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EVALUATION OF FEEDING MORINGA LEAVES AND GINGER POWDER ON PRODUCTIVE PERFORMANCE, BLOOD BIOCHEMICAL PARAMETERS, AND ANTIOXIDANT STATUS OF JAPANESE QUAIL

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ABSTRACT

This study evaluated the effects of Moringa leaves and ginger powder supplementation on the productive performance and serum biochemical parameters of Japanese quail. A total of 270 seven-day-old quails were used in a five-week trial. The birds were assigned to three dietary treatments: T1 (control, no additives), T2 (0.4% Moringa leaves), and T3 (0.2% ginger powder). Body weight and feed consumption were recorded weekly until day 42, and the feed conversion ratio (FCR) was calculated. Blood samples were collected at 42 days for biochemical analysis; the results demonstrated that the inclusion of Moringa leaves and ginger powder significantly improved ($P \leq 0.05$) body weight, weight gain, and FCR. Serum analysis revealed increased albumin and globulin levels alongside reduced glucose concentrations. Additionally, supplementation led to a significant decrease in triglycerides and plasma cholesterol levels compared to the control group. High-density lipoprotein (HDL) and total antioxidant capacity (TAC) were elevated, whereas low-density lipoprotein (LDL), alanine aminotransferase (ALT), and aspartate aminotransferase (AST) levels were reduced in conclusion, the dietary inclusion of Moringa leaves and ginger powder enhanced feed efficiency, improved lipid metabolism, and boosted antioxidant capacity in Japanese quail. These findings suggest that both additives can serve as natural growth enhancers while promoting better health parameters in poultry production.

Keywords: Antioxidants, Blood, Ginger, Moringa, Performance, Quail.

1. INTRODUCTION

The prohibition of antibiotics as growth enhancers within the poultry sector has been instigated due to their detrimental implications for human health. This phenomenon has been evidenced by the emergence of microbial resistance to these substances [1, 2] and moreover, poultry industry plays a huge supply for animal protein in whole world. An increasing focus has been directed towards various herbs, spices, and plant extracts, which are regarded as natural products

and are well-accepted by consumers, as viable feed additives and substitutes for antibiotic growth promoters, particularly following their prohibition by the European Union in 2006 [3]. A multitude of alternatives has been proposed for growth promoters, including organic acids and medicinal plants, which have recently been utilized as natural feed additives in poultry diets to augment the immune response efficacy of avian species [4]. One such botanical is Moringa Oleifera. The foliage of this plant is characterized by high nutritional value and encompasses substantial quantities of vitamins (A, B, C), calcium, iron, phosphorus, and protein [5]. Furthermore, the leaves of M. Oleifera are devoid of heavy metals such as mercury, arsenic, and cadmium, which are recognized as toxic, thereby rendering their incorporation into poultry diets as safe [6]. The presence of vitamins C and E, carotenoids, flavonoids, and selenium positions M. Oleifera as a potential source of antioxidants [7]. The antioxidant constituents (phenols, vitamin C, vitamin E, beta-carotene, zinc, selenium, and flavonoids) found in M. Oleifera enhance the shelf life and quality of meat products during both pre-slaughter and post-slaughter phases [8]. The inclusion of natural antioxidants in animal diets, on the surface of meat, or within active packaging systems has been shown to diminish the activity of pathogenic bacteria and molds while concurrently improving food digestibility [9]. Traditionally, Moringa Oleifera leaves are extensively utilized for their antimicrobial properties [10] and pharmacological attributes [11]. This plant is recognized for its composition of 23% crude protein, 12 MJ/kg of metabolizable energy, and 79.7% digestibility [12]. Additionally, it possesses adequate quantities of carotene, ascorbic acid, iron, methionine, and cysteine [13]. In addition to these nutritional constituents, Moringa leaves also contain phenolic compounds and anti-nutritional factors such as tannins, saponins, phytates, and oxalates [14]. The supplementation of broiler chicken diets with Moringa Oleifera has demonstrably improved oxidative stability in chicken meat [15]. Research indicated that substituting antibiotic growth promoters with either 0.1% or 0.05% Moringa Oleifera leaf powder yielded advantageous effects on growth performance and the productivity of broiler chicken carcasses [16].Ginger (*Zingiber officinale*) is a perennial herb belonging to the Zingiberaceae family. Ginger (Zingiber officinale) is classified as a perennial herb within the Zingiberaceae family. Its cultivation is prevalent across regions in Asia and the Americas. The spice derived from ginger is not only flavorful but also possesses numerous therapeutic properties. Empirical studies have indicated that ginger enhances the functionality of the digestive system by promoting the secretion of pancreatic enzymes, including amylase, lipase, and trypsin. Research has demonstrated that ginger serves to stimulate digestive processes and favorably influences enzymatic activity. Furthermore, it comprises proteolytic enzymes that facilitate digestion, augment gallbladder function, and confer protection to the liver

