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Influence of spearmint (*Mentha Spicata*) growth performance, hematological and lipid profile of broiler

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ABSTRACT

Introduction: Antibiotics and growth stimulants provide health hazards, prompting a demand for antibiotic-free organic broiler production. Natural plant-based feed additives are both safe and cost-efficient. This study aimed to thoroughly investigate the dietary impact of spearmint in various dosages on broiler production performance, hematobiochemical profile, bacterial load, and cost-effective performance. Materials and methods: In the experiment, a total of 225-day-old Cobb 500 broiler chicks were randomly selected into five experimental groups, each consisting of three replications of 15 birds. Groups T0, T1, T2, T3, and T4 consumed basal feed supplemented with 0 ml, 1 ml, 2 ml, 3 ml, and 4 ml of spearmint juice, and the treatment was given at 7 days to 28 days, respectively. Results: In this study, the T0 and T4 groups' total feed intake was considerably (P < 0.05) lower than that of the T1, T2, and T3 groups. Following T1, T3, T4, and T0 groups, group T2 received a 2 ml spearmint treatment, which resulted in a considerably (P < 0.05) greater final live weight. The T2 group had a significantly (P < 0.05) better feed conversion ratio (FCR) in comparison to the T0, T1, T3, and T4 groups. The weight of the broiler chicken's organs (carcass weight, thigh, breast muscle, drumsticks, wings meat, liver, heart, gizzard, and other organs) and dressing % were significantly affected by any of the treatment groups (P < 0.05). Dietary additions affected (P<0.05) the hematobiochemical parameters (concentration of haemoglobin, ESR, WBC, RBC, and lipid profile). Compared to the T0 group, the faecal bacterial load was reduced in the T1, T2, T3, and T4 groups. Conclusion: T2 is more cost-effective than other groups because of their faster rate of body growth. The 2% spearmint-treated group had birds with increased body weight, better FCR, and higher feed intake. Overall, 2% spearmint addition proved to be more beneficial than other treatment groups.

Keywords: broiler, spearmint (*Mentha spicata*), hematology, lipid profile, cost-effective.

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Introduction

Antibiotic Growth Promoters (AGP) will have a significant impact on the livestock and poultry industries. Finding an AGP substitute is necessary to reduce the growth loss. Numerous non-therapeutic options exist, including immune stimulants, enzymes, inorganic acids, probiotics, prebiotics, botanicals, and other management techniques (Banerjee, 1998; Monsoub, 2011). The idea of organic poultry is very

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new and is becoming more and more popular in developed countries. Herbs and spices were added to poultry diets as a non-nutritive feed addition. When these substances are present, the ration's nutritional content is largely supplied to enhance the birds' growth effectiveness, avoid disease, and maximize feed utilization. Among the significant members of the Lamiaceae family are peppermint (Mentha piperita) and spearmint (Mentha spicata) (Zaidi and Dahiya, 2015). According to Sabrina and Metha (1990), active ingredients in herbs help speed up digestion and metabolism. Mentha (mint) mints are fragrant, commonly cultivated, scented plants that are mostly perennial but occasionally annual and may grow in a range of environments (Bbrickell, 2002). The main medicinal properties of mint come from a rich, volatile oil found in the leaves and blossoms. This oil has been shown to contain thymol and highly oxygenated compounds, along with a dihydrocarbon (AOAC.; 1980). It's benefits alcohol, but boiling water is where it really shines. Steams have antispasmodic, choleretic, and carminative properties (Galib et al., 2010). Because it might diminish gastric reflux, which in turn lessens indigestion and colon spasms, mint is usually taken after meals (Spirling and Daniels, 2001). The essential oil is produced from freshly harvested or dried mint leaves using a distillation technique. The essential oil produced was found to have antibacterial, antifungal, antiviral, insecticidal, and antioxidant activities (Singh and Aggarwal, 2013). The essential oil contains high levels of limonene, dihydrocarvone, and 1,8-cineol (Hussain et al., 2010). The characteristic smell of spearmint oil is due to its most abundant ingredient, carvone. According to Abu Isha et al. (2018), there was an improvement in feed conversion rate as a result of increased appetite brought on by the stimulation of gastric and salivary glands by spearmint oil, a decrease in pathogenic bacteria, and improved digestibility. Additionally, there is a suggestion that spearmint oil may stimulate these glands and reduce bacteria, which in turn improves digestibility, FCR, and hematobiochemical profile. Studies in the lab have demonstrated that the growth of Salmonella enteritidis, Candida albican, Staphylococcus aureus, and Escherichia coli is inhibited by the action of peppermint essential oils. Furthermore, feeding spearmint is said to enhance feed intake, which in turn promotes improved chicken growth (Saleh et al., 2014). The mint species has uses in both medicine and commerce. Herbal teas and a variety of meals are flavored and scented with the leaves, stems, and flowers of the Mentha species. Due to inadequate research and information on spearmint in adding poultry ration, that's why this study was conducted. Objective of this study was: 1.To investigate the dietary impact of spearmint in various dosages on broiler production and cost-effective performance. 2. To determine the effect of spearmint on the hematology, lipid profile and bacterial load of broiler.

