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Author (s):	Asim Shahzad Khan[1], Muhammad Asif Raza[1], Shahid Ali Rajput[1], Naheed Bano[1], Atif Rehman[1], Riffat Yasin[2], Muhammad Asghar[1], and Muhammad Uzair Khan[1]
Affiliation (s):	[1]Muhammad Nawaz Shareef University of Agriculture, Multan, Pakistan [2]University of Education, D. G. Khan Campus, Pakistan
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Evaluating the Benefits of Moringa and Neem Leaf Extracts in Broilers

Asim Shahzad Khan[1], Muhammad Asif Raza[1]*, Shahid Ali Rajput[1], Naheed Bano[1], Atif Rehman[1], Riffat Yasin[2], Muhammad Asghar[1], and Muhammad Uzair Khan[1]

[1]Faculty of Veterinary and Animal Sciences, Muhammad Nawaz Shareef University of Agriculture, Multan, Pakistan
[2]Department of Zoology University of Education Lahore, D. G. Khan Campus, Pakistan

ABSTRACT

Background. Plant extracts are among the alternatives to antibiotics. These are regarded as typically safe for animals. Neem and moringa are indigenous and well-known medicinal plants of Pakistan. However, limited studies have been conducted on these plants for their impacts on broilers. In this regard, this study was conducted at the experimental sheds of C-Block in Muhammad Nawaz Shareef (MNS) University of Agriculture, Multan, Pakistan.

Method. A total of 144-day-old chicks were bought and kept in a single group for 7 days. They were weighed and 108 birds with average weights were placed into 12 replicates (9 chicks/replicate) which were allotted names including Gr-1, Gr-2, Gr-3, and Gr-4. Gr-1 was offered only a basal diet, whereas Gr-2, Gr-3, and Gr-4 were supplemented by moringa (4%), neem (4%), and moringa (4%) + neem (4%) leaf extracts respectively in water at 50ml/l. Two rations were prepared. The starter was given for the first 3 weeks and the finisher till the end. Birds were vaccinated. Growth performance data was collected weekly. On the completion of the trial, blood samples were taken (5ml/bird) from 2 birds / replicates for the analysis of blood biochemical parameters. Moreover, 2 birds/replicate were euthanized and carcass samples were collected. The results were statistically analyzed.

Results. The results of the experimental trial depicted that an addition of 4% *Azadiracta indica* (neem) leaf extract at 50ml/l showed better results.

Conclusion. Neem leaf extract is suggested to be used in broilers as a cheap and effective growth promoter without any side effects.

Keywords: antibiotics, broilers, carcass characteristics, growth performance, moringa, neem

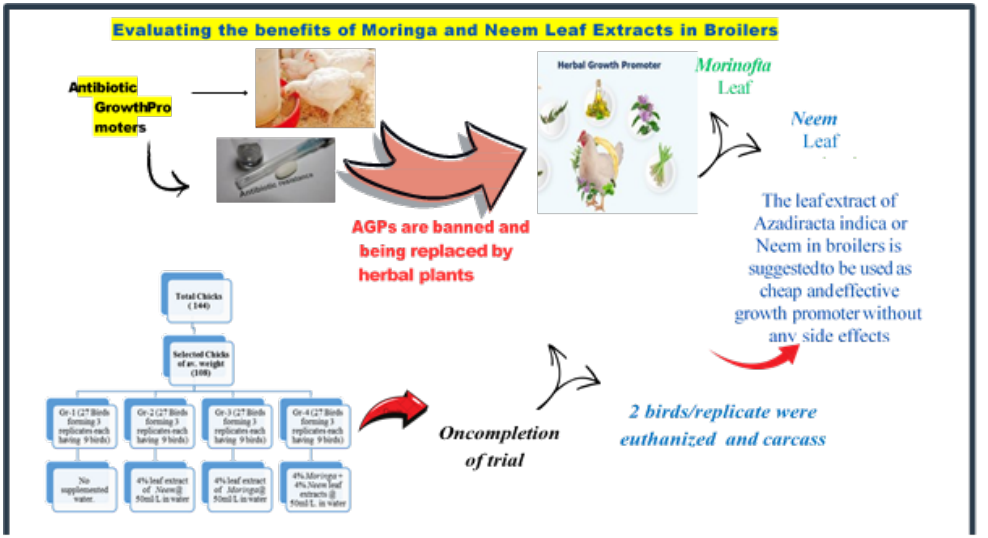
Highlights

- There are well-known medicinal plants with a large number of health benefits. However, limited studies have been conducted on such plants.
- Neem and moringa are indigenous medicinal plants of Pakistan with numerous benefits for living things.

