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A REVIEW ON EFFECTS OF ALOE VERA AS A FEED ADDITIVE IN BROILER CHICKEN DIETS

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Abstract

Prohibition of application of antibiotic growth promoters in broiler chicken diets has resulted in increased use of herbs as natural additives in broiler feeds over the recent years. Researchers particularly look for herbs that can affect such parameters as growth performance, immune response, or treatment of certain diseases. Aloe vera is a well-known herb characterized by properties such as anti-bacterial, anti-viral, anti-fungal, anti-tumor, anti-inflammatory, immunomodulatory, wound-healing, anti-oxidant, and anti-diabetic effects. During the past years, attention has shifted toward Aloe vera as a natural additive to broiler diets, and studies have shown that Aloe vera can improve immune response and growth performance in broilers. In addition, Aloe vera is an excellent alternative for antibiotic growth promoters and anticoccidial drugs. Since Aloe vera can be used for broilers in the form of gel, powder, ethanolic extract, aqueous extract, and a polysaccharide contained in Aloe vera gel (i.e. acemannan), more studies are required to determine the best form and to compare Aloe vera with other medicinal herbs. This paper reviews effects of Aloe vera on intestinal microflora, growth performance, immune response, and coccidiosis in broiler chickens.

Key words: broiler chicken, Aloe vera, microflora, immune system, growth performance, coccidiosis

As a result of the recent ban on the use of antibiotic growth promoters (AGP) in animal feeds, due to concerns about the presence of these substances in animal products and probable bacterial resistance in animals and human body, more studies now look for alternatives for antibiotics in order to eliminate their impact on animals (Yang et al., 2009). Given the significance of healthy animal food as well as human health, a broader range of research is dedicated to replace AGP with other additives, especially probiotics, prebiotics, enzymes, organic acids, and herbs (Verstegen and Williams, 2002). Medicinal herbs, as a new class of additives to animal and poultry feeds, have beneficial properties such as anti-oxidant, anti-microbial, and anti-fungal (Hardy, 2002) as well as immunomodulatory and anticoccidial effects, which lead to

increased use of herbs. Furthermore, many countries around the world, with plenty resources of different kinds of medicinal herbs, can use these herbs as natural feed additives for animals and poultry. The emphasis here is on those herbs that, when used to supplement feeds, are helpful in achieving a larger number of objectives (improving growth performance, improving immunity response, improving intestinal microflora, and controlling particular diseases); in other words the focus is on multifunctional herbs. A well-known herb that has received particular attention from researchers is Aloe vera (*Aloe barbadensis* Miller), known as one of the oldest herbs with a history that dates back to traditional medicine thousands years ago (Christaki and Florou-Paneri, 2010). Aloe vera is found in tropical and sub-tropical climates (Boudreau and Beland, 2006), and many countries have proper geographic features required for growing Aloe vera. The most important part of Aloe vera is its leaf which is composed of two main sections: latex and gel (Boudreau and Beland, 2006). The gel contained in Aloe vera leaves is composed of about 98.5% to 99.5% water (Femenia et al., 1999), and the remaining dry matter contains more than 75 biologically active ingredients (Boudreau and Beland, 2006) which have medicinal effects that are useful in treating diseases. Major ingredients of Aloe vera include anthraquinones, saccharides, vitamins, enzymes, and low-molecular-weight compounds (Choi and Chung, 2003) which give Aloe vera its anti-inflammatory, immunomodulatory, wound-healing, anti-viral, anti-fungal, anti-tumor, anti-diabetic, and anti-oxidant effects (Christaki and Florou-Paneri, 2010). Numerous studies suggest that many benefits of Aloe vera are attributable to polysaccharides contained in Aloe vera gel, which compose a large part of dry matter in this gel (Hamman, 2008). In other words, almost 60% of dry matter of Aloe vera gel is composed of polysaccharides (McAnalley, 1989). A compound often analyzed by researchers is the polysaccharide acemannan which has immunomodulatory, anti-microbial, and anti-tumor effects (Choi and Chung, 2003).