Material and method

Experimental site

The experiment was carried out at Hajee Mohammad Danesh Science and Technology University's Poultry Farm in Dinajpur from March to April 2022.

Experimental birds

For the experiment, 225-day-old broiler chicks (Cobb 500) were collected from the Kazi Farm hatchery via local traders. The chicks were randomly assigned to five nutritional treatment groups (T0, T1, T2, T3, T4), each of consisted of three replications with 15 birds each. The following are the treatments: T0 = control, T1 = control + 1 ml of spearmint juice per litre of water, T2 = control + 2 ml of spearmint juice per liter of drinking water, T3 = control + 3 ml of spearmint juice per kg of feed, and T4 = control + 4 ml of spearmint juice per kg of feed. When the spearmint was adding the feed or water, mixed all the content carefully. After a week of brooding, the course of treatment was administered across 7 to 28 days, accordingly. On the last day of the experiment, for each replication, 2 birds were slaughtered.

Collection and preparation of spearmint

Spearmint was collected from the botanical garden of Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur-5200, Bangladesh. Fresh leaves were collected (Figure 1), cleaned, and ground before water was added in a 1:1ml ratio. Subsequently, the leaves were blended to make juice, which was then refrigerated at 4 °C to preserve the active components.

Figure 1. Spearmint leaf and leaf juice

Managemental practices

For the experimental trial, commercial feed was used. The feed used in the experiment was bought from a feed store in the town of Dinajpur. In different ages, different feeds are

16-28 days. There were three times morning, noon, and evening were given feed of broilers. Housing (intensive and coop), litter water, lighting and sanitization were all necessities provided. Chicks were immunized against Ranikhet Disease (RD) and Infectious Bursal Disease (IBD) as scheduled. Suitable biosecurity protocols were put in place for the duration of the research.

Table 1. Experimental feed composition (Calculated analysis amount 100kg).

Ingredient	Starter (0-14) days	Grower (15-28) days
Crude protein (%)	22	21
Crude fiber (%)	3	3
Crude fat (%)	5	5-6
Lysine (%)	1.30	1.25
Methionine (%)	0.52	0.48
Calcium (%)	1	0.90
Phosphorus (%)	0.50	0.48
Moisture (%)	11	11
Metabolic Energy.ME (kcal/kg)	3000	3100

Ingredient	Amount (%)
Maize	60.70
Soybean meal	32.24
Soyabean oil	3.0
Dicalcium phosphate	2.20
Ground limestone	0.61
Choline chloride	0.10
DL methionine	0.20
L-lysine	0.15
Salt	0.30
Vitamin –mineral premix*	0.50

* Vitamin-mineral premix contains in the following per kg: vitamin A, 2400000 IU; vitamin D, 1000000 IU; vitamin E, 16000 IU; vitamin K, 800 mg; vitamin B1, 600 mg; vitamin B2 , 1600 mg; vitamin B6 , 1000 mg; vitamin B12, 6 mg; niacin, 8000 mg; folic acid, 400 mg; pantothenic acid, 3000 mg; biotin 40 mg; antioxidant, 3000 mg; cobalt, 80 mg; copper, 2000 mg; iodine, 400; iron, 1200 mg; manganese, 18000 mg; selenium, 60 mg, and zinc, 14000 mg.

