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The Influence of Incorporating Red Pepper Powder into the Broiler Ration

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Abstract:
This investigation examined the influence of incorporating red pepper powder into the feed on the productive performance, carcass and blood measurements in broiler chickens under natural conditions. The experiment used one hundred one-day chicks (Ross 308). Each chick was randomly assigned to one of four treatment groups. Red pepper powder was added to the feed at 0.0%, 0.5%, 1.0% and 2.5%. Feed and water were freely given to the chicks throughout the experimental period. Weekly measurements were taken of body weight and feed consumption. Carcass weight, internal viscera, blood cholesterol, triglycerides, glucose, and proteins at 42 days were measured. The results showed that adding red pepper in different proportions to the meat chicken feed significantly affected both BW, and FI. The percentage of adding red pepper was 1%, the best result. On the other hand, this interaction significantly affected all cholesterol, triglycerides and glucose levels in the blood. In conclusion, red pepper powder can be added to broiler feed mixtures by 1% to improve production efficiency.

I. Introduction

Previously, antibiotics were used as growth stimulants to reduce the effects of pathogens and various environmental stresses on bird health. Still, with increasing public awareness of the harmful consequences of antibiotics, along with bacteria becoming more resistant to them, food safeness concerns also forced restrictions on the use of antibiotics by poultry farmers. This concern prompted investigators to explore a substitute for antibiotics. Hence, natural additives emerged as alternative antibiotics with a significant prospect in poultry production [1, 2, 3]. For instance: In heat-stressed poultry, natural alternatives lead to improving innate immunity, having a beneficial effect on the population, and reducing stress [4]. Much attention has been paid to phytochemicals derived from spices and herbs as natural antibiotic choices because of their valuable benefits, such as naturalness, safety, and freedom from toxins [5]. A great variety of plant compounds are categorized, particularly concerning source and preparation, including herbs (floral, non-woody, perennial plants), spices (tasting spices or aromas used in human meals), and aromatic oils (volatile compounds derived by steam distillation or alcohol), or oleoresin (solvent extracts from organic solvents) among botanical additives, the

active ingredient in botanical additives varies according to the portion of the plant utilized (e.g., leaves, roots, seeds, or bark), harvest time, geographic origin, and method of harvesting extraction [6]. Herbs and plant products are incorporated into poultry diets and have been found to help increase body weight, production rates, and feed efficiency [3, 4, 7]. In addition, the active substances in herbs have a role in improving digestion and immunity in poultry [2, 8]. The primary effect of botanical additives arises from the beneficial impact on the microbial environment of the gastrointestinal tract through the control of potential pathogens [3]. An enhancement of the digestive ability in the intestinal tract is one of the indirect effects of vegetable supplements [2, 3]. It also reduces stress on birds to defend against pathogens and also works to increase the ability of the small intestine to absorb critical nutrients, allowing birds to grow faster [1, 9]. It was found that essential oils, representing the active ingredient in many vegetable additives, can destroy the cytoplasmic membrane. Still, they may cross the cytoplasmic membrane and destroy the cell's internal components in many microbes or pathogens [10]. Reducing harmful microbes inside the intestine reduces intestinal diseases and increases the bird's benefit from food, increasing the growth speed [10, 11]. The effect of organic additives such as antimicrobial and antiparasitic improve the microbial environment by reducing the presence of harmful organisms such as E coli and salmonella and promoting the growth of beneficial microorganisms [12]. It was found that some natural additives have an antiparasitic effect, such as coccidiosis, which causes a decrease in the weight of birds and the work of heavy economic losses [3]. A wide range of plant-based food supplements has beneficial effects on the digestive system, such as reducing intestinal discomfort, transit time and digestive secretions, enhancing the activities of digestive enzymes, and all these effects together will affect the increase and improvement of digestion [9]. Plant mixtures have been shown to enhance the enzyme trypsin and lipoamylase in chicken gut broilers [13, 14, 15]. Plant additives have a stimulating effect on chicken intestinal mucus, this should affect microbial adhesion [13]. Thus, they help stabilize the microbial balance in the chicken gut. Some morphological changes occur in the alimentary canal, such as an increase in the size of villi in small intestines and colons [13, 16]. In poultry fattening, egg production, and optimal feeding strategies, digestive health is a prerequisite for optimal performance and profitability. The body rapidly regenerates damaged tissues after intestinal disorders damage the mucosa. This process is complex and consumes extra energy from the body. Alternatively, gastrointestinal disorders affect the health of the mucous membrane, which requires energy to renew it. It comes at the expense of productive performance, whether the production of meat or eggs. Hence, vegetable additives reduce intestinal disorders and maintain the health of the mucous membrane [17]. The optimum performance of the cells is essential for better performance. In broiler chicken experiments, it was noted that using vegetable additives led to an increase in the length and size of the villi, which led to a rise in the ability to absorb nutrients, which is reflected positively in the productive performance of the bird and thus increased profitability [11]. Some vegetable additives are seen to play a role in improving feed palatability and taste. This means an advance in the productive performance of poultry. Some natural additives such as organic acids, probiotics, prebiotics, herbs and spices such as thyme and its extracts increased chicken feed intake [18, 19]. We find that the active ingredients in some herbs, such as carvacrol, are responsible for the tasty effect and thus increase the feed intake [18, 19]. Plant ingredients can enhance food safety in two ways, by reducing pathogens in the gut, thus improving the gut microbial environment, which in turn can minimize carcass contamination at slaughter [20]. There are several biochemical and pharmacological properties of capsaicin, which are contained in spicy red pepper, including antioxidants, immunomodulators, antiallergenic, anti-inflammatory, and anticancer properties, which may reduce cancer risks [21]. Red peppers (Capsicum annuum L.) contain many functional chemical components (capsaicin, provitamin A, vitamins E, C, and capsaicinoids), which greatly help improve the health of birds, in addition to some types of oils from which all kinds of birds can benefit [1, 21]. It contains some essential volatile oils, such as Carine, and other compounds that significantly affect animals, especially birds [22]. Pepper helps increase the production of laying hens, even broilers, as it acts like a powerful probiotic. It increases the percentage of yolk in eggs produced from laying hens, improves the quality and quality of the eggs produced, which ensures healthier bird varieties after the hatching process and contains more essential nutrients in one egg [1, 21]. Pepper helps to stimulate significantly stomach secretions in chickens, which helps to complete the digestion process efficiently, and thus the stomach's digestion efficiency of all kinds of feed becomes high [1, 21]. It can maintain the integrity of tissues and cells in the bird's body, as pepper can be an antioxidant. It is possible to benefit from all available types of feed without

