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Influence of adding several levels of dried parsley (Petroselinum crispum) on growth performance of broiler chicks

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ABSTRACT

The present research examines the impact of varying concentrations of dried parsley (Petroselinum crispum) supplementation on the growth performance, feed conversion ratio, and intestinal histological change of broiler chicks (Ross 308). A total of 224 one-day-old chicks (each group had equal replication) were randomly allocated to four distinct dietary treatments: T1 (control, standard diet), T2 (standard diet supplemented with 100g/kg of parsley), T3 (standard diet supplemented with 200g/kg of parsley), and T4 (standard diet supplemented with 300g/kg of parsley). Growth rate, feed intake, feed conversion ratio, and economic viability were ascertained. Results indicate significant increases in body weight gain, particularly in the early growth phases, with the highest gain being in the T2 and T4 groups. Parsley supplementation reduced feed consumption but concurrently improved feed efficiency, especially in T2. Higher levels of supplementation (T3, T4) had variable effects in enhancing some parameters but reducing intake efficiency in later stages. Intestinal morphology examination showed that mucosal thickness, villi height, and villi thickness were significantly increased in supplemented groups, indicating better nutrient absorption capacity. Economic analysis indicated that moderate inclusion of parsley (T2) was the most cost-effective. These results indicate that parsley in the diet (300-400g) can improve broiler performance, gut health, and economic returns and can be used as a natural substitute for synthetic feed additives.

1. Introduction

Feed additives are essential components that can boost feed utilization efficiency and animal performance. Unfortunately, the usage of chemical products, particularly antibiotics and hormones, may have negative consequences. Many initiatives are being made in the field of animal nutrition to increase animal productivity and thereby profit (Baris, 2023). To preserve the production activity of birds, several factors must be considered, particularly the integrity of the gut, which has recently become the most researched organ because it is a major and comprehensive domain that includes nutrition, physiology, microbiology, and immunology. When the gut's health deteriorates, all digestion and absorption functions suffer (Rinttila et al., 2013). The majority of feed supplements currently supplemented with poultry diets normally contain antioxidants and/or antimicrobials (Majid et al., 2020b). In recent years

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there has been a considerable decrease in the application of antibiotics in animal feed (Ahmed et al., 2022), Nutritional additives containing native antioxidants have been used to counteract the negative impacts on the physiological and health condition of broiler chickens, as well as on their storage time and meat quality (Al-Obaidi et al., 2021), and also a considerable increase in interest for research on the development of new natural products like dietary supplements and medicinal plant extracts. These plant extracts are reported to contain anti-inflammatory, antifungal, antibacterial, and antioxidant activities. They also play antioxidant roles that increase the oxidative stability of meat and meat products by inhibiting the oxidation of meat lipids (Hamma et al., 2024). Flavonoids, which are great substances and contribute a lot to physical health enhancement also exist in medicinal plants, lowering the risk of disease and acting as antioxidants to combat free radicals the parsley plant *Petroselinum sativum* is one of these drugs and medicinal plants (Majid et al., 2020a). The annual culinary herb parsley (*Petroselinum Crispum* L.) is commonly grown in western Asia and Europe (Peter, 2004). Parsley is also thought to be a source of different materials, particularly apigenin and lutulin, as well as multi vitamins and folic acid (Meyer et al., 2006). Essential oils' potential to improve chick growth has been proved by their ability to improve digestive activity by encouraging digestive enzymes to self-excretion and activation; thus, the microbial environment must be neutralized to achieve digestive system health (Hong et al., 2012). This oil contains the most significant chemicals. Apiole, as well as vitamins, some useful metals and the iodine, active principle of the plant (Razzaghi-Abyaneh et al., 2007). The essential oils found in the seeds of this herb range from 2 to 8%, with the most important being tetramethoxyally benzene, as well as other oils including the basic components. This study seeks to explore how adding parsley to the diet of broiler chickens affects their growth and overall performance, building on earlier research to gain a clearer understanding of its potential benefits.

2. Materials and methods

Total of 224 broiler chicks Ross -308, one day old and weighing 38-40 grams, were used. The chicks' groups were assigned to four treatments with four replicates each and were distributed randomly into 16 groups of 14 chicks of average body weight in each pen. Treatments were T1: base diet (control), T2: base diet + 100g/kg of parsley, T3: base diet + 200g/kg of parsley, T4: base diet + 300g/kg of parsley. Experimental diets: The experimental diets were formulated according to the nutrient requirements of the broiler chicks as outlined by the (NRC, 1994). All chicks were fed a standard starter from the first day of age up to the 42nd day, then they were fed according to the different dietary treatments as shown in Table 1.

Study Traits: Body weight gain (BWG) After the end of each period, body weight gain was calculated for each replicate using the following equation:

$$\text{Body weight gain} = LWE - LWB.$$

LWE: Live body weight at the end of the period.

WB: Live body weight at the beginning of the period (Hadme, 1994).

Feed intake (FI): The amount of feed that the chicks in each duplicate did not consume at the end of the week was used to compute feed intake. Every seven days, feed intake was measured and computed using the following formula:

$$\text{Average feed intake (g/bird/period)} = \frac{FB - FE}{TN}.$$

FB: Feed provided at the beginning of period(g).

FE: Feed provided at the end of the period(g).

TN: Total number of birds.

$$\text{Average feed intake(g)} = \frac{FK}{NL \times ND - TD}.$$

FK: Feed intake by bird in known period (g).