Hematological analysis

After 4 weeks, blood samples were collected using a vacutainer tube through the wing vein puncture tubes (BD vacutainer SST Gel-5 ml). They were then allowed to coagulate at room temperature (25 °C) for an hour, which used an ASPO 4 mL clot activator. The serum was extracted from the blood sample by centrifugation at 2000 rpm for 15 minutes. Separated, non-hemolyzed serum samples were kept in clean, dry Eppendorf tubes in the deep freezer (-20 °C) for later use. The analyzes were performed with commercial kits produced by the German cholesterol agent manufacturer Randof (2016). The experiment was conducted using a Merck Microlab300 biochemistry analyzer (India), following the instructions in the manufacturer's booklet. The lipid profiles were determined using biochemical assays.

Collection of fecal sample, storage, transportation, culture and bacterial colony count

On the 28th day, a bacterial colony from one bird was randomly chosen for counting. For bacteriological examination, bird droppings were used to gather feces. Feces were collected and then preserved at 4°C in sealed polythene bags. The dairy microbiology lab received the sample of feces after that. Sample dilution, inoculation, bacterial culture, and ultimately colony count were all meticulously monitored throughout the production of culture medium in the microbiology lab. The colonies are counted after the plate has been incubated under microorganism-appropriate conditions. For the spread, pour, and drop methods, colony counting is self-explanatory: count each colony dot once. A marker can be used to point out each numbered colony on the back of the Petri dish.

Calculation: 1. Total gain in weight = final weight – initial weight. 2. Total feed consumption = total feed offered – total left-over 3. Feed conversion ratio = total feed consumed / total gain in weight . 4. Mortality rate (%) = no. of dead chickens / total no. of birds as a group × 100.

Statistical analysis

The generated data were entered into SPSS version 25 software, which then used one-way ANOVA to analyze them in compliance with the Complete Randomized Design (CRD) principles. Every value was reported as mean ± SEM, and significance was assessed ($P > 0.05$). The Duncan test was used to compare the means of the treatment groups.

Results and Discussion

Dietary effect of spearmint on body weight

The weekly body weight gain in the first and second weeks of age did not differ significantly across treatments ($P > 0.05$). According to similar findings by Amasaib et al. (2013), the addition of spearmint leaf extract in the first and second weeks of age had no effect on broiler chicken weight gain. Only in the third week of life it become clear that the body weight gain in all treatment groups (T1, T2, T3, and T4).It was significantly greater than that of the control group. This could be spearmint-fed groups consumed more feed. Amasaib et al.'s (2013) findings did not support this result. These findings were consistent with those of Galib et al. (2010), who discovered that peppermint addition had no effect on overall body weight but did improve performance over the control group. Demir et al. (2008) revealed similar findings on the effect of spearmint on reducing body weight. The T1, T2, T3, and

Table 2. The effect of spearmint on body weight gram/ broiler.

	Dietary Treatment Groups					
Weeks	**T_0 (control)**	**T_1**	**T_2**	**T_3**	**T_4**	**Level of significant**
Initial body weight	38.5 ± 0.27	38.5 ± 0.13	38.2 ± 0.35	38.2 ± 0.13	38.8 ± 0.18	NS
1st week	173.3 ± 1.16	177.2 ± 1.29	177.3 ± 1.49	173.6 ± 1.23	170.9 ± 1.22	NS
2nd week	272.7 ± 0.54^{a}	285.1 ± 0.57^{c}	288.8 ± 0.80^{d}	279.4 ± 1.55^{b}	284.1 ± 0.49^{c}	*
3rd week	426.1 ± 1.95^{a}	493.0 ± 2.54^{b}	591.1 ± 9.26^{e}	509.4 ± 2.84^{c}	548.8 ± 1.28^{d}	*
4th week	504.7 ± 1.40^{a}	608.7 ± 1.78^{c}	672.7 ± 0.67^{e}	624.4 ± 1.72^{d}	599.7 ± 2.24^{b}	*
Final body weight	1376.9 ± 5.05^{a}	1564.1 ± 6.18^{b}	1729.9 ± 12.22^{d}	1586.9 ± 7.34^{bc}	1603.6 ± 5.23^{c}	*

a, b, c means having different superscript in the same row differed significantly (P<0.05). * = P<0.05 level of significance, NS=Non-significant

(P > 0.05) compared to the T0 group (Table.2), consistent with previous studies by Ocak et al. (2008), Rahman et al. (2017), Abu Isha et al. (2018), and Al-Ankari et al. (2004).