A review of literature on the history of Aloe vera uses indicates that application of Aloe vera dates back to distant past when it was used in traditional medicine (Christaki and Florou-Paneri, 2010; Ahlawat and Khatkar, 2011), and currently many countries use Aloe vera in manufacturing drugs, cosmetics, and food for human consumption (Eshun and He, 2004). Furthermore, farmers use Aloe vera to control and treat poultry diseases in rural areas (Mwale et al., 2005), and recently, it has also gained attention in poultry farming industry, particularly in farming broilers. Since it is extremely important to avoid using AGP in poultry feed for the purpose of producing healthy foods and maintaining human health, the present paper aims to review effects of Aloe vera as a natural feed additive on broilers. Although a broad range of studies on Aloe vera mainly suggests its effects on immune response in poultry, we will also review other effects of Aloe vera, such as impacts on intestinal microflora, growth performance, and anticoccidial effects in broilers, as discovered by other studies in this area.

Effects on intestinal microflora

Balance of intestinal microflora in broilers is an important factor contributing to improved growth performance and immune response, and anti-bacterial compounds,

like herbs, play a significant role in balancing and improving intestinal microflora in chickens. Numerous studies have reported anti-bacterial effects of Aloe vera gel (Kwon et al., 2011; He et al., 2011; Pandey and Mishra, 2010; Mbanga et al., 2010; Alemdar and Agaoglu, 2009; Agarry et al., 2005). Few experiments have been carried out on the impacts of Aloe vera on intestinal microflora in broilers. The studies, however, indicate that Aloe vera can improve intestinal microflora and its ecosystem in broilers' intestines; increase in Aloe vera gel in broiler feeds (1.5%, 2%, and 2.5%) leads to increased *Lactobacillus* count and decreased *E. coli* count (Darabighane et al., 2012). In addition, Jiang et al. (2005) reported an increase in *Lactobacillus* count and *Bifidobacteria* count as well as a reduction in *E. coli* count when acemannan (0.1% and 0.05%), polysaccharide (0.1%), and Aloe vera gel (0.1%) were added to broiler feed. In the same vein, Dai et al. (2007) found that herbs and polysaccharide contained in Aloe vera can reduce *E. coli* count while increasing the number of *Lactobacillus* and *Bifidobacteria*. Although the exact mechanism through which Aloe vera affects intestinal microflora in broilers is unknown, it is likely that this effect is similar to the anti-bacterial effects of some herbs and mushrooms that improve intestinal microflora. On the other hand, it is also likely that the polysaccharide contained in Aloe vera (acemannan) follows a mechanism like that of prebiotics since studies found prebiotic-like impacts of polysaccharides contained in medicinal herbs and mushrooms (Guo et al., 2003, 2004 b). Other researchers attribute anti-bacterial effects of Aloe vera to its fumaric acid content (He et al., 2011).

Effects on immune response

Improved or reinforced immune response in poultry creates resistance against diseases, and health of a flock, which can be the result of preparedness of immune system against pathogenic agents, is an important factor in improving homogeneity, long life, and growth performance of birds. Therefore, greater emphasis has been placed by researchers on improving immune response. Previous studies show that the polysaccharides contained in medicinal herbs and mushrooms can improve the response of immune system (Guo et al., 2004 a). An important property of Aloe vera that has been the subject of many *in vivo* and *in vitro* experiments is improvement in immune response, probably due to the acemannan contained in Aloe vera (Harlev et al., 2012; Djeraba and Quere, 2000; Zhang and Tizard, 1996; Karaca et al., 1995). Acemannan contained in Aloe vera gel is a β (1-4)-linked acetylated mannan containing mannose that can attach to mannose receptors in macrophages (Karaca et al., 1995) and activate these macrophages. In addition, acemannan can stimulate production of cytokines, release of nitric oxide (Zhang and Tizard, 1996; Karaca et al., 1995). Experiments on chickens suggest promoted macrophage activities in broilers caused by the acemannan contained in Aloe vera (Djeraba and Quere, 2000; Karaca et al., 1995).