NL: Number of livings in same period.

ND: number of periods days.

TD: Total age of died birds (Hadme, 1994).

Feed conversion ratio (FCR): The following formulae are used to compute the feed conversion ratio, which is the quantity of feed intake estimated to unit weight for each weight growth estimated in the same unit:

Table 1: Nutrition composition and chemical analysis.

Ingredient, % as feed-basis	Starter diet (1-14 days) %	Growth diet (15-28 days) %	Finisher diet (36-42 days) %
Wheat	23.6	23	27.5
Corn	35.5	34.8	39.7
Meat and bone meal (40%)	3	0.6	0.4
Soybean meal (%44)	29.9	33.04	23.28
Sunflower seed Oil	4	5	5
Dual-calcium phosphate	2.3	1.94	1.86
Limestone	1.15	1.16	1.11
Salt	0.25	0.25	0.25
Methionine	0.2	0.11	0.8
Premix[1]	0.1	0.1	0.1
Total	100	100	100
Chemical analysis of the feed			
** Crude protein %	22	20	17
* Metabolizable energy Kcal/kg	2919	3056	3079
** Ether extract %	5.3	6.05	6.12
* Crude fiber %	3.57	3.65	4.00
** Calcium %	1.19	1.11	1.22
** Phosphor %	0.76	0.55	0.57
* Lysine %	1.19	1.2	1.01
* Methionine + Cysteine %	0.89	0.92	0.89

Vitamins A (800.000 IU), D3(170.000 IU), E (980mg), K3(95mg), B1(1mg), B2 (220mg), B6 (75mg), B12 (800mg), Folic acid (20 mg), Choline Chloride (12.000 mg), and Antioxidant (1.900 mg) are included in the Premix. Calcium 24.00%, Sodium5.40%, Phosphorus 8.40%, Methionine 5.40%, Methionine+ Cystine 5.70%, and Lysine 5.60%. Iron 2.5 mg, Copper 400 mg, Zinc 2.600 mg, Selenium 7.5 mg.

$$\text{Feed conversion ratio} = \frac{AID}{AWSD}.$$

AID: Average of feed intake by one bird in a duration.

AWSD: Average of weight gain by one bird in same duration.

Energy Intake (EI): At the end of each replicate's week, the energy intake of the chicks was determined by comparing their feed intake to the calorie content of their diet. Every seven days, energy intake was measured and computed using the following formula:

$$Energy\ intake = FI \times AED$$

FI: Feed intake.

AED: Amount of energy in the diet.

Energy Efficiency (EE): Using the following formula, energy efficiency was determined by dividing the quantity of energy consumed by the amount of body weight gained during a certain time period:

$$\text{Energy efficiency} = \frac{EID}{BWD}.$$

EID: Energy intake by one bird in a duration.

BWD: Body weight gain by one bird in same duration.

Protein Intake (PI): Protein intake was computed using this equation by dividing the amount of feed consumed by the amount of protein consumed during a certain time period:

$$Protein\ intake = FI \times AD$$

FI: Feed intake.

AD: Amount of protein diet.

Protein efficiency (PE): Protein efficiency, which can be computed using the following formulae, is the ratio of protein intake to predicted body weight increase during the same time period:

$$\text{Protein efficiency} = \frac{PID}{BWD}$$

PID: Protein intake by one bird in a duration.

BWD: Body weight gain by one bird in same duration.

Mortality and Viability percentage: The date of occurrence was used to record any mortality that occurred in each replication. The following formula was used to determine the ratio percentage:

$$M\% = \frac{ND}{NT} \times 100.$$

ND: Number of dead birds.

NT: Number of total reared birds.

$$\text{Viability}\ \% = 100 - \text{mortality}.$$

Production Index (PI) Production index calculated b: Production index calculated by following formulas: - y following formulas:

$$PI = \frac{AW \times VP}{ND \times FC \times 10}.$$

AW: Average body weight (g).
VP: Viability percentage.
ND: Number of days breeding.
FC: Feed conversion ratio.

At the end of each week, a delicate balance was used to measure each chick. The arithmetic mean end live weight for the period of each chick was subtracted from the arithmetic mean initial live weight of the period, the latter being mostly weekly, to get the average daily body weight gain. A specific quantity of feed was provided to the chicks in every duplicate weekly. The residuals were gathered at the end of the same week, and the quantity of feed eaten was calculated by dividing the difference between the feed provided to the birds at the beginning of every week and the feed remaining at the end of the week. (Al-Hadme, 1994) method were used to determined feed intake and feed conversion ratio (FCR). Histological markers related to the small intestine: on day 42, at the end of the experiment, four birds per replicate were chosen at random, which were killed by cervical dislocation and opened. A 2cm long segment was excised from the proximal part of the jejunum, opened, washed with normal saline and fixed using a 10% formalin neutral buffered solution, then a series of histopathological preparations to get 5μm thick tissue sections, which were then stained using hematoxylin and eosin and viewed under a series of light microscopy magnifications (Culling et al., 2014).

3. Data analysis

Excel software was used to analyze all the data obtained during the experiment. Calculations for the parameters for the various therapies will be performed. Data were analyzed using (SAS, 2012). Significant treatment differences were found at the P≤0.05 level by using the Duncan test.