Feed intake

Table. 3 provides information on average weekly feed consumption and total feed use. According to the table, feed intake was highest in the T0 group and lowest in the T4 group during the first week of the bird, but highest in the T1 group and lowest in the T0 group during the second week. Feed consumption peaked in the T2 group in the third and fourth weeks of life and was lowest in the T0 group. Based on the results of the current study, it can be stated that the T2 group had the highest weekly feed intake compared to the control group and that supplementation with spearmint leaf extract at levels of 2 ml improved feed intake. The T2 group consumed the most feed overall per broiler, and the T0 group consumed the least of the various experimental groups. The increase in feed intake shown in this study may have resulted from spearmint's flavoring impact (Deyoe et al., 1962). The results of this study's feed intake were found (P<0.01) to be consistent with those of Amasaib et al. (2013), Ocak et al. (2008), Rahman et al. (2017), Abu Isha et al. (2018), and Al-Ankari et al. (2004).

Feed conversion rate

During the first week of the experiment, the T0 group had the highest weekly feed conversion ratio, and the T2 and T3 groups had the lowest. In the second week, the FCR of the T2 and T4 groups was higher than that of the T0, T1, and T3 groups. It was found that the FCR values for the T0 group were greater and those for the T2 group were better in the third week. The T2 and T4 groups outperformed the T0, T1, and T3 groups in terms of FCR values during the four-week age period. At age 28, broiler feed efficiency was considerably lower and better in T2 (1.35 ± 0.71) than in other treatment groups (P<0.1) (Table.4) These results are consistent with those of Amasaib et al. (2013), Ocak et al. (2008), Rahman et al. (2017), Abu Isha et al. (2018), and Al-Ankari et al. (2004).

Carcass quality

Table. 5 shows that broiler meat yield features following various spearmint treatments. The samples with the highest live weights were T2 (1729.98±12.22) and T4 (1603.67±5.23). The live weights with the lowest values are T0 (1376.91±5.05) and T1 (1564.13±6.18). The samples with the highest carcass weights were T2 (1001.17±3.28) and T4 (955.50±21.27). T1 (963.44±4.44) and T0 (1376.91±5.05) are the carcass weights with the lowest values. Supplementing with 2 ml of spearmint significantly raised the dressing percentage (P < 0.05). These findings are harmonious with those of Ocak et al. (2008), Rahman et al. (2017),

Table 3. Effect of spearmint on feed intake of broiler (gram)

	Dietary Treatment Groups					
Weeks	**T_0 (control)**	**T_1**	**T_2**	**T_3**	**T_4**	**Level of significant**
1st week	192.53±0.72	185.24±2.63	183.59±3.88	179.68±2.31	180.52±0.64	NS
2nd week	372.49 ± 1.23^{a}	384.14 ± 1.87^{c}	381.68 ± 1.48^{bc}	375.99 ± 1.17^{a}	376.81 ± 2.09^{ab}	*
3rd week	682.64 ± 0.80^{a}	729.72 ± 1.93^{b}	795.61 ± 2.63^{e}	745.03 ± 1.01^{c}	764.04 ± 0.84^{d}	*
4th week	882.40 ± 1.70^{a}	983.61 ± 2.63^{d}	971.73 ± 0.67^{c}	964.57 ± 0.74^{b}	882.98 ± 1.40^{a}	*
Total Feed Intake	2130.06 ± 4.45^{a}	2282.71 ± 9.06^{bc}	2332.61 ± 8.66^{d}	2265.27 ± 5.23^{c}	2204.35 ± 4.97^{b}	*

a, b, c means having different superscript in the same row differed significantly (P<0.05). * = P<0.05 level of significance, NS=Non-significant

Table 4. Effect of spearmint on FCR

	Dietary Treatment Groups					
Weeks	**T_0 (control)**	**T_1**	**T_2**	**T_3**	**T_4**	**Level of significant**
1st week	1.11 ± 0.01	1.05 ± 0.01	1.04 ± 0.01	1.03 ± 0.01	1.06 ± 0.01	NS
2nd week	1.37 ± 0.00^c	1.35 ± 0.00^b	1.32 ± 0.01^a	1.35 ± 0.00^b	1.33 ± 0.01^a	*
3rd week	1.60 ± 0.01^d	1.48 ± 0.01^c	1.35 ± 0.02^a	1.46 ± 0.01^c	1.39 ± 0.00^b	*
4th week	1.75 ± 0.00^e	1.62 ± 0.00^d	1.44 ± 0.00^a	1.54 ± 0.00^c	1.47 ± 0.01^b	*
Final FCR	1.55 ± 0.88^e	1.46 ± 1.47^d	1.35 ± 0.71^a	1.43 ± 0.71^c	1.37 ± 0.95^b	*

a, b, c means having different superscript in the same row differed significantly (P<0.05). * = P<0.05 level of significance, NS=Non-significant

