Scientific Research Publishing

Open Journal of Animal Sciences, 2022, 12, 200-209
https://www.scirp.org/journal/ojas
ISSN Online: 2161-7627
ISSN Print: 2161-7597

Research Advance on Application of Microbial Fermented Fodder in Broilers Production: A Short Review

Yihai Chang[1,2,3], Saeed Hamid Saeed Omer[1,2], Gaoqiang Li[1,2,3], Haoshuai Lian[1,2,3], Yongli Liu[1,2,3]

[1]Henan Baiyian Biological Engineering Co., Ltd., Zhengzhou, China
[2]Jiaozuo Baiyian Biological Engineering Co., Ltd., Jiaozuo, China
[3]Feed Alternative Antibiotics Engineering Technology Research Center of Jiaozuo City, Jiaozuo, China
Email: saeed2014shs@yahoo.com

How to cite this paper: Chang, Y.H., Omer, S.H.S., Li, G.Q., Lian, H.S. and Liu, Y.L. (2022) Research Advance on Application of Microbial Fermented Fodder in Broilers Production: A Short Review. *Open Journal of Animal Sciences*, **12**, 200-209.
https://doi.org/10.4236/ojas.2022.122015

Received: December 27, 2021
Accepted: March 19, 2022
Published: March 22, 2022

Abstract

Recently, interest in animal production and poultry production in particular has increased, because poultry meat and eggs and their products are more widely consumed than other products. Human health is also considered one of the priorities. Nowadays, the fermentation industry has become very popular due to its great benefits in the pharmaceutical industry, the improvement of foodstuffs and the animal feed industry and its improvement. Moreover, microbial fermentation can enhance the content and digestibility of nutrients in nontraditional diets while decreasing the quantity of crude fiber and anti-nutritional elements such as tannins. The functional components (organic acids, bioactive peptides, lactic acid bacteria) found in microbial fermented feed can increase meat production in cattle, pigs, and sheep, and broiler productivity, carcass quality, intestinal health, immunological function, and so on. This paper examines the application study of microbial fermented feed in broiler production and serves as a resource for microbial fermented feed promotion and use in broiler production.

Keywords

Fermented Feed, Microbial Fermented, Broilers Production

1. Introduction

Microbial fermentation has the potential to increase crude protein content in feed while decreasing crude fiber, anti-nutritional factor (ANF), and toxic and hazardous substances [1] [2] [3]. A large number of lactic acid bacteria and organic acids contained in microbial fermentation feeds [4] can protect feeds from

contamination by pathogenic microorganisms [5]. Besides, the use of fermented feed in feeding broilers, it is also widely used in the production of pigs and ruminants [6] [7]. Moreover, feeding microbial fermented feed can protect the intestinal health of broilers [7] and promote the growth of broilers as well as increase relative weight, villi, and the length of the small intestine [8] [9] [10]. This review of the progress in research of the use of microbial fermented feed in the production of broilers, the application research progress of fermented feed in broiler production is expected to provide a reference for the promotion and application of microbial fermented feed in broiler production [11].

2. Features of Fermented Feed

Fermentation has the potential to improve the microbial composition and nutritional properties of feed [1] [12] [13] [14]. Researchers reported that the organic acid content of fermented corn seeds increased, the pH value dropped from 5.5 to 4.2, the number of lactose-negative enterobacteria, yeasts, and molds decreased significantly, and lactic acid bacteria increased [5] [15] [16]. **Table 1** shows the pH value, microorganism and organic acid composition of non-fermented feed, fermented dry feed, and fermented liquid feed. Feed can protect the gastrointestinal function and health of broilers [1] [3] [17]. In a study, it was proven that unsoaked corn seeds reduce mycotoxins during the fermentation process [18]. On the other hand, researchers reported that zearalenone was reduced under solid-state fermentation conditions [19]. Some studies have shown that the microorganisms involved in fermentation play a key role in the degradation or conversion of mycotoxins into non-toxic compounds. Feed metabolites such as organic acids and bacteriocins, can inhibit the growth of bacteria, molds, and fungi during feed storage, thereby prolonging the shelf life of feeds [20] [21]. Acetic acid and biogenic amines (cadaverine, putrescine, histamine) contained in the fermented feed will affect the palatability of the feed [14]. Studies have shown