4. Results

The results in Table 2 show the effects of supplementation with different amounts of dried parsley (Petroselinum crispum) on live body weight g/bird), There are significant differences only in the 15–21-day period, where T1 (control) had significantly lower weights than T2 and T4. The absence of significant differences in final body weight shows that parsley supplementation has no significant effect on overall growth.

The effect of supplementing different levels of parsley (Petroselinum crispum) on weight gain in dissimilar phases of age of broiler chicks is shown in Table 3. There were no significant differences among the treatments in the age periods (28-36 and 36-42 days), as well as overall. Nonetheless, an overview of the results indicates that during the distinct age ranges of (15-21) and (36-42) days, treatment differences were significant (P≤ 0.05). Treatment T1 (control) recorded the lowest body weight gain (BWG) of 443g, which was significantly less than that of T2 (463g), T3 (457g), and T4 (475g). Conversely, during the range of (22-28) days, T1 (700g) recorded the highest BWG, which was significantly different from that of T4 (489g), the treatment that recorded the lowest BWG.

Regarding the feed intake recorded in Table 4, on Days 15-21, T4 indicates the greatest intake and T1 indicates the least. Again, such a difference is not statistically significant.

During 22-28 days, T1 indicates the greatest intake and T4 indicates the least. Finally, during 29-35 days, T4 indicates the greatest intake, and T3 indicates the least. On 36-42 days, the Most consumed are T1 and T2, and the least consumed is T4, Feed consumption is affected by parsley supplementation, higher levels of parsley (T3, T4) will reduce total consumption; the effect is more pronounced in later stages of growth.

Table 2. Influence of adding several levels of dried parsley (*Petroselinum crispum*) on live body weight (g/bird) of broiler chicks (mean± S.E.).

Treatments	Age periods (days)				
	7-14	15-21	22-28	29-35	36-42
T_1	457 ± 32.92a	900b ± 33.07b	1600 ± 70.71a	2120 ± 33.91a	2870 ± 122.83a
T_2	468 ± 09.31a	931a ± 23.49a	1480 ± 80.00a	2040 ± 47.33a	2990 ± 074.83a
T_3	462 ± 09.37a	919a ± 19.95a	1490 ± 48.47a	2020 ± 43.39a	2780 ± 161.71a
T_4	476 ± 16.88a	951a ± 17.57a	1440 ± 53.38a	2025 ± 28.81a	2850 ± 104.88a

T1: base diet (control), T2: base diet + 100g of Parsley, T3: base diet + 200g of Parsley, base diet + 300g of Parsley. Similar letters in same column indicate no significant differences (P>0.05).

Table 3. Influence of adding several levels of dried parsley (*Petroselinum crispum*) on body weight gain (g/bird) of broiler chicks (mean± S.E.).

Treatments	Age periods (days)				
	15-21	22-28	29-35	36-42	Overall
T_1	443 ± 40.92b	700 ± 26.76a	520 ± 30.32a	750 ± 52.02a	2433 ± 77.31a
T_2	463 ± 15.01a	549 ± 18.41ab	560 ± 59.85a	950 ± 65.60a	2552 ± 49.64a
T_3	457 ± 19.34a	571 ± 08.50ab	530 ± 27.02a	760 ± 68.48a	2343 ± 46.51a
T_4	475 ± 15.01a	489 ± 42.91b	585 ± 16.52a	825 ± 7.75a	2414 ± 69.54a

T1: base diet (control), T2: base diet + 100g of Parsley, T3: base diet + 200g of Parsley, base diet + 300g of Parsley. Similar letters in same column indicate no significant differences (P>0.05).

Table 4. Influence of adding several levels of dried parsley (Petroselinum crispum) on feed intake (g) of broiler chicks (mean± S.E.).

Treatments	Age periods (days)				
	15-21	22-28	29-35	36-42	Overall
T1	586.35 ± 27.59b	868.90 ± 0.22a	853.08 ± 55.81b	1351.66 ± 53.14a	3660.000 ± 171.09a
T2	609.86 ± 16.98a	766.52 ± 0.40bc	822.01 ± 89.37c	1347.80 ± 61.39a	3546.214 ± 190.77b
T3	610.07 ± 09.37a	819.78 ± 0.27b	751.22 ± 39.17d	1297.04 ± 25.53b	3478.123 ± 096.12b
T4	631.83 ± 12.52a	743.15 ± 0.13c	916.84 ± 66.52a	1254.15 ± 17.80c	3545.99 ± 141.95b

T1: base diet (control), T2: base diet + 100g of Parsley, T3: base diet + 200g of Parsley, base diet + 300g of Parsley. Similar letters in same column indicate no significant differences (P>0.05).

The results shown in Table 5 indicate the effect of adding different levels of dried parsley (Petroselinum crispum) on the feed conversion ratio (g feed intake/g live body weight), days 15-21: No significant difference between treatments. Days 22-28: T1 has the best FCR (1.24), while T4 has the worst (1.51) (higher values = lower efficiency). On days 29-35, T2 and T3 exhibit the best FCR (~1.41-1.46), with the worst being that of T1 (1.64). During 36-42 days, T2 exhibits the best efficiency (1.61), with the worst being that of T3 (1.90). Parsley supplementation generally enhances feed efficiency, with a particular improvement in T2. Greater parsley levels (T3, T4) have variable advantages, with possible detriments in the latter stages.