In a study on Aloe vera effects on humoral immunity of broilers, Darabighane et al. (2012) reported an increase in antibody titer against Newcastle disease virus (NDV) on days 24 and 38 by adding Aloe vera gel to broiler feeds (at 1.5%, 2%, and 2.5%). These findings are consistent with those of Valle-Paraso et al. (2005) who reported that broilers treated with 2% Aloe vera gel (mixed with their drinking

water) showed significant increase in antibody titer against NDV on days 37 and 52, compared to the control group. In another study, Alemi et al. (2012) added Aloe vera gel powder (at 0.5%, 0.75%, and 1%) to broiler feeds and reported an increase in antibody titer against NDV. Moreover, another study reported an improvement in antibody titer in broilers against NDV as a result of adding acemannan (0.1% and 0.05%), polysaccharide (0.1%), and Aloe vera gel (0.1%) to broiler feed (Jiang et al., 2005). Yet, another study reported reduced loss and clinical symptoms, in infections by NDV, as a result of using *Aloe secundiflora* in broilers (Waihenya et al., 2002).

In addition to Aloe vera effects on antibody titer against NDV, researchers have investigated antibody titer against sheep red blood cells (SRBC). For instance, Darabighane et al. (2012) observed an increase in antibody titer against SRBC in broilers treated with Aloe vera gel, compared to the control group, and Akhtar et al. (2012) reported that ethanol and aqueous extracts of Aloe vera pulp orally administered at 300 mg/kg body weight/day for three consecutive days to broilers increased antibody titer against SRBC compared to the control group. In a study on antibody titer against SRBC, Besharatian et al. (2012) reported an increase in total immunoglobulin of 35-day-old broilers that received Aloe vera leaf powder (0.5% and 1% mixed with feed) and aqueous extract of Aloe vera leaf (15 and 30 ml/l, added to drinking water). Another study on the effects of Aloe vera gel powder (mixed with feed) on antibody titer against SRBC found a significant increase in antibody titer for the groups treated with 0.75% and 1% Aloe vera gel powder compared to the control group and the group receiving 0.5% Aloe vera gel powder (Mahdavi et al., 2012). Furthermore, Shokraneh et al. (2012) reported an increase in antibody titer against SRBC in broilers as a result of continuous increase in Aloe vera gel in drinking water at 0.5%, 0.75%, and 1% as well as in intermittent application of Aloe vera gel at 1% (using Aloe vera for 5 days and stopping the application for 9 days); the group that continuously received 1% Aloe vera gel added to drinking water had the highest level of antibody titer.

The findings of Besharatian et al. (2012), Akhtar et al. (2012), and Darabighane et al. (2012) in connection to effects of Aloe vera on cellular immunity after PHA-P injection indicate improved cellular immune response in broilers that received Aloe vera: Aloe vera leaf powder (0.5% and 1%) and aqueous extract of Aloe vera leaf (15 and 30 ml/l) (Besharatian et al., 2012), ethanolic extract of Aloe vera pulp (300 mg/kg body weight/day for three consecutive days) (Akhtar et al., 2012), and 2.5% Aloe vera gel (Darabighane et al., 2012) showed the best performance compared to other groups. Therefore, Aloe vera can affect humoral and cellular immunity as evidenced by those studies that examined Aloe vera effects on immune response of broilers.

On the other hand, assessment of blood parameters showed an increase in total white blood cell and lymphocyte counts on days 37 and 52 for broilers that received 2% Aloe vera gel (mixed with drinking water) compared to the control group (Valle-Paraso et al., 2005). In addition, Darabighane et al. (2011 a) reported an increase in total white blood cell count of broilers as a result of adding Aloe vera gel to broiler feeds. In another study that used Aloe vera gel powder in broiler feeds, a significant increase was observed in total white blood cell count, red blood cell count, and hemoglobin in groups treated with Aloe vera gel powder compared to the control

group, with the 1% Aloe vera gel powder group showing the highest hemoglobin, red blood cell, and white blood cell count (Mahdavi et al., 2012).