*Corresponding Author: asif.raza@mnsuam.edu.pk

- This study was planned to check the impact of neem and moringa leaf extracts as alternatives to antibiotics in broiler feed. It could pave the way for future research.

GRAPHICAL ABSTRACT



1. INTRODUCTION

Human population is rising as 75 million people are added to the global population, annually. Further, it is estimated that in 2050 human population will exceed 9.5 billion [1]. This rapid increase in population puts pressure to fulfil the basic human needs, such as dietary needs. Hence, it is a big task for human beings to achieve a balance diet at low cost. In poor and developing countries, the demand for animal protein is rising [2]. Protein is a very important part of human diet. About 60-65% of the total protein used by human beings is taken from plants. Staple cereals such as wheat, rice, and maize are considered as the main sources of plant proteins [3]. However, dependence on these sources can lead to a shortage of certain amino acids, especially lysine [4]. Hence, human beings need some sort of animal protein. Scientists are striving to provide animal proteins adequately in the form of meat, eggs, milk, and oil. They are also trying to innovate to lower down the costs of such protein sources. Over the last few years, the demand for protein ingredients in human diet has risen conspicuously. The world market for proteinaceous food was about 38 billion US dollars in 2019 and it is expected to rise at a rate of more than 9% between 2020 and 2027. Meat is considered as an important part of people's daily diet because it has a high protein content and an adequate number of micro-nutrients for its consumers. Humans can get the protein in the form of meat from livestock and fish aquaculture. The production of poultry meat has been greater as compared to any other type of meat in the world since the 1960s. This higher production efficiency is beneficial for developing countries.

The poultry sector is an important field

of livestock farming which ensures food security and general human health [4]. Poultry meat is a very important source of animal protein for people and it contributes to maintain their health in certain countries, including Pakistan. In Pakistan, poultry meat alone contributes 27% of the total meat production. The word "poultry" is often used as an alternative word for chicken [5]. Poultry products have proteins, micronutrients, and vitamins, which make them important for the health of consumers. Poultry meat contains almost all essential amino acids which the human body needs. By using certain breeding techniques, poultry products are being improved worldwide [6]. In general, broiler meat is the best and the most inexpensive source of protein and other nutrients for human beings.

Broiler is a chicken (*Gallus gallus domesticus*) that is bred and raised for quick meat production. Broilers have an average life span of 7-8 years. Commercially, they are slaughtered after 5 weeks of age. So, they do not reach their normal age limit. They yield high quality meat for the users. They are reared in large and open houses or sheds, where they walk, get fed, and communicate with each other. Broiler chickens are among the most widely farmed animals in the world. They have been selectively bred to possess certain desirable traits, such as growing heavy breast muscles, which are then sold as "white meat" or "chicken breasts." Unluckily, broilers face many diseases caused by various pathogenic microbes. Therefore, proper microbial control is required to ensure the healthy growth of broiler chicken [7]. Hence, farmers are suggested to use antibiotic growth promoters in animal feed.

Antibiotics are growth promoters as they control diseases. They work to change the metabolism of bacteria and suppress their reproduction in the gut. Antibiotics are placed into different classes on the basis of their chemical nature, the way of action, and the type of treating bacteria. Bactericidal antibiotics are antibiotics which kill the bacteria, while bacteriostatic antibiotics make them weak by stopping their reproduction and empowering the immune cells to engulf them by phagocytosis. When mixed with water, an antibiotic may help the bird to recover rapidly from infections.

Several researches predicted that the application of antibiotics in livestock feed may increase the antimicrobial resistance of the respective livestock [8]. Antimicrobial resistance occurs when pathogens become modified with the passage of time and medicines can't affect them. Such pathogens may be transferred from animals to humans [9]. Therefore, the use of antibiotic growth promoters in animal feed has been banned in many countries across the globe.