Figure 1 illustrates the impact of incorporating various concentrations of dried parsley (Petroselinum crispum) on the economic metrics and production indices of grill chicks at varying ages.

Table 5. Influence of adding several levels of dried parsley (Petroselinum crispum) on feed conversion ratio (g feed intake / g live body weight gain) of broiler chicks (mean± S.E.).

Treatments	Age periods (days)				
	15-21	22-28	29-35	36-42	Overall
T1	586.35 ± 27.59b	868.90 ± 0.22a	853.08 ± 55.81b	1351.66 ± 53.14a	3660.000 ± 171.09a
T2	609.86 ± 16.98a	766.52 ± 0.40bc	822.01 ± 89.37c	1347.80 ± 61.39a	3546.214 ± 190.77b
T3	610.07 ± 09.37a	819.78 ± 0.27b	751.22 ± 39.17d	1297.04 ± 25.53b	3478.123 ± 096.12b
T4	631.83 ± 12.52a	743.15 ± 0.13c	916.84 ± 66.52a	1254.15 ± 17.80c	3545.99 ± 141.95b

T1: base diet (control), T2: base diet + 100g of Parsley, T3: base diet + 200g of Parsley, base diet + 300g of Parsley. Similar letters in same column indicate no significant differences (P>0.05).

The study's results indicated significant differences (P≤0.05) throughout all timeframes. In the age range of 15 to 21 days, T4 exhibited the greatest production index measure (339), whereas T1 (control) recorded the lowest mean (317). The minimum mean (252) was observed in T2, whilst the maximum mean (333) for the age range (22-28) was achieved in T1 (control). The peak mean of T4 for the interval of 29 to 35 days was 210, whereas the minimum mean in T1 (control) was 186. T2 (231) exhibits the highest mean for the age range of 36-42 days, while T3 displays the lowest mean (190).

Figure 2 presents the economic results of the study, indicating extremely significant differences (P≤0.05) in the financial outcomes among the various treatments. The T2 chicks possessed a greater economic value of 52 compared to the T0 (control) birds' monetary value of 46.

When protein intake is calculated, parsley supplement mostly reduces protein intake, except for T4 at some age periods; there are notable differences (P < 0.05) among treatments at most age periods.

In 15-21 days, T4 shows the highest protein intake (139.02 g), while T1 shows the lowest (129.01 g), Parsley supplementation slightly increases protein intake in the early stages.

T1 has the highest intake (173.81 g) during days 22-28, while T4 has the lowest (148.68 g).

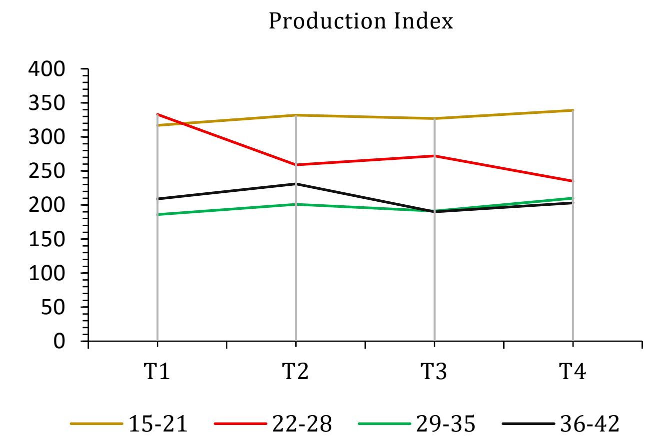

Figure 1. Influence of adding several levels of dried parsley (*Petroselinum crispum*) on the production index of broiler chicks (mean± S.E.).

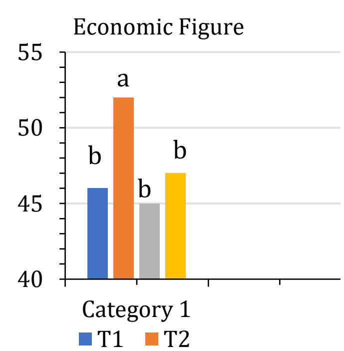

Figure 2. Influence of adding several levels of dried parsley (*Petroselinum crispum*) economic figure of broiler chicks (mean± S.E.).

Supplementation with parsley reduces protein intake significantly during this period.

From 29-35 days, T4 had the maximum intake (183.40 g), while the minimum was T3 (150.29 g), Parsley has a different effect, where T4 has a positive effect while T3 reduces protein intake.

During 36-42 days, T1 and T2 use the maximum amount (229 g) while T4 uses the minimum (213.22 g), Parsley supplementation reduces protein intake in later stages to a limited degree.

Table 6. Influence of adding several levels of dried parsley (Petroselinum crispum) on protein intake (g) of broiler chicks (Mean± S.E.).

Treatments	Age periods (days)				
	15-21	22-28	29-35	36-42	Overall
T1	129.01 ± 2.94b	173.81 ± 0.89a	170.66 ± 3.54b	229.81 ± 10.78a	622.23 ± 9.77a
T2	134.19 ± 3.76ab	153.30 ± 2.93c	164.43 ± 2.98b	229.18 ± 7.49a	602.91 ± 8.21b
T3	134.26 ± 2.61ab	164.01 ± 0.63b	150.29 ± 7.56c	220.50 ± 3.64b	591.29 ± 2.93c
T4	139.02 ± 0.77a	148.68 ± 1.37c	183.40 ± 2.91a	213.22 ± 3.29b	602.84 ± 8.92b

T1: base diet (control), t2: base diet + 100g of parsley, t3: base diet + 200g of parsley, base diet + 300g of parsley. Similar letters in same column indicate no significant differences (P>0.05).