Table 1. The pH value, microorganism and organic acid composition of non-fermented feed, fermented dry feed and fermented liquid feed.

index	Non-fermented feed	Fermented dry feed	Fermented liquid feed
pH value	-	3.85	4.45
Lactic acid bacteria/(lgCFU/g)	4.3	9.4	9.6
Yeast/(lgCFU/g)	<3.0	8.0	7.2
Enterobacter/(lgCFU/g)	5.4	<3.0	<3.5
Acetic acid/(mmol/kg)	10	15	24
Total short-chain fatty acids/(mmol/kg)	5.8	NM	38.4
Lactic acid/(mmol/kg)	8	50	160

Note: NM means not determined.

that fermentation can damage certain nutrients in the feed, such as the degradation of free lysine, which will have a negative impact on animal performance [22]. However, improving fermentation conditions (adding organic acids, lactic acid bacteria, enzymes) can speed up the fermentation process and improve the nutritional value and palatability of the final fermented product [14]. Generally, the single feed material is subjected to microbial fermentation [23].

3. Application of Microbial Fermented Feed in Broiler Production

3.1. The Effect of Microbial Fermented Feed on Broiler Performance

Feeds such as wheat, soybeans, barley, and rapeseed meal contain large amounts of non-starch polysaccharides (NSP), but poultry lack endogenous NSP hydrolase. The soluble NSP in the feed will increase the digestive viscosity of the small intestine of broilers and reduce the digestibility of nutrients [24]. 18.7% - 23.5% of NSP in rapeseed meal, adding complex enzymes (glucanase, xylanase and pectinase) when fermenting rapeseed meal can reduce the total amount of NSP by 31% - 42% [25]. Researchers conducted an experiment to study the effects of replacing soybean meal with fermented soybean with Aspergillus oryzae on digestive enzyme activity of broiler chickens in a 45-day diet. The results showed that the fermented soybean meal increased the activity of protazo enzymes trypsin and lipase in the intestines of broilers [26]. On the other hand, with the same period month and a half, the effect of wet and fermented feed on the intestinal tissue and the shape of 360 chicks was also studied for the purpose of fattening while providing all the necessary needs. The results were showen that the feeds that contain fermented feed had a positive effect [27] [28].

Researchers have confirmed that feeding fermented small or barley can significantly increase the weight gain and slaughter rate of 42-day broilers [29]. Furthermore, some research has shown that adding 1% Lactobacillus, Bacillus fermented barley, or wheat to the Ross 308 broiler diet can significantly improve broiler growth performance [30]. On the other hand, researchers found that replacing 0%, 5%, 10%, and 15% of soybean meal in the AA broiler diet with fermented rapeseed meal n growth performance, serum biochemistry variable and intestinal morphology of broilers. The results showed that the body weight gain was less for birds fed fermented feed by 15% [31]. However, it has been proven that adding 5% lactobacillus, *Bacillus natto*, *Aspergillus niger* solid-state fermented corn gluten meal to the diet of yellow feather broilers can significantly increase the daily feed intake and daily gain of broilers and reduce the feed-to-weight ratio [32]. Besides the partial substitution of soybean meal in the fermented feed industry[33], Aljubori *et al.* found that in the 0 - 28 d Cobb 500 broiler diet, 10% Lactobacillus salivarius solid-fermented rapeseed meal was used to replace soybean meal in the same amount, and 30% fermented rapeseed was used in the 29 - 35 d diet [34].