Abu Isha et al. (2018), and Al-Ankari et al. (2004). However, these were dissimilar from Amasaib et al. (2013), who found that adding spearmint to chicken did not significantly raise the dressing percentage. There were notable differences in the percentages of drumstick and breast meat in different diets. As spearmint levels grow, grill meat—especially the drumstick and breast—nearly increases linearly. The findings of the tabulation indicate that the amount of spearmint had a considerable impact on the meat's characteristics. Chopra et al. (1992) reported that the herb with beneficial effects on the digestive system performed better (Brander, 1985). All the meat yield parameters were significantly different (P<0.05).

Serum biochemical profile

Blood biochemical properties in broilers Table 6 displays the effect of spearmint on the lipid profile of broilers. Total cholesterol levels differed significantly (P < 0.01) between treatment groups, with T0 having higher levels and T2 having lower levels. T0 had significantly higher blood triglyceride levels compared to T3, who had lower levels (P<0.01). T3 had a significantly higher high-density lipoprotein HDL value than T0, which had a lower value (P<0.01). Low-density lipoprotein (LDL) levels were significantly higher in T0 and lower in T2. LDL values were lower in the spearmint treatment group compared to the control group. The experimental group that took spearmint supplements had increased blood levels of HDL mg/dl, while spearmint considerably reduced blood LDL levels. This could be because spearmint serves as an antioxidant, inhibiting the oxidation of LDL and cholesterol (Mathur et al., 1996) and slowing the

Table 5. Effect of spearmint on Carcass quality of different dietary groups (gram)

	Dietary Treatment Groups					
Meat yield trait	**T_0 (control)**	**T_1**	**T_2**	**T_3**	**T_4**	**Level of significant**
Live weight	1376.9 ± 5.05^a	1564.1 ± 6.18^b	1729.9 ± 12.22^d	1586.9 ± 7.34^{bc}	1603.6 ± 5.23^c	*
Carcass weight	798.9 ± 1.64^a	963.4 ± 4.44^b	1001.1 ± 3.28^c	955.5 ± 21.27^b	979.2 ± 9.28^{bc}	*
Breast weight	227.1 ± 0.86^a	345.8 ± 2.74^d	398.5 ± 1.42^e	320.3 ± 0.29^c	310.3 ± 2.66^b	*
Thigh weight	198.6 ± 1.55^a	234.2 ± 0.80^b	285.4 ± 0.27^e	254.3 ± 2.02^c	273.6 ± 2.81^d	*
Drum stick meat	86.4 ± 2.80^a	120.1 ± 1.43^b	131.0 ± 1.19^c	119.8 ± 0.70^b	124.2 ± 0.70^b	*
Wing meat weight	99.2 ± 0.37^a	116.8 ± 1.97^b	135.0 ± 0.72^d	126.7 ± 1.71^c	124.3 ± 0.93^c	*
Head	30.8 ± 0.34^a	34.7 ± 0.55^c	41.2 ± 0.28^b	35.8 ± 1.00^b	35.03 ± 0.73^b	*
Gizzard weight	38.1 ± 2.10^a	42.0 ± 0.20^{ab}	50.4 ± 1.01^c	55.2 ± 1.06^d	43.3 ± 1.06^b	*
Liver	41.0 ± 1.12^a	57.4 ± 0.70^c	73.8 ± 0.47^e	46.2 ± 1.07^b	65.9 ± 2.48^d	*
Heart	7.39 ± 0.09^a	7.57 ± 0.32^a	13.0 ± 0.15^c	11.3 ± 0.14^b	11.2 ± 0.09^b	*
Spleen	2.4 ± 0.01	2.54 ± 0.08	3.50 ± 0.10	3.57 ± 0.05	2.77 ± 0.15	NS
Intestine weight	99.3 ± 1.22^b	108.20 ± 1.91^c	107.3 ± 0.58^c	116.6 ± 2.23^d	94.15 ± 0.47^a	*
Mortality rate	0.33 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	*

a, b, c means having different superscript in the same row differed significantly (P<0.05). * = P<0.05 level of significance, NS=Non-significant