Consequently, several researches recommended that natural feed additives should be used in place of synthetic growth promoters [10]. As a result, many herbal products are being used currently as natural growth promoters in chicken diet, instead of antibiotic growth promoters [11]. Due to the safer mechanism of growth stimulation, natural feed additives are considered important in poultry feed [12]. Phytobiotics present in plant oils, some herbs, spices, and different plant extracts are natural feed alternatives currently being used in place of antibiotic growth promoters [10]. The effects of several portions of these plants and their extracts on poultry feed have been evaluated in different studies. A number of chemicals, including phytochemicals found in different plant parts, are used as natural growth promoters in broiler chicken.

Moringa oleifera is a very useful plant found across India and Africa. It can flour-

ish in different tropical and subtropical climates. It grows best and germinates efficiently in temperatures ranging from 20 to 30°C. Moreover, it is also able to thrive in arid and less fertile areas [13]. Moringa, an edible plant, has many properties but still remains underutilized in Pakistan. Its leaves, pods, flowers, and fruits are very nutritious. These are often used as vegetables in different parts of the world. It can also improve liver and kidney functions [14]. Further, it contains a large number of nutrients, such as vitamins, minerals, and antioxidants [15]. It has been revealed that moringa leaves have vitamin C, beta-carotene, ω-3 and ω-6 fatty acids, polyphenols, phenolic acids, flavonoids, alkaloids, and glucosinolates [16].

Azadirachta indica, commonly known as neem, is another medicinal plant which is a slow-growing, local plant of Indian subcontinent. It is a local tree of South and Southeast Asia [17] and grows naturally in all regions of Pakistan. It has several phytochemicals including azadiractin, nimbidin, nimbin, and quercetin. Approximately, 140 compounds have been extracted from various parts of the neem tree which have many bioactive properties [18]. The leaves, seeds, and bark of the neem tree reportedly have antibacterial properties. It also has immune-stimulating, anti-inflammatory, antibacterial, antiviral, and antifungal characteristics and also prevents cell breakdown [19]. It is generally assumed that both neem and moringa leave extracts have medicinal/immune-modulator properties and are good substitutes for antibiotic growth promoters. Therefore, this research project was planned to evaluate the effect of neem and moringa leaf extracts on growth efficiency, carcass traits, and certain blood parameters of broiler chicken.

2. MATERIALS AND METHODS

The study was conducted at the experimental sheds of C-Block in Muhammad Nawaz Shareef University of Agriculture, Multan, Pakistan. Fresh, green, and undamaged mature leaves of both *Azadirachta indica* (neem) and *Moringa oleifera* were collected from the local areas of Multan and dried in a shady area at room temperature for one week, without direct exposure to sunlight. These leaves were turned over regularly. Regular turning ensured smooth exposure to air which prevented moisture and fungal growth. Turning of leaves also dispersed heat and stopped the degradation of certain phytochemicals. The dried leaves were ground using hammer mill without washing to form a fine powder of 80 mesh. Washing before grinding may cause the clogging of the grinder, clumping instead of fine powder, and can also promote fungal growth if some moisture is retained in the powder. The powders were stored in dry plastic bags in a dark cool place. Thereafter, leaf powders were added separately at 40 g neem and 40 g moringa into 1000 ml of distilled water and boiled at 80°C for 3 hours at neutral pH, with manual stirring for 15-30 minutes for better extraction. These mixtures were allowed to cool at room temperature for 2 days [11]. Then, they were filtered using Whatman filter paper to obtain fiber and dust free leaf extracts, that is, 4% leaf extracts of moringa and neem leaves. The 4% leaf extracts were mixed with water and provided to the experimental birds at 50 ml/l, according to the experimental design. A total of 144, day-old, young chicks (n= 144) were procured. They were raised collectively for a period of one week. Then, these birds were subjected to weigh one by one and 108 birds of average weight were randomly distributed into 4 treatment groups, namely Gr-1, Gr-2, Gr-3, and Gr-4. Each group had 27 chicks with 3 replicates,

that is, 9 chicks per replicate.

Two experimental rations were formulated and given *ad libitum* to the birds (Table 1). They were called starter and finisher rations. Starter ration was given to chickens for the first 3 weeks and finisher was given to them in 4th and 5th weeks of age.