Aljubori *et al.* found that in the 0 - 28 d Cobb 500 broiler diet, 10% Lactobacillus salivarius solid-fermented rapeseed meal was used to replace soybean meal in the same amount, and 30% fermented rapeseed was used in the 29 - 35 d diet. The same amount of meal instead of soybean meal does not affect the daily gain and feed-to-weight ratio of broilers [34]. Shayerizadeha *et al.* found that using *Lactobacillus acidophilus*, *Bacillus subtilis*, and *Aspergillus niger* solid-state fermented rapeseed meal instead of 50% soybean meal in the Cobb 500 broiler diet can significantly improve the daily gain and feed-to-weight ratio of broilers [35] [36]. Furthermore, replacing corn with 5% - 15% fermented banana peel in the diet of Roman broilers had no effect on the growth performance of the broilers [37]. Microbial fermentation improves feed nutritional indicators as well as feed palatability [38]. Microbial fermentation improves feed nutritional indicators as well as feed palatability [38]. Fermented feed improves the digestion and absorption of nutrients by increasing the villus height of the duodenum and jejunum of broilers and the ratio of villus height to crypt depth (VH:CD) [6] [39] [40]. Fermented feed could improve the environment of the gastrointestinal tract of broilers, such as lowering the pH value, the activity of pathogenic microorganisms, and increasing the production of short-chain fatty acids [41].

3.2. Effect of Microbial Fermented Feed on Slaughter Performance and Meat Quality of Broilers

Regarding the performance and quality of broiler meat, a study has shown that replacing ordinary soybean meal with 7% fermented soybean meal in the diet of yellow-feather broilers can significantly improve broiler half-cleansing. Also increases the rate of full evisceration, pectoral muscle rate, and leg muscle rate, reducing the abdominal fat rate of broilers [28] [33]. Moreover, it was found that using 6% Candida tropicalis and Saccharomyces cerevisiae fermented cotton meal in the diet of yellow feather broilers to replace ordinary cotton meal can significantly reduce the abdominal fat rate of yellow feather broilers [42]. Niu *et al.* [43] found that using the equivalent amount of 6% Candida tropicalis fermented cotton meal in the diet of Cobb broilers instead of soybean meal can significantly reduce the belly fat content and subcutaneous fat thickness of broilers. Researchers reported that replacing soybean meal with 4%, 8%, and 12% fermented cotton meal in the diet of yellow feather broilers showed that the birds fed 8% solid-state fermented cottonseed meal had increased (p 0.05) serum immunoglobin M, immunoglobulin G, and complement C4 levels on day 42 compared with birds fed a control diet [44].

The use of some fermented seed powders in the diet of broilers can lead to an improvement in the broiler's chest muscles and an increase in the height of the villus [31]. Shayerizadeha *et al.* reported that using fermented rapeseed meal instead of 50% soybean meal in the Cobb 500 broiler diet can significantly reduce the content of cholesterol, malondialdehyde, and total saturated fatty acids in the leg muscles of broilers, and increase the content of total polyunsaturated fatty acids [36]. Furthermore, feeding 10% fermented corn meal has been shown to

increase the proportion of -linolenic acid, -linolenic acid, and oleic acid in broiler breast fat [45]. It could be said that feeding wet fermented feed has no effect on the slaughter rate of broiler chickens, and will lower the breast meat rate of broiler chickens, which may be related to the characteristics of fermented feed ingredients and the different dosage ratios [6].