Table 6. Effect of spearmint on serum biochemical profile

	Dietary Treatment Groups					
Serum biochemical	**T_0 (control)**	**T_1**	**T_2**	**T_3**	**T_4**	**Level of significant**
Total cholesterol	176.4 ± 1.35^{e}	165.0 ± 0.24^{d}	120.5 ± 1.35^{a}	135.9 ± 1.03^{b}	147.7 ± 1.49^{c}	*
Triglyceride	71.2 ± 0.80^{d}	59.5 ± 0.35^{c}	53.9 ± 1.66^{ab}	50.8 ± 0.37^{a}	55.5 ± 2.23^{bc}	*
HDL	35.1 ± 0.87^{a}	42.7 ± 0.61^{c}	39.8 ± 0.17^{b}	46.3 ± 0.72^{d}	47.8 ± 1.18^{d}	*
LDL	103.1 ± 0.53^{e}	96.1 ± 1.25^{d}	55.3 ± 1.00^{a}	91.2 ± 0.85^{c}	63.0 ± 1.38^{b}	*

a, b, c, d, e means having different superscript in the same row differed significantly (P<0.05). * = P<0.05 level of significance, NS=Non-significant

thermogenesis process. The amount of spearmint supplement gradually decreased as it was increased in all treated groups. The findings of this study seem to be closely related to those of Dalal et al. (2018), Alzawqari et al. (2016), and Yeasmin et al. (2023), who discovered that increasing levels of natural supplementation resulted in a reduction in serum cholesterol and achieved the best results with spearmint supplementation. They also observed that blood HDL (mg/dl) levels rose and decreased in response to increased spearmint supplementation amounts. The results seem to corroborate those of Aljumaily et al. (2019), who found that natural organic supplements, such as spearmint, recorded lower triglyceride levels than control; and Dalal et al. (2018), who found that serum triglyceride levels and LDL levels of spearmint supplements were similar to those of the control group. The authors are Saleh et al. (2014) and Abdel-Wareth and Lohakare (2014). Toghyani et al. (2010), Akbari, and Torki (2014) agree that spearmint supplementation affects the lipid profile of the chicken body.

Hematological parameters

Haematological properties Table.7 shows how spearmint affects broiler chicks. All the blood parameters were significant (P<0.05). According to Nobakht and Aghdam Shahriar (2011), Akbari and Torki (2014), and Rahimi et al. (2011), Rahim et al. (2012) found the same hematologically significant results as a supplement of spearmint.