against toxic substances. Additionally, ginger functions as a potent antioxidant, attributed to its bioactive compounds such as shogaol, which exhibits antioxidant properties comparable to those of vitamin E. It has been documented [17] that ginger qualifies as a medicinal herb that can be incorporated into poultry nutrition to optimize feed conversion efficiencies, thereby resulting in enhanced body weight. Moreover, it also enhances [18] the avian immune response and bolsters resistance to bacterial infections, consequently diminishing mortality rates.

2. MATERIAL AND METHODS

This investigation was undertaken within a privately-owned agricultural barn located in Sorman City, Libya, started from January 2023 to February 2023, over a duration of five weeks. The objective was to examine the impact of incorporating Moringa leaves and ginger powder into the dietary regimen on the productive efficiency, blood biochemical parameters, and antioxidant capacity of Japanese quails. A total of 270 unsexed quail chicks (white, gray, and black plumage at the age of one week having similar body weight) were utilized in this research. The birds were randomly distributed into three experimental treatments with 90 chicks in each group, each treatment consisting of 3 replicates (cage), with 30 birds per replicate. The quails were maintained in cages within a closed facility that was furnished with management conditions conducive to quail husbandry. The barn was thermally regulated using electric heaters, and the illumination system was operational continuously for 24 hours daily. A 2 balanced diets and water were offered to the control and treatment groups ad-libitum throughout the duration of the experiment, that is Quail starter (0-3 weeks) and Quail finisher (4-6 weeks) as per the recommendation of NRC requirements [19].

The ginger powder and moringa leaves utilized in this study were provided from local markets (dry moringa leaves) and was sourced from India, subsequently dried, ground, and preserved until their incorporation into the diet. The three experimental treatments comprised:

- Treatment 1 (T1): Control diet without any addition.
- Treatment 2 (T2): Addition of 0.4% Moringa leaves to the diet.
- Treatment 3 (T3): Addition of 0.2% ginger powder to the diet.
  It is worth to mention that the selected ratio of Moringa leaves and ginger powder was based on literature review.

2.1 Studied Traits:

1. **Live body weight:** Quails were weighed at the end of each week from the start of the experiment until the end of the sixth week using a sensitive scale.

2. **Weight gain:** The weight gain achieved by the birds was calculated according to the equation mentioned by [20]. Weight gain (g) = Live body weight at the end of the experiment – Live body weight at the start of the experiment.
3. **Total feed intake:** Total feed intake was calculated using the following equation: Total feed intake = Amount of feed provided at the start of the week – Remaining feed at the end of the week.
4. **FCR:** Expressed as grams of feed intake required to achieve a weight gain of one gram. Calculated according to the method described by [21]: **FCR** = Amount of feed intake during the week (g) / Weight gain during the same period (g).