fear of the risk of indigestion for birds due to the high efficiency of food digestion. It helps fight different kinds of bacteria, so it is an antibiotic when birds are infected with any intestinal bacteria. It helps increase intestinal absorption after eliminating harmful bacteria [1, 21]. Several studies have shown that red pepper improves broiler chickens' performance [1, 21]. As well as boosting pancreatic and intestinal enzymes, red pepper increases body weight, stimulates bile acid secretion, decreases heat stress, enhances the digestibility of feed and intake, improves feed conversion efficiency, lowers mortality, improves carcass properties, blood measurements, and improves profitability in broiler chickens [21]. Therefore, we aim to investigate whether red peppers (Capsicum annuum L.) can improve broiler chicken production and performance characteristics (Live and carcass weights, feed intake) and biochemical blood indices (triglycerides, cholesterol, glucose and albumin) in the broiler production cycle.

II. Material and methods

This investigation used one hundred-one-day-old mix-sex chicks (Ross 308). The birds were raised in deep litter cages in the same experimental room using wire cages. The birds were provided with a commercial vegetable-based diet (according to NRC requirements), and water was provided *ad libitum* during the experiment (42 days). Starter diets were fed to chicks for two weeks, grower diets for weeks three and four, and finisher diets for weeks five and six (Table 1). During routine bird management, the average air temperature and relative humidity were 28.1 ± 0.5 °C and 15.0 ± 0. 4 %, respectively. One hour of darkness was included in the lighting program. Birds were allocated into four treatments, each with five replicate pens and five chicks each, using a Completely Randomized Designed (CRD). There were four food treatments: a basal diet (control group), a basal diet with red pepper powder (0.5 %) as treatment group 2, a basal diet with red pepper powder (1 %) as treatment group 3, and a basal diet with red pepper powder (2.5 %), as treatment group 4, respectively. There was no restriction on feeding or watering. Bird performance was evaluated based on weekly feed intake measurements and weight growth. The mortality rate was recorded every day. Upon completion of the experiment (d 42), five birds were randomly chosen from each treatment, and the internal organs (chest, thigh, abdominal fat, liver, spleen, heart, proventriculus and gizzard weight) of the carcass and the yield of the carcass were measured. Blood samples were used for triglycerides, cholesterol, glucose, albumin, and total protein determination at the end of the study.