Table 7. Influence of adding several levels of dried parsley (Petroselinum crispum) on energy intake (g) of broiler chicks (mean± S.E.).

Treatments	Age periods (days)				
	15-21	22-28	29-35	36-42	Overall
T1	1711.57 ± 44.95c	2655.38 ± 116.31a	2607.08 ± 221.33b	4161.85 ± 560.21a	11045.93 ± 1266.72a
T2	1780.24 ± 95.20b	2342.55 ± 95.34c	2512.09 ± 108.64c	4149.95 ± 378.49a	10702.51 ± 1801.66b
T3	1780.80 ± 118.3b	2505.30 ± 102.47b	2295.79 ± 310.12d	3993.64 ± 351.27c	10496.99 ± 631.82c
T4	1844.36 ± 84.86a	2271.15 ± 68.42d	2801.89 ± 306.47a	3861.55 ± 487.21b	10701.81 ± 1103.69b

T1: base diet (control), t2: base diet + 100g of parsley, t3: base diet + 200g of parsley, base diet + 300g of parsley. Similar letters in same column indicate no significant differences (p>0.05).

As shown in Table 7, parsley supplementation reduces the energy intake in general, Significant differences ($P < 0.05$) between treatments are seen for the importance of periods. During Days 15-21, T4 has the highest energy intake (1844.36 g) and T1 has the lowest (1711.57g), Parsley supplementation improves the energy intake slightly during the first phase. During Days 22-28, T1 has the highest energy intake (2655.38 g) whereas T4 has the lowest (2271.15 g), Parsley supplementation decreases energy intake significantly during this period. During Days 29-35, T4 has the highest energy intake (2801.89 g) whereas T3 has the lowest (2295.79 g), Parsley effects are different with T4 having a positive effect, whereas T3 decreases energy intake. During Days 36-42, T1 and T2 recorded the highest energy intake (4149-4161g) and T4 the lowest (3861.55 g), Parsley supplement reduces the energy intake slightly in later phases.

In comparison of the food conversion efficiency of energy was the second transaction less Efficient; and the differences between transactions and the control were morally superior to the transactions of the other.

The feed conversion ratio of energy (FCRE) is an indicator of how efficiently the birds are using energy to deposit body weight; greater values reflect poorer efficiency. On days 15-21, there was no treatment variation (T1-T4 range: 3.85-3.90), and no effect of parsley supplementation on energy efficiency early in life. From days 22-28, T1 has the highest efficiency (3.80, lowest FCRE), and T4 has the lowest efficiency (4.65, highest FCRE). Parsley supplementation increases the energy conversion ratio during this period, i.e., greater energy requirements. From Days 29-35, T1 has the highest FCRE (5.02, lowest efficiency). and T3 has the lowest FCRE (4.34, highest efficiency), Parsley supplementation has more efficient energy utilization than that of T1. During days 36-42, T1 and T3 show maximum FCRE (5.55 and 5.26), i.e., low efficiency, and T2 shows maximum efficiency (4.37), Parsley supplementation (T2, T4) improves energy efficiency during later stages.

Table 8. Influence of adding several levels of dried parsley (Petroselinum crispum) on feed conversion ratio of energy (g) of broiler chicks (mean± S.E.).

Treatments	Age periods (days)				
	15-21	22-28	29-35	36-42	Overall
T1	3.87 ± 1.02a	3.80 ± 2.01c	5.02 ± 2.03a	5.55 ± 2.14a	4.54 ± 1.21a
T2	3.85 ± 1.06a	4.27 ± 1.47b	4.49 ± 1.78c	4.37 ± 1.18c	4.20 ± 2.03c
T3	3.90 ± 0.99a	4.39 ± 0.96a	4.34 ± 2.11c	5.26 ± 2.16a	4.48 ± 1.04ab
T4	3.89 ± 1.041a	4.65 ± 1.14a	4.79 ± 1.07b	4.68 ± 0.94b	4.44 ± 1.38b

T1: base diet (control), t2: base diet + 100g of parsley, t3: base diet + 200g of parsley, base diet + 300g of parsley. Similar letters in same column indicate no significant differences (p>0.05).

Table 9. Influence of adding several levels of dried parsley (Petroselinum Crispum) on feed conversion ratio of protein (g) of broiler chicks (Mean± S.E.).

Treatments	Age periods (days)				
	15-21	22-28	29-35	36-42	Overall
T1	0.30 ± 0.07a	0.25 ± 0.04c	0.33 ± 0.05a	0.31 ± 0.07a	0.26 ± 0.21a
T2	0.29 ± 0.05a	0.28 ± 0.06b	0.30 ± 0.09bc	0.25 ± 0.21b	0.24 ± 0.18a
T3	0.30 ± 0.07a	0.29 ± 0.21ab	0.29 ± 0.07c	0.29 ± 0.06a	0.26 ± 0.07a
T4	0.29 ± 0.07a	0.31 ± 0.07a	0.32 ± 0.06ab	0.26 ± 0.08b	0.25 ± 0.09a

T1: base diet (control), t2: base diet + 100g of parsley, t3: base diet + 200g of parsley, base diet + 300g of parsley. Similar letters in same column indicate no significant differences (p>0.05).