Table 7. Effect of spearmint on hematological parameter

	Dietary Treatment Groups					
Hematological parameter	**T_0 (control)**	**T_1**	**T_2**	**T_3**	**T_4**	**Level of significant**
Hemoglobin (g/dL)	11.7 ± 0.11^{b}	12.3 ± 0.09^{c}	13.3 ± 0.06^{d}	10.8 ± 0.19^{a}	13.6 ± 0.17^{d}	*
ESR	4.0 ± 0.00^{b}	3.27 ± 0.18^{a}	6.27 ± 0.13^{d}	4.47 ± 0.24^{b}	5.13 ± 0.13^{c}	*
Total WBC count/L	9.5×10^{9} ± 0.2^{d}	9.2×10^{9} ± 0.2^{d}	7.8×10^{9}± 0.6^{c}	5.3×10^{9} ± 0.8^{b}	4.9×10^{9} ± 0.6^{a}	*
Neutrophil (%)	7.0 ± 0.12^{b}	5.73 ± 0.18^{a}	8.40 ± 0.20^{c}	7.20 ± 0.31^{b}	5.27 ± 0.13^{a}	*
Lymphocytes (%)	85.7 ± 0.75^{a}	89.07 ± 0.24^{b}	88.07 ± 0.75^{b}	84.2 ± 0.12^{a}	90.73 ± 0.07^{c}	*
Monocyte (%)	3.53 ± 0.27^{ab}	4.27 ± 0.27^{c}	3.20 ± 0.12^{a}	4.07 ± 0.07^{bc}	4.40 ± 0.23^{c}	*
Eosinophil (%)	2.80 ± 0.42^{ab}	3.07 ± 0.07^{ab}	2.40 ± 0.20^{a}	2.27 ± 0.13^{a}	3.53 ± 0.29^{b}	*
PLT (/L)	184 ×10^{9} ± 8.2^{be}	134×10^{9} ± 9c	175×10^{9} ± 6.6^{d}	129×10^{9} ± 2821.2^{b}	123×10^{9} ± 6.82^{a}	*
RBC (1x10^{6}/µL)	1.88 ± 0.08^{a}	2.51 ± 0.05^{c}	2.35 ± 0.01^{bc}	2.59 ± 0.23^{c}	2.06 ± 0.02^{ab}	*
PCV (%)	25.2 ± 0.07^{b}	27.6 ± 0.11^{c}	22.5 ± 0.09^{a}	25.12 ± 0.47^{b}	22.10 ± 1.23^{c}	*
MCV (fL)	122.6 ± 0.07^{c}	121.5 ± 0.07^{b}	118.5 ± 0.06^{a}	123.4 ± 0.04^{d}	121.52 ± 0.32^{b}	*
MCH (pg)	60.3 ± 0.06^{b}	57.7 ± 1.23^{a}	60.9 ± 0.34^{bc}	62.59 ± 0.36^{c}	57.73 ± 0.45^{a}	*
MCHC (g/dL)	49.3 ± 0.06^{b}	49.0 ± 0.07^{b}	51.3 ± 0.05^{d}	50.47 ± 0.02^{c}	47.79 ± 0.40^{a}	*
MPV (fL)	13.2 ± 0.06^{a}	14.2 ± 0.03^{c}	14.5±0.05^{d}	13.05±0.14^{a}	13.61 ± 0.12^{b}	*
PDW (%)	17.8 ± 0.18^{ab}	17.6 ± 0.34^{ab}	18.9±0.17^{c}	17.38±0.23^{a}	18.34 ± 0.08^{bc}	*
PCT (%)	1.39 ± 0.02^{b}	1.85 ± 0.00^{e}	1.65±0.01^{c}	1.74±0.02^{d}	1.26 ± 0.00^{a}	*
RDW SD (fL)	74.0 ± 0.22^{d}	53.4 ± 0.08^{c}	50.38±0.09^{a}	51.82±0.19^{b}	50.16 ± 0.07^{a}	*
RDW CV %	9.4 ± 0.05^{a}	10.5 ± 0.06^{b}	10.19±0.16^{b}	10.22±0.20^{b}	14.35 ± 0.19^{b}	*

a, b, c means having different superscript in the same row differed significantly (P<0.05). * = P<0.05 level of significance, NS=Non-significant

Table 8. Effect of spearmint on bacterial load count in faecal sample of broiler

Parameters		Dietary Treatment Groups					
		T_0 (control)	T_1	T_2	T_3	T_4	Level of significant
Faeces	*E. coli*	272.3 ± 10.34^a	242 ± 1.56^b	233.0 ± 14.72^c	124.5 ± 8.43^d	87.4 ± 10.48^e	*
	Salmonella sp.	278.3 ± 17.25^a	238 ± 1.28^b	229.6 ± 12.18^c	121.4 ± 8.21^d	109.4 ± 4.96^e	*

a, b, c, d, e means having different superscript in the same row differed significantly (P<0.05). * = P<0.05 level of significance, NS=Non-significant

Table 9. Effect of spearmint on economics of broiler production kept under different treatment groups from day old chick to 28 days of age