Figure 1. Chicks During the Adaptation Period of Seven Days

Table. 1. Formulation of Trial Feeds

Ingredients	Starter Feed (%)	Finisher Feed (%)
Maize	35.5	34.5
Wheat	9.5	9.5
Rice polish	5.5	5.5
Rice broken	5.5	8.5
Wheat bran	2.5	5.5
Guar meal	4.3	3.3
Sunflower meal	5.3	4.3
Corn gluten 60%	6.5	5.5
Soybean meal	9.5	9.5
Fish meal	7.3	5.3
Soya oil	3.15	3.15
Molasses	3.2	3.2
Lime stone	1.3	1.3
Mono and di-calcium phosphate	0.157	0.157
Pre-mix	0.6	0.6
Salt	0.193	0.193
Total	100	100

Table 2. Chemical Composition of Experimental Rations

Ingredients	Starter Feed (%)	Finisher Feed (%)
Crude Proteins %	22.1	20.1
Energy Kcal/Kg	3095	3005
Crude Fibers %	4.21	4.61

The birds in the 4 allotted groups were given feed and water according to the following program.

Gr-1 was given basal diet without any supplemented water.

Gr-2 was given basal diet along with water supplemented with 4% leaf extract (50ml/l) of *Azadiracta indica* (AZI).

Gr-3 was offered basal diet and water supplemented with 4% leaf extract (50ml/l) of *Moringa oleifera* (MRO).

Gr-4 was reared on basal diet and

water supplemented with 4% *M. oleifera* + 4% *A. indica* leaf extracts (50ml/l).

Chicks were kept in separate pens of 4×3 ft² for the assessment of the effect of different extracts and to avoid cross-contamination. Strict sanitation practices were maintained in experimental sheds before and during the experiment. A total of 200 g of $KMnO_4$ and 400 ml of formalin (40%) solution was sprayed in the shed before rearing chicks.

The double the amount of formalin was used as compared to $KMnO_4$ by weight (2:1 ratio). A layer composed of about 3 inches of sand was utilized as a litter material in each pen. Similarly, water was showered twice a day on sand to make it cool, so that chicks may feel comfortable even on hot days. To keep the litter material in dry and good condition, it was stirred twice a day during the trial. Vaccination was done for Newcastle disease (ND) and Infectious Bursal disease (IBD). ND vaccination was performed twice during the trial on the 1st day in eye drops and on the 14th day in drinking water, while the vaccine for IBD was used on the 10th and 20th day in drinking water. The purpose of the vaccination was to prevent mortality and to control virus in trial chicks.

3. 1. Analysis

3.1.1 Body Weight Gain (BWG). The start weights of the chicks were measured at the start of the trial. Then, the birds were weighed on a weekly basis to note the body weight gain during each week. The previous week's body weight was subtracted from the current week's body weight by using the given formula:

Weight Gain = Current Week's Weight (g)- Previous Week's Weight (g)

3.1.2. Feed Consumption (FC). To weigh the feed intake, the feed given in each pen was recorded with the help of digital balance. All the values were added to get the total feed given in all pens. Next day, early in the morning, the uneaten feed was collected from all the pens and weighed.

Feed intake was checked by using the given formula:

Feed Intake = Feed given (g) - Remaining feed (g)

While, feed intake during a particular week was determined by the added amount of consumed feed during 7 days.

3.1.3. Feed Conversion Ratio (FCR). FCR was calculated per week during the trial by using the given formula:

F.C.R. = Feed given (g) / Animal weight gain (g)

3.1.4. Serum Biochemical Evaluation. On the 35th day of the experiment, blood samples (about 5 ml each) from 2 birds of each replicate were taken in sterilized disposable 24-guage needle syringes. Then, they were centrifuged in Remi R-8C / R-12C at the rate of 3000 rpm for 15 minutes at 25°C to get serum samples. These samples were kept at -20°C. Afterward, the samples were used for the evaluation of total proteins (TP, g/L), total albumin (ALB, g/L), total globulin (GLU, g/L) along with aspartate aminotransferase (AST, IU/L), alanine aminotransferase (ALT, IU/L), and alkaline phosphatase (ALP, IU/L). The analysis of the sera was carried out by using an automatic biochemistry analyzer known as Mindray BS-120, which is manufactured by Mindray.