Protein feed conversion ratio (FCRP) is an estimate of protein efficiency—the greater the FCRP, the more protein required for weight gain, thus less efficient; parsley supplementation would appear to enhance the efficiency of protein conversion compared to the control.

On days 15-21, no treatment difference (T1-T4 interval: 0.29-0.30). There is no effect of parsley supplementation on protein conversion at early periods.

On days 22-28, T1 is the least efficient (0.25, highest FCRP), and T4 is the most efficient (0.31), Parsley supplementation improves protein utilization (T2-T4 > T1).

T1 has the lowest efficiency (0.33, highest FCRP) during days 29-35, while T3 is the most efficient (0.29). Supplementation with Parsley reduces protein requirements for weight gain.

Although T1 and T3 during days 36-42 experience the highest FCRP (0.31 and 0.29), i.e., lower efficiency. T2 and T4 are the most efficient (0.25-0.26).

Table 10. Influence of adding several levels of dried parsley (*Petroselinum crispum*) on histological traits of broiler jejunum at age 42 days.

Parameter \ Treatment	T1 M.	T1 F.	T2 M.	T2 F.	T3 M.	T3 F.	T4 M.	T. F.	Mean	Sem	Significant
Mucosa broiler thickness (µm)	15.667 bc	17.33 Bc	13.5 c	13.5 c	15.67 bc	28.5 a	17.67 bc	24 ab	17.9	1.307	0.05
Villi height (µm)	51.33 bcd	42 Cd	64.5 ab	74.33 cd	51 bcd	55 bc	73 a	38.5 d	52.85	2.72	0.0028
Villi thickness (µm)	21 b	19.67 B	15.5 b	17.33 b	26.67 a	19.5 b	16.67 b	21 b	19.33	1.53	0.0108
Depth of Crypts of Lieberkuhn (µm)	22.33	16.67	20.5	13.33	24	14	23.33	19	17.9	1.307	N.S

Table 10 compares intestinal histological traits in male (M) and female (F) broiler chickens under different treatment groups (T1-T4). Parsley supplement has a significant effect on mucosa thickness, villi height, and villi thickness. Crypt depth is not significantly different (N.S.), which means there is no effect on this trait. Parsley supplementation enhances villi thickness, villi height, and mucosal thickness. T3 (moderate parsley) shows the most consistent improvements in gut morphology, specifically in villi thickness. Conversely, T2F and T4M show the tallest villi, suggesting a better ability to absorb nutrients. Nonetheless, crypt depth is not changing, indicating that parsley does not affect intestinal regeneration much.

5. Discussion

We can attribute improvements in results to the use of this drug. Parsley was anticipated with the growth of chemical producers and a range of medications that prevent and treat illness (Casanova et al., 2024; Chauhan & Aishwarya, 2018). However, the opposite of current diseases already known to man occurred, and chronic diseases started to appear and spread. This could be because many industrial medications that work on immunosuppression also have long-term negative effects (Ricci & Roviello, 2023; Li, et al., 2023), It finally appeared, and numerous plants with medicinal properties are very beneficial. Each plant or herb contains a variety of components that are placed in such a way that they do not have a significant detrimental impact on human health (Albadwawi et al., 2022; Subaş et al., 2024). Parsley (*Petroselinum crispum*) as a dietary supplement in poultry has been demonstrated to influence several parameters like growth, intake, feed conversion ratio, and intestinal morphology. (Jaffer, 2013; Abbas, 2010) observed that dietary use of parsley significantly enhanced feed intake in broiler chickens, while (Tahan & Bayram, 2011) observed a synergistic effect of dried parsley on feed intake in laying quail. The findings show that parsley may enhance feed consumption and also the efficiency of conversion. Besides, parsley has become known as a significant medicinal herb because of its health-enhancing properties, such as its high content of vitamin C, iron, calcium, phosphorus, and volatile oils. These substances are accountable for their antioxidant property and possible anticancer properties (Nielsen et al., 1999). These characteristics are part of the general trend of using plants that exert fewer side effects than synthetic drugs, which can lead to chronic disease or suppress the immune system (Nielsen et al., 1999). Parsley has gained worldwide acceptance for its medicinal and nutritional importance, as it enhances immunity and health outcomes in animals and humans. Growth performance studies show that dietary inclusion of parsley has an irregular impact on body weight, such that significant variations are observed only for specific growth stages (Al-Kassie, 2008).