2.2 Blood Biochemical Components: At the end of the experiment, four avian specimens from each replicate were euthanized, and blood samples were collected. The blood serum was isolated utilizing a centrifuge operating at 3000 revolutions per minute for a duration of 15 minutes and subsequently preserved at -20°C until the starting of biochemical analysis. The assays encompassed the quantification of total protein, albumin, globulin, glucose, cholesterol, HDL, LDL, and triglycerides employing pre-prepared analytical kits from Biolabo, France, in accordance with the guidelines stipulated by the manufacturer, utilizing a spectrophotometer at the designated wavelength for each specific analysis. The concentrations were computed employing formulas provided by the manufacturer. Furthermore, the enzymatic activities of AST (Aspartate Transaminase), ALT (Alanine Transaminase), and TAC (total antioxidant capacity) were assessed utilizing pre-prepared analytical kits devised by Biomerieux, France, adhering to the supplied protocols.

2.3 Data Analysis: The data obtained were subjected to analysis utilizing the SPSS software version 27 through variance analysis, and treatment means were compared employing the [22] test.

The statistical model utilized was: $yi = \mu + Ti + Eijk$ where: yi = response; μ = overall mean; Ti = treatment effect; Eijk = experimental error.**3.**

3. RESULTS AND DISCUSSION

Table (1) and Figure (1) delineates the influence of incorporating Moringa leaves and ginger powder on the productive efficacy of Japanese quails. Initial body weight comparisons among the experimental treatments revealed no statistically significant differences. Nevertheless, the results of the statistical analysis demonstrated significant differences ($P \leq 0.05$) in the final body weight among the various treatments, with the addition treatments exhibiting a marked enhancement relative to the control group, despite the absence of significant differences among the addition treatments themselves. Furthermore, the

statistical analysis results for the same table indicated significant differences (P≤0.05) in the total weight gain rate, wherein the addition treatments surpassed the control treatment. The total weight gains recorded were 168.84g, 170.06g, and 154.68g for Moringa leaves, ginger powder, and the control group, respectively. These findings are in agreement with the studies of [23, 24, 25], who demonstrated significant effects (P≤0.05) on body weight and weight gain in avian subjects consuming diets enriched with ginger powder. A similar pattern was noted by [26, 27] in their investigation into the effects of ginger on quails and by [28, 29, 30] in studies involving ginger's utilization in broiler chickens' diets.These observations are corroborated by [31], who examined the implications of varying levels of ginger powder on multiple avian species.

Table 1: Effect of adding *moringa* leaves and ginger powder on some productive performance of quail bird g/treatment/week.

Studied Traits	T1	T2	T3	P.Value
Initial weight (g)	31.12±0.05 [a]	31.16±0.04 [a]	31.48±0.07 [a]	0.092
Final weight (g)	185.80±2.08 [b]	200.00±1.60 [a]	201.54±1.52 [a]	0.0001
Total weight gain (g)	154.68±1.36 [b]	168.84±1.67 [a]	170.06±1.57 [a]	0.0001
Total feed intake (g)	547.38±3.75 [a]	541.24±3.68 [a]	538.64±2.64 [a]	0.0631
FCR (g feed/g weight gain)	3.53±0.18 [a]	3.20±0.19 [b]	3.16±0.21 [b]	0.0001

Means within a row not sharing a common superscript are significantly different ($P \leq 0.05$).