Table 1: Nutritional composition of starter, grower, and finisher diets

Diet	Starter 1-2 week	Grower 3-4 week	Finisher 5-6 week
Ingredients and composition			
Yellow corn	61.9	68.5	73.3
Soybean meal (44% CP)	35.5	28.8	24
Dicalcium-phosphate	2.0	2.0	2.0
Premix*	0.12	0.2	0.2
DL-methionine	0.1	0.1	0.1
Choline	0.1	0.1	0.1
Salt	0.3	0.3	0.3
Nutrient chemical composition **			

ME (kcal kg^{-1})	3014	3058	3115
Crude Protein	22.2	19.9	18.1
ME/CP	135.7	153.6	172
Calcium (%)	1.07	0.95	0.94
Phosphorus (%)	0.76	0.74	0.73
Lysine (%)	1.26	1.09	1.02
Methionine (%)	0.49	0.48	0.46
Methionine and cystine (%)	0.89	0.75	0.69
Sustain (%)	0.40	0.39	0.34

*: One kilogram of premix consists of 12,000,000 IU Vit. A, 2,500,000 IU Vit. D3, 1 g Vit. E, 2 g Vit. K3, 1 g Vit. B1, 5 g Vit. B2, 0.01 g Vit. B12, 30 g Nicotinic acid, 3 g Ca-pantothenate, 1 g folic acid, 0.05 g biotin, 40 g Fe, 5 g CU, 60 g Mn, 0.1 g I, 60 g Zn, 0.15 g Co, 10 g BHT

**: According to NRC tables (1994), the chemical compositions of feed ingredients were calculated.

2.1. Statistical Analysis

This study used a randomized design and an ANOVA involving repeated measures (MIXED model) procedures for SAS analyzing collected data. As dependent variables, the performance traits of the birds were included in the model. The independent fixed effects consist of the experiment's impact (control or food supplementation), the age in a week, and the respective interaction. A random effect was applied to the bird. Tukey-Kramer test separated the mean differences among different treatments. At $P < 0.05$, significance was determined.

III. Result and discussion

Chickens benefit greatly from pepper since it contains many valuable chemical components and compounds, all of which improve their health. They also benefit from specific oil sources that all birds benefit from. Therefore, Table (2) shows the effect of adding different percentages of red pepper powder to broiler feed on average live body weight and feed intake (g) per week throughout the experiment. The outcomes show that there are highly significant differences in the average live body weight throughout the experiment period when using red pepper compared to the control group, where the groups that added different percentages of red pepper powder to their feed were significantly superior to the control group in this capacity, and the treated birds were recorded. With red pepper by 1%, the highest average live body weight compared to the control group and the rest of the other treatments for the same weeks.

Moreover, it turned out that the more the percentage of red pepper increased from 1% to 2%, the more body weight decreased clearly and began to decrease when the rate of addition increased to the level of adding 2% red pepper, especially from the third week of the experiment. Table (2) shows that the 1% red pepper group was distinguished from the rest of the additives by retaining Significantly superior to the control group ($P < 0.05$) from the first week until the end of the sixth week of the experiment. The improvement in body weight can be attributed to the role of red pepper powder in regulating digestion and metabolism by containing the active substance Capsaicin which enhances the actions of pancreatic and digestive enzymes, boost the production of bile acid, reduced gastrointestinal transit time, accelerates digestion and improves body weight in the broiler [1, 9]. The results of this investigation are agreeing with what Adedoyin [1] and Munglang and Vidyarthi [9] indicated: adding red pepper powder to broiler feed in different proportions led to an improvement in live weight. El-Tazi [23] showed that broiler body weight and feed efficiency were significantly improved with hot

red pepper in their diet at 0.5, 0.75, and 1% concentrations. The improvement in weight gain can be attributed to the fact that red pepper contains some ingredients with high nutritional value, such as the terpenoid compound capsaicin, capsantine and capsisin, and vitamin contents.