Parameters (Tk.)	Dietary Treatment Groups				
	T_0 (control)	T_1	T_2	T_3	T_4
Chick cost	35	35	35	35	35
Litter cost / bird	4.5	4.5	4.5	4.5	4.5
Vaccine and medicine	2	2	2	2	2
Feed cost / broiler production (BDT)	138.4 ± 4.61^a	148.3 ± 3.28^c	151.5 ± 5.06^d	147.22 ± 5.32^c	143.26 ± 5.14^b
Dietary treatment cost/broiler production	0.00	2	3	4	5
Miscellaneous cost	5	5	5	5	5
Total cost/broiler	184.9 ± 3.74^a	196.8 ± 5.66^c	201.0 ± 6.04^d	197.7 ± 5.08^c	194.7 ± 5.00^b
Average live weight/broiler (gm)	1376.9 ± 5.05^a	1564.1 ± 6.18^b	1729.9 ± 12.22^d	1586.9 ± 7.34^{bc}	1603.6 ± 5.23^c
Sale price Tk./kg	160	160	160	160	160
Sale price / broiler	220.1 ± 15.5^a	250.2 ± 12.54^b	276.6 ± 13.54^c	253.7 ± 16.04^b	256.4 ± 10.24^b
Net profit Tk./ broiler	35.2 ± 2.24^a	53.4 ± 4.58^b	75.5 ± 5.14^d	56.0 ± 4.34^b	61.7 ± 5.29^c
Profit Tk./kg live weight	25.5 ± 2.74^a	34.1 ± 2.52^b	43.7 ± 3.85^c	35.3 ± 3.68^b	38.5 ± 3.48^b
Profit compare Tk. between control	0	18.2 ± 1.5^a	40.3 ± 2.34^c	20.8 ± 1.74^a	26.5 ± 2.64^b

a, b, c means having different superscript in the same row differed significantly (P<0.05)

Effect of spearmint on bacterial load count

The Table.8 shows the effect of spearmint juice on microbial load count in faecal sample. The E. coli load was significantly (P<0.01) higher in T0 (272.33±10.34), followed by T1 (242 ± 11.56), T2 (233.00±14.72) , T3 (124.50±8.43) and T4 (87.48±10.48)respectively and Salmonella sp. load was also significantly (P<0.01) highest in T0 (278.33 ± 17.25) where as it was 238±10.28, 229.67 ± 12.18 , 121.43 ± 8.21 and 109.45±4.96 in T1, T2 and T3 and T4 respectively. It's possible that intermediate nutrition metabolism is connected to the stabilizing influence on gut flora (Jamroz et al., 2003). In addition, it has been proposed that spearmint oil may activate these glands and decrease bacteria, improving the hematobiochemical profile, digestibility, and FCR. Experimental studies have shown that the activity of peppermint essential oils inhibits the growth of Salmonella enteritidis, Candida albicans, Staphylococcus aureus, and Escherichia coli. Additionally, it has been suggested that giving spearmint to chickens can increase their consumption of feed, which will help their growth (Saleh et al., 2014; Abu Isha et al., 2018).

Cost-effectiveness of broiler production

The cost of producing various treatment groups of broilers is given in Table 9. As shown in Table. 9, the average raising expenses of broilers kept in treatment groups T0, T1, T2, T3, and T4 were 220.16, 250.24, 276.64, 253.76, and 256.48 Taka, respectively. The overall cost of miscellaneous expenses, which included labour, disinfection, and estimated electricity costs, were 5 Tk per broiler. The average live weight/broiler for groups T0, T1, T2, T3, and T4 was 1.376, 1.564, 1.729, 1.586, and 1.603 kg, respectively. The broiler was priced at Tk. 160/kg when sold at live weight. In the T0, T1, T2, T3, and T4 groups, the net profit per kg of live weight was revealed to be taka, 25.21, 34.14, 43.70, 35.33, and 38.50. The amount of spearmint employed in the diet has an impact on the broiler's profit margin. According to Zafar and Fatima (2018) and Yeasmin et al. (2023), poultry production benefits more from organic natural supplements. They have the purpose of reducing feed costs by lowering dose rates without compromising performance because they are more bioavailable and effective. Abdallah et al. (2009) claim that an organic mineral diet benefits the economy. It was discovered that replacing inorganic minerals with organic minerals improved bird performance and chick immune responses.

Conclusions

Therefore, Spearmint supplementation enhanced growth performance, decreased microbial loads, and improved hematobiochemical conditions (P< 0.05). With more 2 ml of spearmint, overall performance and quality were improved. We may conclude that including spearmint in broiler diets could assist in cost-effective and efficient broiler production. As a result, adding 2 ml of spearmint supplement during broiler production may be recommended.

Authors' contributions

This work was carried out in collaboration among all authors. Author MAJ designed the study, collected data, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors TY, US, NA, SHS, MAH, EA and MH managed the literature searches and given proper guideline. MDB and EA were performed microbial load count. All authors read and approved the final manuscript.

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Conflicts of interest

The authors declare that there are no conflicts of interest

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