3.3. The Impact of Microbial Fermented Feed on the Intestinal Microecology of Broilers

The intestinal microflora will participate in the host's immune defense mechanism against pathogens [46]. Adding microbial fermented feed to broiler diets can increase the number of beneficial bacteria in the intestines and reduce the number of harmful bacteria. For example, feeding broilers with fermented complete feed can significantly reduce the number of *E. coli* in the jejunum of broilers and increase the number of lactic acid bacteria [47]. Furthermore, adding fermented cotton meal to the diet can significantly increase the number of lactobacilli in the cecum of broilers and reduce the number of coliforms [7]. To enhance that, it has been investigated to feed fermented corn-soybean meal diets to green-footed hemp chickens for 31 - 73 days and found that the number of *Escherichia coli* and Staphylococcus aureus in the ileum of broiler chickens decreased significantly, the number of lactobacilli increased significantly, and the pH value of the ileum gradually decreased [27]. In addition, added 15% Bacillus polymyxa fermented palm meal to the broiler diet and found that the number of lactic acid bacteria in the intestinal tract of broiler chickens increased significantly and the total number of bacteria decreased [48]. According to some studies, using fermented rapeseed meal instead of 50% soybean meal in the Cobb 500 broiler diet can significantly increase the intestinal lactic acid content and number of lactic acid bacteria in broiler chickens, reduce Salmonella colonization, and reduce the number of *E. coli* in the ileum [36]. On the other hand, adding 10% solid-state fermented corn gluten meal to the diet of yellow feather broilers found that the number of intestinal *Escherichia coli* in broilers was significantly reduced, and the number of lactobacilli was significantly increased [36], and in the Roman broiler diet, 5% - 15% fermented banana peel was used to replace corn, and it was found that the number of coliforms in the ileum of broiler chickens had a downward trend [37]. However, used fermented barley or wheat to test it. It was found that it had no effect on the number of *E. coli* in the broiler's intestines [30]. The increase in acid is linked to the quality of the feed. It was found that the addition of it was found that adding 4% fermented feed to the diet of Emei black chickens can increase the concentration of acetic acid and propionic acid in the cecum of broilers [40].

3.4. The Effect of Microbial Fermented Feed on the Morphology of Broiler's Intestines

Intestinal mucosa can reduce the harm of harmful substances and pathogenic microorganisms to the body [49]. In a study, it was shown that the use of fer-

mented soybean meal in broiler diets can significantly increase the height of the duodenum and jejunum villi of broilers, and reduce the crypt depth of the jejunal mucosa [26]. In a study, it was reported that adding fermented rapeseed meal to broiler diets can significantly increase the ratio of jejunum villus height to crypt depth in broiler chickens [50]. On the other hand, they also found that adding fermented rapeseed meal to broiler diets can significantly increase the height of ileum and jejunum villi and the VH:CD value of broilers [51]. Low toxin and low antigenic substances, small peptides [51], and low ANF will have a positive effect on the improvement of broiler intestinal mucosal morphology [26].

3.5. The Effect of Microbial Fermented Feed on the Immune Function of Broilers

Feeding fermented rapeseed meal can significantly increase serum immunoglobulin IgG and immune protein IgM levels in broilers [51]. Furthermore, feeding fermented feed can significantly increase broiler duodenal secretory IgA (S IgA) content [40]. Soybean meal and corn gluten meal have been used in yellow-feather broiler diets where it was found that broiler spleens. The index thymus index increased significantly [26] [32]. Fermented feed can induce recirculating antibodies and improve the intestinal mucosal immunity of broilers [52], resulting in a decrease in the ratio of heterophile cells to lymphocytes in broilers [30] and alleviating oxidative stress [53]. Small peptides in fermented feed can make broiler immune globules. The protein content is increased to improve the immune function of broilers [51]. Changes in the intestinal flora of broilers will also affect the immune response of broilers [6]. Feeding microbial fermented feed usually increases the number of lactic acid bacteria in the intestines of broilers, which is beneficial to the immune function of broilers. However, lactic acid bacteria can induce the production of Th2 cytokines such as interleukin-4 (IL-4) and IL-10, thereby promoting the development of B cells and the production of antibodies [54].

4. Conclusion

Microbial fermented feed has the characteristics of low pH, high lactic acid bacteria, and high lactic acid content, and plays an important role in improving the broiler's intestinal health, regulating immune function, and improving production performance. Due to the differences in the amount and moisture content of fermented raw materials, fermented bacteria, and nutrient components of the fermented feed, the research results are different. Making full use of unconventional feed resources in various parts of the world to produce fermented feed materials can reduce feed costs and increase meat chicken production efficiency. In the future, we can carry out in-depth research on the selection of strains, fermentation technology, product nutritional parameters, and appropriate dosages in diets for different broiler breeds, different growth stages, and cost performance

based on different types of unconventional feed materials, so as to provide fermented feeds with no resistance. Reasonable utilization in broiler breeding provides reference.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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