Figure 2. Taking Blood Samples for Serum Analysis

3.1.5. Carcass Characteristics. Similarly, on the 35th day, 2 chicks per replicate were picked up and kept fasted for more than 20 hours. Fasting before slaughter makes the carcass analysis accurate and also improves meat quality by cleaning the digestive system. Live body weight was calculated by using digital balance before slaughter. The birds were killed humanly by using a sharp knife and were left to bleed out completely for 15 minutes. The purpose of bleeding chicks during carcass analysis is to completely drain the blood from their bodies after death. This helps to improve the quality, appearance, and shelf life of the meat. It also prevents spoilage and makes the meat safer and more hygienic for consumption. While, the purpose of scalding and defeathering of chicks during carcass analysis is to make feather removal easier and more efficient. Scalding involves dipping the carcass in hot water for a short time, which loosens the feathers by weakening the follicles. Afterward, defeathering is done either manually or mechanically to remove all feathers. This step helps to prepare the carcass for further processing and ensures cleanliness and accuracy during analysis. After scalding in warm water (70°C), the carcass was defeathered manually. The head and both shanks were detached. Visceral organs were removed by making an incision at the vent area. Then, the carcass was washed and hot carcass weight was recorded. The carcass percentage was calculated as follows:

Carcass Percentage (%) = [Carcass weight ÷ Live Weight] × 100

The dressed carcass was cooled for more than 20 hours. Cooling controls the spoilage and maintains the freshness, color, and texture of the meat. It also helps in accurate measurements. Then, carcass weight was taken as cold weight. Basic parts were obtained from the cold carcass and each part was weighed.

Figure 3. Hot Carcass after De-feathering

3.1.6. Statistical Analysis. One-way analysis of variance (ANOVA) was employed to determine the statistical differences among means. Duncan's test was utilized to conduct multiple comparisons among the groups. Together, they provided a clear picture of how treatments compared. All the data was expressed as the mean ± SD and the significance level was set as $p < 0.05$. IBM SPSS (version 22) was used for the analysis.

3. RESULTS

The results along with statistical descriptions are explained below.

3.1. Body Weight Gain

Table 3. Effect of Leaf Extract Supplementation on Weight, Feed Intake, and FCR in Broilers

Parameter	Gr-1	Gr-2	Gr-3	Gr-4	SE (±)	*p*-value
Initial Weight (g)	175 ± 0.00	176 ± 0.00	176 ± 0.00	173 ± 0.00	–	–
Final Weight (g)	1620 ± 24.6	1850 ± 24.6	1802 ± 24.6	1765 ± 24.6	24.6	0.022
Weight Gain (g)	1445 ± 20.8	1674 ± 20.8	1626 ± 20.8	1592 ± 20.8	20.8	0.028
Feed Intake (g)	3080 ± 19.5	3142 ± 19.5	3120 ± 19.5	3105 ± 19.5	19.5	0.087 ns
FCR	2.13 ± 0.03	1.87 ± 0.03	1.92 ± 0.03	1.95 ± 0.03	0.03	0.031

$p < 0.05$ = significant, $p < 0.01$ = highly significant, ns = not significant

3.2. Mortality Record

The observations showed that 10 (6.94% n=144) birds died during trial. The lowest mortality, that is, 1 (0.69%) was seen in G-2, while there were 5 (3.47%) deaths in G-4.

Table 4. Carcass Characteristics of Broilers Fed with Moringa Leaf Extract, Neem Leaf Extract, and their Combination.

Variables	Gr-1	Gr-2	Gr-3	Gr-4	SE	*p*-value
Carcass %	64.87 ± 0.45^{b}	69.16 ± 0.47^{a}	64.74 ± 0.44^{b}	67.45 ± 0.46^{ab}	0.46	0.032
Breast %	20.94 ± 0.38^{b}	25.50 ± 0.42^{a}	20.88 ± 0.36^{b}	21.48 ± 0.40^{b}	0.39	0.028
Thigh %	21.00 ± 0.41	22.01 ± 0.45	20.14 ± 0.39	20.41 ± 0.40	0.42	0.087
Liver	2.40 ± 0.12	3.00 ± 0.14	3.03 ± 0.15	2.42 ± 0.13	0.13	0.066
Heart	0.50 ± 0.03	0.60 ± 0.03	0.61 ± 0.04	0.61 ± 0.04	0.03	0.093
Gizzard	1.48 ± 0.05^{b}	1.69 ± 0.06^{a}	1.62 ± 0.06^{a}	1.50 ± 0.05^{b}	0.06	0.041
Fats %	2.92 ± 0.10	2.86 ± 0.11	3.01 ± 0.12	3.06 ± 0.11	0.11	0.139