Table 2: The average (mean ± SE) body weight and feed intake (g) of birds when supplementary red pepper powder (0, 0.5, 1, and 2.5%) are added to diet ration*

Wk		Control (0 %)	Peper (0.5 %)	Peper (1 %)	Peper (2.5%)
1st	BW	157.7 ± 1.54^{B}	170.2 ± 1.54^{Ac}	172.8 ± 1.54^{Ac}	168.6 ± 1.54^{Ac}
	FI	170.66 ± 3.36^{B}	170.73 ± 3.36^{Be}	181.86 ± 3.36^{Ac}	174.51 ± 3.36^{Bd}
2nd	BW	404.4 ± 35.98^{B}	445.6 ± 5.14^{Bd}	460.1 ± 5.14^{Ac}	440.4 ± 5.14^{Be}
	FI	523.18 ± 6.94^{A}	522.2 ± 6.94^{Ac}	519.96 ± 6.94^{Ac}	502.67 ± 6.94^{Bd}
3rd	BW	805.5 ± 82.6^{B}	880.3 ± 11.8^{Ac}	875.0 ± 11.8^{Ac}	875.9 ± 11.8^{Ac}
	FI	934.99 ± 25.69^{B}	920.78 ± 25.69^{Be}	959.07 ± 25.69^{Ac}	925.19 ± 25.69^{Bd}
4th	BW	1288.7 ± 168.7^{B}	1373.1 ± 24.1^{Ad}	1399.6 ± 24.1^{Ac}	$1334.7 \pm 2\ 4.1^{Ae}$
	FI	1012.48 ± 19.25^{B}	1071.84 ± 19.25^{Ad}	1115.8 ± 19.25^{Ac}	1056.93 ± 19.25^{Ae}
5th	BW	1544.6 ± 34.9^{B}	1829.2 ± 34.9^{Ad}	1889.9 ± 34.9^{Ac}	1792.8 ± 34.9^{Ae}
	FI	1180.69 ± 36.12^{B}	1188.53 ± 36.12^{Be}	1236.83 ± 36.12^{Ac}	1223.74 ± 36.12^{Ad}
6th	BW	1729.0 ± 59.4^{B}	2445.0 ± 59.4^{Ad}	2551.1 ± 59.4^{Ac}	2440 ± 59.4^{Ae}
	FI	1246.14 ± 52.71^{B}	1139.81 ± 52.71^{Ae}	1296.75 ± 52.71^{Ac}	1283.8 ± 52.71^{Ad}

* Values with a different superscript differ significantly at $P<0.05$

* $^{A, B}$: Treatment differences (Control vs red pepper addition)

* ^{c,d,e}: Differences within the red pepper treatments (0.5% vs 1% vs 2.5 %)

The results show significant differences between the treatment and control groups in the average weekly feed consumption throughout the experiment (Table 2). The birds to which different percentages of red pepper powder were added to their feed were more consuming the feed compared to the other birds control birds, where it is noted that the group of 1% red pepper was higher in the average feed consumption compared to the rest of the groups and the control. The increased feed consumption of groups of birds to whose feed red pepper powder was added can be explained by the fact that pepper acts as an appetizer [1, 9, 23]. The obtained results agree with what was mentioned by Eltazi [23], who stated that adding pepper powder to broiler feed significantly improved the amount of feed consumed compared to the control group. In the 2.5 % red pepper group, less feed intake and body weight were observed, possibly caused by intestinal irritation or hepatitis due to the high concentrations of hot red pepper [24].

Table (3) presents the effect of using different levels of red pepper in the chicken diet on the live body weight, carcass weight, and the relative weight of the major cuts of the carcass at the age of 42 days. Appear results showed that adding red pepper powder to broiler feed did not cause significant differences in chest, thigh, spleen and liver weight ($P> 0.05$). While the results showed that there was a significant decrease ($P\leq0.05$) in the relative weight of abdominal fat when using red pepper at a rate of 1 and 2.5 %, compared with control birds and 0.5 % red pepper group that shows higher abdominal fat weight percents. Due to pepper's effective action in stimulating stomach secretions, chickens can digest food more efficiently and complete digestion more quickly. Thus, all types of feed are digested efficiently by the stomach. Additionally, pepper acts as an antioxidant, preserving the integrity of tissues and cells within the bird. As well as fighting different kinds of bacteria, it is used as an antibiotic when birds are infected with intestinal bacteria. Following the elimination of harmful bacteria, it assists in increasing intestinal absorption.