In examining the effects of Aloe vera on lymphoid organs, researchers reported relative weight gain in these organs of broilers (Darabighane et al., 2012; Akhtar et al., 2012; Feng et al., 2011; Jiang et al., 2005). Besharatian et al. (2012) did not observe a significant difference in weight of lymphoid organs, but reported a weight gain in spleen and bursa. Such relative increase in the weight of lymphoid organs as a result of adding Aloe vera to feed or drinking water suggests immune (humoral and cellular) system readiness against antigens.

Furthermore, it has been reported that adding acemannan to NDV vaccine resulted in a significant increase in antibody titer against NDV 21 days after injection, compared to broilers that were injected vaccines that did not contain acemannan, while adding acemannan to infectious bursal disease virus vaccine had no effect on improving antibody titer 21 days after injection, although on days 28 and 35 a significant difference was observed in antibody titer (Chinnah et al., 1992). In addition, the polysaccharides contained in Aloe vera can improve immune system response in chickens that received *B. avium* inactivated vaccine (Sun et al., 2011). Moreover, it has been reported that adding Aloe vera and beta-glucan led to stimulation of humoral and cellular immune response in dogs after vaccination (Altuğ et al., 2010).

Many studies have examined immunomodulatory effects of Aloe vera and many researchers have attributed these effects on humoral and cellular immune response to acemannan (Tizard and Ni, 1998). However, one should also take into account indirect immunomodulatory effect resulting from intestinal microflora since Aloe vera can reduce the number of pathogens in intestines, thereby improving immune response and body resistance.

Effects on growth performance

Greater body weight and better feed conversion ratio (FCR) are among important economic goals in broiler farming. The bans on application of AGP have affected this goal, resulting in poor growth performance of broilers. Many studies have examined potential effects of feed additives, like prebiotics, probiotics, organic acids, and herbs, on growth performance compared to those of antibiotics. An experiment for comparing the effects of Aloe vera gel (mixed with feed) and AGP (virginiamycin) indicated that AGP (virginiamycin) resulted in better growth performance compared to the performance of groups that received Aloe vera gel (at 1.5%, 2%, and 2.5%), and the control group while no significant difference was observed between the antibiotic group and the 2% Aloe vera gel group in terms of body weight gain and FCR (Darabighane et al., 2011 b). In the same vein, Mmereole (2011) proposed that Aloe vera leaf powder (1%) can be used as a proper alternative for AGP (Teramycin).

Several studies have been conducted to examine the effects of Aloe vera powder on growth performance of broilers. Mehala and Moorthy (2008) fed broilers with Aloe vera powder (0.1% and 0.2%) and Curcuma longa powder (0.1% and 0.2%) and a mixture of these two powders, and reported no significant difference in body weight gain and FCR, except for the first week of treatment. In addition, no difference was observed in terms of feed intake. However, Alemi et al. (2012) reported

a better growth performance in broilers treated with 0.75% and 1% Aloe vera gel powder compared to the 0.5% Aloe vera gel powder group and the control group.

Olupona et al. (2010) supplemented broiler drinking water with Aloe vera and reported an increase in final body weight, weekly body weight gain, and average feed intake in the groups that received Aloe vera (at 15, 20, 25, 25, and 30 cm^3/dm^3). In addition, improvement in FCR was observed for broilers treated with Aloe vera compared to the control group, but the difference was not significant. Hassanbeigy-Lakeh et al. (2012) supplemented broiler drinking water with Aloe vera gel (0.6, 1.2, 1.8, 2.4, and 3 ml per liter) and found that Aloe vera gel had no effect on feed intake over the total experiment period, and that the largest body weight gain and the smallest FCR was observed in the 1.8 (ml per liter) Aloe vera gel group. On the other hand, Sinurat et al. (2002) examined Aloe vera gel and whole leaf added to broiler feed in both dry and fresh forms and found that adding fresh gel (0.25 g/kg) and dry gel (0.25 and 0.1 g/kg) improves FCR.