$p < 0.05$ = significant, $p < 0.01$ = highly significant

3.3. Serum Biochemical Evaluation

The analysis of the sera was carried out by using an automatic biochemistry analyzer, namely Mindray BS-120, which is manufactured by Mindray. The results are shown below in Table 5.

Table 5. Serum Biochemical Indices of Broilers Supplemented with Moringa Leaf Extract, Neem Leaf Extract, and their Combination.

Parameter	Gr-1	Gr-2	Gr-3	Gr-4	SE	*p*-value
Total Proteins (g/dl)	3.23 ± 0.09^{a}	3.03 ± 0.08^{a}	3.03 ± 0.08^{a}	2.91 ± 0.07^{a}	0.08	0.084
Albumin	1.23 ± 0.06^{a}	1.37 ± 0.07^{ab}	1.47 ± 0.08^{a}	1.43 ± 0.07^{a}	0.07	0.049

Parameter	Gr-1	Gr-2	Gr-3	Gr-4	SE	*p*-value
(g/dl)						
Globulin (g/dl)	1.96 ± 0.06^{a}	1.67 ± 0.05^{b}	1.57 ± 0.05^{bc}	1.47 ± 0.04^{c}	0.05	0.017
AST (IU/L)	530.33 ± 12.44^{a}	430.00 ± 11.36^{b}	390.00 ± 10.85^{b}	320.00 ± 9.74^{c}	11.60	0.001
ALT (IU/L)	23.33 ± 0.87^{a}	19.00 ± 0.78^{b}	15.67 ± 0.74^{bc}	12.67 ± 0.69^{c}	0.77	0.002
ALP (IU/L)	419.77 ± 11.2	394.93 ± 10.73^{a}	396.50 ± 10.80^{a}	340.77 ± 9.42^{b}	10.54	0.021

$p < 0.05$ = significant, $p < 0.01$ = highly significant

4. DISCUSSION

This research aimed to check the effect of the addition of 4% moringa and neem leaf extract as 50 ml/l in drinking water on broilers. Their effects were checked on the growth, carcass characteristics, and serum biochemistry of broilers. Before this research, such concentrations had not been used for broilers.

4.1. Growth Performance

Prominent changes were observed in the growth of treatment groups. The results disclosed that the addition of leaf extracts in drinking water clearly affected the growth of birds of all groups except Gr-1. In the current study, the final body weight of broilers improved significantly (p = 0.022) across the treatment groups receiving leaf extracts in drinking water, with the highest value recorded for Gr-2 (1850 ± 24.6 g) as compared to Gr-1 (Control: 1620 ± 24.6 g). This indicates that supplementation with plant extracts had a positive impact on growth performance.

The results about FCR made it clear that Gr-2 had the best values, followed by Gr-3, Gr-4, and Gr-1. Similarly, total weight gain followed a comparable trend (p = 0.028), where Gr-2 exhibited a higher weight gain (1674 ± 20.8 g) than the control (1445 ± 20.8 g). These results are compatible with the results of [11], who found that the use of supplemented water with neem, moringa, and chicory leaf extracts can increase growth performance in broilers. On the contrary, these results are different from the observations of [18], who saw no clear development in the growth activity of broilers who were offered supplemented feed with the leaf powder of neem plant.

Improvement in body weight and weight gain may be attributed to the bioactive compounds present in leaf extracts, such as flavonoids, tannins, and essential oils, which have been reported to enhance nutrient utilization and stimulate digestive enzymes.