Body weight gain (BWG) varied over time, and groups supplemented with parsley generally outperformed control groups in terms of growth, particularly in the early stages of development (Hernandez et al., 2004). The rich phytochemical profile of parsley, especially the flavonoid apigenin, which has anti-inflammatory, immunomodulatory, and antioxidant qualities, is primarily responsible for this beneficial effect. It has been demonstrated that apigenin lowers oxidative stress in the gastrointestinal tract, protecting cellular integrity and encouraging the best possible absorption of nutrients (Shukla & Gupta, 2010). Additionally, parsley contains essential oils with antimicrobial properties like myristicin and eugenol, which help to improve the balance of gut microflora, which is crucial for early chick development and feed utilization. At later developmental stages, the addition of parsley was linked to a lower overall feed intake. Apigenin's regulatory function in neuropeptides and hormones associated with appetite and satiety, including cholecystokinin and ghrelin, as well as its impact on gastrointestinal motility, may be the cause of this effect (Vieira, 2008). Moderate amounts of parsley inclusion increased feed efficiency while lowering feed intake, most likely as a result of improved nutrient digestibility and increased enzymatic activity (Rajput et al., 2013). High levels of inclusion, however, could have mild anti-nutritional effects or reduce palatability, which would reduce the feed conversion ratio (FCR) benefits. According to economic assessments, parsley is a feasible natural supplement in commercial poultry systems since it optimizes production indices and yields higher financial returns (Cross et al., 2007). However, the notion that parsley may modify hepatic metabolism or change nutrient partitioning is supported by decreases in protein and energy intake during specific growth periods (Hernandez et al., 2004). Parsley has also been demonstrated to enhance intestinal morphology, with notable effects on mucosal integrity, crypt depth, and villus height—all important markers of the effectiveness of nutrient absorption (Windisch et al., 2008). These morphological changes are probably caused by apigenin's antioxidant properties, as well as its ability to improve mucosal repair and lower inflammation. All things considered, adding parsley to broiler diets seems to have several advantages, including bettering growth performance, increasing feed conversion, promoting gut health, and lowering dependency on artificial feed additives—all of which are in line with the growing desire for more sustainable and natural methods of raising chickens.

6. Conclusions

Parsley supplementation influences the performance of broilers, particularly in early growth stages, feed efficiency, and intestinal morphology. T2 and T3 levels improve feed conversion and economic efficiency, while T4 levels may reduce intake and improve energy conversion ratios. The results suggest an optimal level of supplementation to gain maximum advantages without any potential harm.

Conflict of interest.

The authors declare that there are no conflicts of interest pertaining to this manuscript.

CRediT authorship contribution statement.

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References

Abbas, R. J. (2010): Effect of using fenugreek, parsley, and sweet basil seeds as feed additives on the performance of broiler chickens. *International Journal of Poultry Science*, *9*(3), pp. 278–282. DOI: 10.3923/ijps.2010.278.282

Ahmed, A., Hamma, A., Mahmood, A. & Khidhir, Z. (2022): Preservative Effects of Gynura Procumbens Powder Used with Broiler Ration on Their Frozen Meat Stored for Different Periods. Current Research on Engineering, 8, pp.149-166. doi: 10.26579/jocrest.8.2.12

Albadwawi, M. A., Ahmed, Z. F., Kurup, S. S., Alyafei, M. A., & Jaleel, A. (2022): A comparative evaluation of aquaponic and soil systems on yield and antioxidant levels in basil, an important food plant in Lamiaceae. Agronomy, 12(12), p.3007. https://doi.org/10.3390/agronomy12123007

Al-Obaidi, A. S., Mahmood, A. B., Khidhir, Z. K., Zahir, H. G., Al-Doori, Z. T. & Dyary, H. O. (2021): Effect of different plants' aromatic essential oils on frozen Awassi lamb meat's chemical and physical characteristics. Italian Journal of Food Science, 33, pp.98-106. DOI: https://doi.org/10.15586/ijfs.v33i4.2099

Al-Kassie, G. A. M. (2008): The effect of anise and rosemary on broiler performance. *International Journal of Poultry Science*, *9*(3), pp.271–274. DOI: 10.3923/ijps.2008.243.245

Baris, A. (2023). Impact of feed quality on livestock productivity. Journal of Livestock Policy, 2(1), 1-8.

Casanova, L. M., dos Santos Nascimento, L. B., & Costa, S. S. (2024): What Is New about Parsley, a Potential Source of Cardioprotective Therapeutic Substances? Nutraceuticals, 4(1), pp.104-126. https://doi.org/10.3390/nutraceuticals4010008.

Chauhan, E. S., & Aishwarya, J. (2018): Nutraceuticals potential of Petroselinum Crispum: A review. stress, 20(25), p.26. DOI: 10.19080/JCMAH.2018.07.555707

Cross, D. E., McDevitt, R. M., Hillman, K., & Acamovic, T. (2007): The effects of herbs and their associated essential oils on performance, digestive enzymes, and gut morphology in broilers. *British Poultry Science*, *48*(4), pp. 496–506. DOI: 10.1080/00071660701463221

Culling, C. F. A., Allison, R. T., & Barr, W. T. (2014). *Cellular pathology technique*. Elsevier.

Hadme, J. (1994): The Scientific Manual for the Production of Meat and Layer chicken, the first edition, the madena Establishment for Press, Dar alam. Jeddah, Saudi Arabia.

Hamma, A. A., Mohammed, M. M., Al-Obaidi, A. S., Mahmood, A. B., Khidhir, Z. K. & Aldoori, Z. (2024): Effect Of Longevity Spinach Leaves Powder (Lsp) As A Broiler Feed Additive On Some Physical And Chemical Parameters Of Frozen Stored Thigh Meat. Mesopotamia Journal of Agriculture, 52. Pp.82-98. https://doi.org/10.33899/mja.2024.145203.131011013

Hernandez, F., Madrid, J., Garcia, V., Orengo, J., & Megias, M. D. (2004): Influence of two plant extracts on broiler performance, digestibility, and digestive organ size. *Poultry Science*, *83*(2), pp.169–174. DOI: 10.1093/ps/83.2.169