Table 3: Average (mean ± SD) live carcass weight (g/bird) and internal viscera (% of carcass weight) when supplementary red pepper powder (0, 0.5, 1, and 2.5%) are added to diet ration*

Variable	Control (0 %)	Peper (0.5 %)	Peper (1 %)	Peper (2.5%)
Live wt	2135.0 ± 123.3^{B}	2582.5 ± 123.3^{Ac}	2489.3 ± 123.3^{Ac}	2543.8 ± 123.3^{Ac}
Carcass wt	$1385.0a \pm 101.1^{B}$	1805.0 ± 101.1^{Ac}	1690.6 ± 101.1^{Ac}	1701.2 ± 101.1^{Ac}

Chest	21.20 ± 1.26^{A}	21.25±0.75^{Ac}	22.17± 0.42^{Ac}	22.48±2.23^{Ac}
Thigh	22.76 ± 0.66 ^{Ac}	22.91± 0.92 ^{Ac}	23.11±1.02 ^{Ac}	22.20±0.89 ^{Ac}
Abdominal fat	1.62 ±0.67^{A}	1.58 ± 0.35^{Ac}	1.40 ± 0.34^{Bd}	1.22 ± 0.30^{Be}
Liver	2.48 ± 0.21^{B}	2.59 ± 0.46^{Ac}	2.57 ±0.30^{Ac}	2.45 ± 0.25^{Bd}
Spleen	0.11 ± 0.01^{A}	0.12 ± 0.02^{Ac}	0.12± 0.02^{Ac}	0.13 ± 0.04^{Ac}
Heart	0.60 ± 0.05^{A}	0.57 ± 0.05 ^{Ac}	0.59 ± 0.03 ^{Ac}	0.56 ± 0.04^{Ac}
Proventriculus and Gizzard	3.69 ± 0.32^{B}	3.36 ± 0.36^{Bd}	3.73 ± 0.36^{Ac}	3.73 ± 0.49^{Ac}

* Values with a different superscript differ significantly at P<0.05
* $^{A, B}$: Treatment differences (Control vs red pepper addition)
* ^{c,d,e}: Differences within the red pepper treatments (0.5% vs 1% vs 2.5 %)

Table 4 showed significant differences in glucose, cholesterol and triglyceride levels. The 1 and 2.5 % red pepper group recorded the lowest cholesterol, glucose, and triglyceride levels in comparison to the control group. These results are consistent with Puvača et al. [25] and Abd El-Hack et al. [9]. It may be due to red pepper's bioactive components inhibiting 3-hydroxy-3-methylglutaryl coenzyme A reductase activity (a key enzyme in cholesterol metabolism). This decreases cholesterol production and intestinal resorption, reducing cholesterol synthesis [9, 26].

Table 4: The average (mean ± SD) blood glucose, cholestrol, triglyceride, albumin and total protein of chicken when supplementary red pepper powder (0, 0.5, 1, and 2.5%) are added to diet ration*

Contents	Control (0 %)	Peper (0.5 %)	Peper (1 %)	Peper (2.5%)
Blood glucose (g / 100 ml)	281.60 ± 2.31^{A}	259.37 ± 3.20^{Bc}	230.01 ± 1.97^{Bd}	232.95 ± 5.21^{Bd}
Blood Cholesterol (mg /100 ml)	191.08 ± 1.53^{A}	187.28 ± 6.18^{Ac}	163.82 ± 1.52^{Bd}	151.03 ± 1.44^{Ae}
Blood Triglyceride (mg / 100 ml)	100.15 ± 0.41^{A}	93.42 ± 0.47^{Ad}	84.89 ± 0.64^{Bc}	85.90 ± 0.57^{Bc}
Albumine (g/100 ml)	1.552 ± 0.04^{B}	1.601 ± 0.06^{Be}	1.845 ± 0.06^{Ad}	1.990 ± 0.07^{Ac}
Total protein (g /100 ml)	3.855 ± 0.06^{B}	3.913 ± 0.07^{Be}	4.817 ± 0.05^{Ad}	5.453 ± 0.5^{Ac}

* Values with a different superscript differ significantly at P<0.05
* $^{A, B}$: Treatment differences (Control vs red pepper addition)
* ^{c,d}: Differences within the red pepper treatments (0.5% vs 1% vs 2.5 %)

IV. Conclusion

Natural feed additives can be used as growth stimulants besides antibiotics found in spices, herbs, and natural oils. Red pepper has antioxidant, antimicrobial, growth-stimulating and immunostimulating effects in poultry production. It also plays a significant role in increasing digestive enzymes' activity and ability to absorb. Red pepper has a beneficial impact on the normal function of the alimentary canal and the general performance of birds (feed intake, nutrient digestibility, body weight gain, and carcass quality) and blood biochemicals (Cholesterol, triglycerides, glucose and proteins). Therefore, natural red pepper additives should be encouraged in poultry production because of their sound effects.

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