4.2. Carcass Quality Examination

Leaf extracts of neem and moringa were added separately and in combination with each other to the water given to the trial birds. This showed a significant effect on carcass percentage, meat yield at breast area, and gizzard weight. However, no clear improvement was seen in thigh meat, giblets, and abdominal fats (Table 4). The dietary inclusion of neem and moringa leaf extracts showed a positive influence on various carcass characteristics of broilers. Birds receiving neem extract (Gr-2) demonstrated significantly higher carcass yield

and breast meat percentage, as compared to the control and moringa-supplemented groups ($p < 0.05$). This may be attributed to the bioactive compounds present in neem, such as flavonoids and limonoids, which are known to enhance protein synthesis and promote lean muscle deposition. The combination group (Gr-4) also showed improved carcass traits, though the response was less prominent than that observed with neem alone. Moringa-supplemented broilers (Gr-3), despite not showing significant improvement in carcass or breast percentage, exhibited increased gizzard development. This could be due to the fibrous nature of moringa leaves, which may stimulate gizzard activity and muscular growth. Both neem and moringa groups (Gr-2 and Gr-3) had significantly higher gizzard weights as compared to the control, indicating enhanced digestive efficiency. No significant effects were observed in thigh percentage, on liver, heart, or abdominal fat deposition, suggesting that these leaf extracts did not negatively impact internal organ development or fat metabolism. Overall, neem extract alone proved the most effective in improving economically important carcass traits, especially breast yield, making it a promising natural growth promoter in broilers. These results are similar to the observations of [19], who saw better weight gain in broilers fed with moringa [20]. Although, these results are different from, who depicted no differences in carcass percentage in broilers fed with moringa [21].

4.3. Serum Biochemical Evaluation

The serum biochemical profile of broilers in this study demonstrated marked effects of neem and moringa leaf extracts, particularly on liver function indicators. The treated groups, especially those receiving both neem and moringa treatments (Gr-4), showed significantly reduced levels of AST, ALT, and ALP, as compared to the control group ($p < 0.05$). These enzymes are well-established markers of liver health; their decreasing amount suggests a hepatoprotective role of the combined extracts.

The elevated amount of albumin in treated groups further supports the notion of improved hepatic protein synthesis. Although total protein levels remained statistically unchanged, a significant decrease in globulin concentration was observed with extract supplementation, particularly in the combination group. This may reflect a redistribution of protein fractions or a reduction in immune stimulation, possibly due to the antimicrobial or anti-inflammatory properties of phytogenic additives. Overall, the combination of neem and moringa extracts proved the most effective in promoting liver health and stabilizing serum biochemical markers in broilers. This shows that the proteins of the treatments were similarly available to the birds, which confirms the observations of [22]. ALT, ALP, and AST levels were also depressed by giving moringa and neem leaf extracts. It shows that moringa and neem leaf extracts had no toxic effect within the liver parenchyma of broilers.

4.4. Conclusion

The current study demonstrates that the supplementation of neem (*Azadirachta indic*a) and moringa (*Moringa oleifera*) leaf extracts at 4% concentration in drinking water (50 ml/l) has beneficial effects on broiler health and productivity. Among all treatment groups, neem extract alone (Gr-2) showed the most significant improvement

in body weight gain, feed conversion ratio, carcass yield, and breast meat percentage, indicating its potential as a natural growth promoter. Moreover, the reduction in liver enzyme levels (AST, ALT, ALP) and the increase in serum albumin suggest a positive influence on liver health without any adverse effects. The findings support the hypothesis that plant-based phytogenic additives, particularly from neem, can serve as effective and sustainable alternatives to conventional antibiotic growth promoters. These natural extracts not only enhance performance and carcass quality but also contribute to the better internal health status of broilers. This research adds new insights into the use of local medicinal plants in poultry nutrition and suggests that neem leaf extract is a promising, low-cost, and safe growth enhancer for broiler production. Future studies are recommended to explore different dosage levels, long-term effects, and the molecular mechanisms underlying the observed benefits.

Author Contribution

Asim Shahzad Khan: conceptualization, methodology, writing– original draft, data curation, formal analysis. **Muhammad Asif Raza:** writing- review & editing. **Shahid Ali Rajput:** investigation. **Naheed Bano:** Formal Analysis **Atif Rehman:** project administration. **Riffat Yasin:** visualization. **Muhammad Asghar:** software. **Muhammad Uzair Khan:** formal analysis.

Conflict of Interest

The authors of the manuscript have no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

Data Availability Statement

Data supporting the findings of this study will be made available by the corresponding author upon request.

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Generative AI Disclosure Statement

The authors did not used any type of generative artificial intelligence software for this research.

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