Hong, J. C., Steine, T., Aufy, A., & Lien, T. F. (2012): Effects of supplemental essential oil on growth performance, lipid metabolites and immunity, intestinal characteristics, micro biota and carcass traits in broilers. *Livestock Science*, *144*, pp.253–262. DOI: 10.1016/j.livsci.2011.12.008

Jaffer, M. R. (2013): The effect of a mixture of thyme and parsley in the diet on performance of broiler. *Global Journal of Bio Science and Biotechnology*, *2*(3), pp.390–392. www.scienceandnature.org/GJBB/GJBB_Vol2(3)2013/GJBB-V2(3)2013-19.pdf

Li, H., Ghorbani, S., Ling, C. C., Yong, V. W., & Xue, M. (2023): The extracellular matrix as modifier of neuroinflammation and recovery in ischemic stroke and intracerebral hemorrhage. Neurobiology of Disease, 186, p.106282. DOI: 10.1016/j.nbd.2023.106282

Majid, R., Khidhir, Z., Hamma, A. & Albashr, K. (2020a): Effect of Using Parsley (*Petroselinum crispum*) As Feed Additive on Some Meat Traits of Broiler Chicks. Tikrit Journal for Agricultural Sciences, 20, pp. 68-79. https://doi.org/10.25130/tjas.20.2.7

Majid, R. H., Albashr, T. K. M., Hamma, A. A. & Khidhir, Z. K. (2020b): Effect of dietary supplementing cumin (*Cuminum cyminum* L.) on meat traits of the broiler chicks. Basrah Journal of Agricultural Sciences, 33, pp.159-171. https://doi.org/10.37077/25200860.2020.33.1.12

Meyer, H., Bolarinwa, A., Wolfram, G., & Linseisen, J. (2006): Bioavailability of apigenin from apiin-rich parsley in humans. *Annals of Nutrition and Metabolism*, *50*(3), pp.167–172. https://doi.org/10.1159/000090736

Nielsen, S. E., Young, J. F., Daneshvar, B., Lauridsen, S. T., Knuthsen, P., Sandstrom, B., & Dragsted, L. O. (1999): Effect of parsley (Petroselinum crispum) intake on urinary apigenin excretion, blood antioxidant enzymes, and biomarkers for oxidative stress in human subjects. *British Journal of Nutrition*, *81*, pp.447–455. DOI: 10.1017/s000711459900080x

NRC (National Research Council). (1994). *Nutrient requirements of poultry: Ninth revised edition*. National Academy Press.

Peter, K. V. (2004). *Handbook of herbs and spices* (Vol. 2). Woodhead Publishing Limited. https://www.academia.edu/18671222/Handbook_of_Herbs_and_Spices_Vol_2

Rajput, N., Muhammad, N., Yan, R., Zhong, X. and Wang, T., (2013): Effect of dietary supplementation of curcumin on growth performance, intestinal morphology and nutrients utilization of broiler chicks. The Journal of Poultry Science, 50(1), pp.44-52. https://doi.org/10.2141/jpsa.0120065

Razzaghi-Abyaneh, M., Yoshinari, T., Shams-Ghahfar, O., Rezaee, M. B., Nagasawa, H., & Sakudas. (2007): Dillapiof and Apiol as specific inhibitors of the biosynthesis of aflatoxin G1 in Aspergillus parasitic us. *Bioscience, Biotechnology, Biochemistry*, *71*(a), pp.2329–2332. DOI: 10.1271/bbb.70264

Ricci, A., & Roviello, G. N. (2023): Exploring the protective effect of food drugs against viral diseases: Interaction of functional food ingredients and SARS-COV-2, influenza virus, and HSV. Life, 13(2), p.402. https://doi.org/10.3390/life13020402

Rinttila, T., & Apajalahti, J. (2013): Intestinal microbiota and metabolites—implications for broiler chicken health and performance. *Journal of Applied Poultry Research*, *22*, pp. 647–658. https://doi.org/10.3382/japr.2013-00742

Shukla, S., & Gupta, S. (2010). Apigenin: A promising molecule for cancer prevention. Pharmaceutical Research, 27(6), 962–978. https://doi.org/10.1007/s11095-010-0089-7

Subaş, T., Özgen, U., Gökkaya, İ. and Renda, G., (2024): *Petroselinum Crispum* (Mill.) Fuss (Parsley), A Food And Medicinally Important Plant: A Review Of Recent Studies Between 2013-2023. *Journal of Faculty of Pharmacy of Ankara University*, *48*(2), pp.727-750. https://doi.org/10.33483/jfpau.1362626.

SAS. (2012). SAS/STAT User's Guide for Personal Computers, Release 9.1. SAS Institute Inc.

Tahan, M., & Bayram, I. (2011): Effect of using black cumin (Nigella sativa) and parsley (*Petroselinum crispum*) in laying quail diets on egg yield, egg quality, and hatchability. *Archiva Zootechnica*, *14*(4), pp.39–44. http://www.ibna.ro/arhiva/AZ%2014-4/AZ%2014-4_03%20Bayram.pdf

Vieira, S. L. (2008). Chelated minerals for poultry. *Brazilian Journal of Poultry Science*, *10*, 73-79. https://doi.org/10.1590/S1516-635X2008000200001

Windisch, W., Schedle, K., Plitzner, C., & Kroismayr, A. (2008): Use of phytogenics in animal nutrition. *Journal of Animal Science*, *86*(14_suppl), pp.E140–E148. DOI: 10.2527/jas.2007-0459