liliaceae family includes an important medicinal plant Aloe vera. In the form of powder or gel, it is one of the most important ingredients in poultry feed. After being mixed in water, Aloe vera is given to broilers as a feed additive in varying amounts and in different forms. In addition to antioxidant properties, aloe vera is antibacterial, antiviral, and anti-stimulatory. Anthraquinones, acemannan, and polysaccharides are some of its major constituents. The anti-inflammatory effects of aloe vera are beneficial to a variety of illnesses and serve to increase resistance to diseases such as coccidiosis, SRBC, and Newcastle disease. The bacteria's growth is positively impacted by it, as well as the immune system and intestinal flora. In broiler chicken, Aloe vera proved to be a superior alternative to antibiotics as both a growth promoter and anti-infective especially, to cope with coccidiosis.

References

1. Siegel PB. Evolution of the Modern Broiler and Feed Efficiency. <http://dx.doi.org/10.1146/annurev-animal-022513-114132>,2014;2:375-385.

2. Mottet A, Tempio G. Global poultry production: current state and future outlook and challenges. *Worlds. Poult. Sci. J*,2017;73:245-256.
3. Rocchi L, Paolotti L, Rosati A, Boggia A, Castellini C. Assessing the sustainability of different poultry production systems: A multicriteria approach. *J. Clean. Prod*,2019;211:103-114.
4. Yang C, Chowdhury MAK, Hou Y, Gong J. Phytogetic Compounds as Alternatives to In-Feed Antibiotics: Potentials and Challenges in Application. *Pathog*,2015;4:137-156.
5. Oladeji IS, Adegbenro, Muyiwa Osho IB, Olarotimi OJ. The Efficacy of Phytogetic Feed Additives in Poultry Production: A Review. *Turkish J. Agric. - Food Sci. Technol*,2019;7:2038-2041.
6. Maan AA. The therapeutic properties and applications of Aloe vera: A review. *J. Herb. Med*,2018;12:1-10.
7. Singh P, Babu S, Raksha B, Pooja S. Babu Bioactive, S. Compounds and Medicinal Properties of Aloe Vera L.: An Update. *An Updat. Artic. J. Plant Sci*,2014;2:102-107.
8. Jadhav AS, Patil OA, Kadam SV, Bhutkar MA. Review on Aloe Vera is used in Medicinal Plant. *Asian J. Res. Pharm. Sci*,2020;10:26.
9. Tiwari M, Upadhayay M. The medicinal plant components and applications (Aloe vera). ~ 89 ~ *J. Med. Plants Stud*,2018;6:89-95.
10. Manvitha K, Bidya B, Karkala Manvitha C. Aloe vera: a wonder plant its history, cultivation and medicinal uses. ~ 85 ~ *J. Pharmacogn. Phytochem*,2014;2:85-88.
11. Sierra-García GD, Castro-Ríos R, González-Horta A, Lara-Arias J, Chávez-Montes A. Acemannan, an Extracted Polysaccharide from Aloe vera: A Literature Review: <https://doi.org/10.1177/1934578X1400900836>,2014;9:1217-1221.
12. Gao Y, Kuok KI, Jin Y, Wang R. Biomedical applications of Aloe vera. <https://doi.org/10.1080/10408398.2018.1496320>,2018;59:S244-S256.
13. Jalal H. Role of Aloe Vera as A Natural Feed Additive in Broiler Production. *Turkish J. Agric. - Food Sci. Technol*,2019;7:163-166.
14. Hartady T, Syamsunarno MRAA, Priosoeryanto BP, Jasni S, Balia RL. Review of herbal medicine works in the avian species. *Vet. World*,2021;14:2889.
15. Zayed R. Effects of aqueous extract of Aloe vera leaves on performance, hematological and cecal histological parameters in commercial broiler chickens. *Damanhour J. Vet. Sci*,2020;5:4-10.
16. Wang Y. A green method of preparing a natural and degradable wound dressing containing aloe vera as an active ingredient. *Compos. Part B Eng*,2021;222:109047.
17. Darabighane B. Effect of Aloe vera and vitamin E supplementation on the immune response of broilers. *Rev. Colomb. Ciencias Pecu*,2017;30:159-164.
18. Bolu SA. Effects of aloe vera leaf extract on growth, clinical chemistry and histology of selected organs in Turkey poult challenged with *Escherichia coli*. *Anim. Nutr. Feed Technol*,2015;15:21-29.
19. Moorthy M, Mehala C, Saravanan S, Edwin SC. Aloe vera in White Leghorn Layer Diet. *Int. J. Poult. Sci*,2009;8:706-709.
20. Kumar R, Singh AK, Gupta A, Bishayee A. & Pandey, A. K. Therapeutic potential of Aloe vera—A miracle gift of nature. *Phytomedicine*,2019;60:152996.
21. Mehala C, Moorthy M. Effect of Aloe vera and Curcuma longa (Turmeric) on Carcass Characteristics and Biochemical Parameters of Broilers. *Int. J. Poult. Sci*,2008;7:857-861.
22. Ebrahim AA, Elnesr SS, Abdel-Mageed MAA, Aly MMM. Nutritional significance of aloe vera (*Aloe barbadensis* Miller) and its beneficial impact on poultry. <https://doi.org/10.1080/00439339.2020.1830010>,2020;76:803-814.
23. Eevuri TR, Putturu R. Use of certain herbal preparations in broiler feeds - a review. *Vet. World*,2013;6:172-179.
24. Mmereole FUC. Evaluation of the dietary inclusion of Aloe Vera as an alternative to antibiotic growth promoter in broiler production. *Pakistan J. Nutr*,2011;10:1-5.
25. Mohamed SM, El-Eraky WA, Al- Gamal MF. Effects of feeding Aloe Vera Leaves Powder on Performance, Carcass and Immune Traits of Broiler Chickens. *Zagazig Vet. J*,2017;45:72-78.
26. He X. Advances in antiviral polysaccharides derived from edible and medicinal plants and mushrooms. *Carbohydr. Polym*,2020;229:115548.
27. Guo FC, Savelkoul HFJ, Kwakkel RP, Williams BA, Verstegen MWA. Immunoactive, medicinal properties of mushroom and herb polysaccharides and their potential use in chicken diets. *Worlds. Poult. Sci. J*,2003;59:427-440.
28. Shahid RA. Amelioration of pathological effects of Newcastle disease by Aloe vera. *Pure Appl. Biol*, 2020, 9.
29. Raza A. Antiviral and immune boosting activities of different medicinal plants against Newcastle disease virus in poultry. *Worlds. Poult. Sci. J*,2015;71:523-532.
30. Darabighane B, Nahashon SNA. review on effects of Aloe vera As A feed Additive in broiler chicken diets. *Anim. Sci*,2014;14:491-500.
31. Naghi Shokri A, Ghasemi HA, Taherpour K. Evaluation of Aloe vera and synbiotic as antibiotic growth promoter substitutions on performance, gut morphology, immune responses and blood constituents of broiler chickens. *Anim. Sci. J*,2017;88:306-313.