Since coccidiosis may compromise growth performance, researchers have examined potential effects of Aloe vera on improving growth performance in broilers with coccidiosis and found that Aloe vera powder (0.1%, 0.3%, and 0.5%) added to the feed of these broilers does not lead to significant difference in terms of body weight gain (Yim et al., 2011). Darabighane and Zarei (2011) showed that adding 1.5%, 2%, and 2.5% Aloe vera gel to the feed of broilers with coccidiosis improved FCR for these broilers compared to the control group.

Findings on the effects of Aloe vera on growth performance are inconsistent and these discrepancies can be attributed to the form of supplement (leaf powder, gel powder, or fresh gel), dosage, or whether Aloe vera is added to feed or drinking water. However, particular attention must be paid to anti-bacterial activities and improvement in immune response as these two factors may contribute to better growth performance in broilers (Yang et al., 2009), and previous studies confirm these two properties (anti-bacterial effect and improvement in immune response) for Aloe vera. In fact, anti-bacterial properties of Aloe vera improve intestinal microflora and reduce pathogens, thereby changing intestinal morphology and improving growth performance. On the other hand, by improving immune response in broilers and increasing body resistance, Aloe vera indirectly affects growth performance.

Effects on coccidiosis

Coccidiosis is one of the costliest and the most common diseases in poultry farming industry with detrimental impacts on growth performance. An excellent way to control coccidiosis is to use anticoccidial drugs. However, high treatment costs and heightened resistance against these drugs have shifted attentions toward herbs for controlling the disease. Application of Aloe vera for treatment of poultry diseases is not limited to large-scale farming (industrial applications); for example, different species of Aloe can be found in Zimbabwe, and in Mushagash, smallholder farmers use Aloe vera and Aloe spicata to treat broilers with coccidiosis (Mwale et al., 2005). In an *in vitro* experiment to compare the effects of Aloe vera and Aloe spicata on inhibition of the sporulation of avian coccidia oocysts, Mwale et al. (2006) reported

that increase in Aloe vera and Aloe spicata content significantly decreases coccidia oocyst count.

Yim et al. (2011) reported that broilers that received Aloe vera powder (0.1%, 0.3%, and 0.5%) had smaller fecal oocyst shedding count compared to infected group fed with the standard diet. In addition, Akhtar et al. (2012) found in their studies that fecal oocyst shedding in broilers orally administered with ethanol and aqueous extracts of Aloe vera pulp at 300 mg/kg body weight/day for three consecutive days was significantly lower compared to the infected control group. Moreover, broilers that received aqueous extract of Aloe vera pulp had the lowest mean score lesion in caeca and intestine in comparison to the control group and the group that received ethanol extract of Aloe vera pulp. Also Darabighane and Zarei (2011) reported that broilers receiving 2.5% Aloe vera gel added to their feed had the smallest fecal oocyst shedding among all groups.

Since Aloe vera positively affects immune response and previous studies well established the role of immune system in treatment of coccidiosis in poultry, the anticoccidial effects of Aloe vera are attributable to stimulation of immune system. Akhtar et al. (2012) attributed anticoccidial effects of Aloe vera to production of antibody against coccidiosis, which probably reduces the number of fecal egg and increases weight gain. Yim et al. (2011) argued that through cellular mediated response, Aloe vera can provide a more favorable effect compared to antibody response.

In general, and based on the findings of the previous studies, Aloe vera is regarded as a proper alternative for treating coccidiosis in a more economical way.

Conclusion

Aloe vera, as an additive to broiler chicken feed, has great potentials for improving intestinal health, immune system response, and growth performance. It can also be used in controlling coccidiosis. Advantages of Aloe vera added to broiler feeds depend on several factors: form of use (powder, gel, extract (ethanolic or aqueous), polysaccharide extracted from gel), dosage, genetics of broilers, ingredients of diet, and farm management. Therefore, more studies are required to determine effective dosage and form of use.

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