32. Akram MZ. Evaluation of dietary supplementation of Aloe vera as an alternative to antibiotic growth promoters in broiler production. *Turkish J. Vet. Res*,2019;3:21-26.
33. Akhtar M. Immunostimulatory and protective effects of Aloe vera against coccidiosis in industrial broiler chickens. *Vet. Parasitol*,2012;186:170-177.
34. Khaliq K, Akhtar M, Awais MM, Anwar MI. Evaluation of Immunotherapeutic Effects of Aloe vera Polysaccharides Against Coccidiosis in Chicken,2017;23:895-901.
35. Darabighane B, Zarei A, Shahneh AZ. The effects of different levels of Aloe vera gel on ileum microflora population and immune response in broilers: a comparison to antibiotic effects. <http://www.tandfonline.com/action/journalInformation?show=aimsScope&journalCode=taar20#.VsXoziCLRhE>,2011;40:31-36.
36. Yadav DC, Bidhan DS, Sharma V, Sahu S. Effect of Aloe Vera (Aloe barbadensis) Supplementation on Production Indices, Mortality and Cost of Production of Broiler Chicken. *J. Anim. Res*,2011;7:107.
37. Quezada MP, Salinas C, Gotteland M, Cardemil L. Acemannan and Fructans from Aloe vera (Aloe barbadensis Miller) Plants as Novel Prebiotics. *J. Agric. Food Chem*,2017;65:10029-10039.
38. Liu C. Extraction, Purification, Structural Characteristics, Biological Activities and Pharmacological Applications of Acemannan, a Polysaccharide from Aloe vera: A Review. *Mol*,2019;24:1554.