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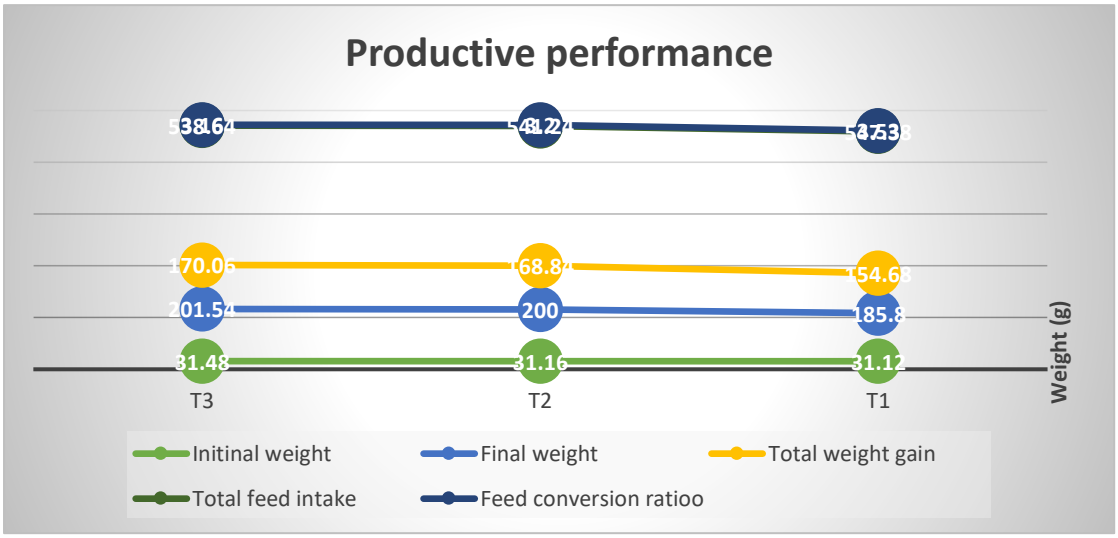

Figure 1: Effect of adding *moringa* leaves and ginger powder on some productive performance of quail bird g/treatment/week.

Table (1) elucidates the impact of the incorporation of Moringa leaves and ginger powder on the productive performance of Japanese quails. Comparative analyses of initial body weights across the experimental treatments indicated no statistically significant disparities. However, the outcomes of the statistical evaluation revealed significant differences ($P \leq 0.05$) in the final body weight among the disparate treatments, with the inclusion treatments demonstrating a pronounced enhancement in comparison to the control group, notwithstanding the lack of significant differences among the inclusion treatments themselves. Moreover, the results of the statistical analysis pertaining to the same table revealed significant differences ($P \leq 0.05$) in the total weight gain rate, whereby the inclusion treatments exceeded the control treatment. The total weight gains observed were 168.84g, 170.06g, and 154.68g for Moringa leaves, ginger powder, and the control group, respectively. These results align with the findings of [23, 24, 25], who established significant effects ($P \leq 0.05$) on body weight and weight gain in avian subjects consuming diets fortified with ginger powder. A comparable trend was noted by [26, 27] in their examination of the effects of ginger on quails, as well as by [28, 29, 30] in their investigations involving the incorporation of ginger into the diets of broiler chickens. These observations are substantiated by [31], who investigated the ramifications of varying concentrations of ginger powder on multiple avian species. Table (1) also indicates the effect of adding Moringa leaves and ginger powder on feed consumption rate, where a non-significant reduction in feed consumption rate was observed in the addition treatments compared to the control treatment. The total feed consumption rates in the three treatments (control, Moringa, ginger) were 547.38g, 541.24g, and 538.64g, respectively.

Table (1) also shows the effect of adding Moringa leaves and ginger powder on FCR. A significant improvement (P≤0.05) in FCR was observed due to the addition of Moringa leaves and ginger powder, with values of 3.20g and 3.16g for the two treatments, respectively, compared to 3.53g for the control treatment. The improvement in FCR with the addition of ginger roots and Moringa leaves can be attributed to the efficiency of the digestive system in digesting feed materials through the role of active substances contained in them, which include digestive enzymes [32]. Additionally, ginger contains the compound gingerol, which stimulates bacterial growth, enhancing the bird's health and feed utilization [33].Regarding the effect of Moringa leaves, the results were consistent with [34], attributing the effect to reducing the activity of pathogenic bacteria and molds and improving the digestion process of the feed. These findings are also consistent with those mentioned by [35, 36].

Table (2) indicates the effect of adding Moringa leaves and ginger powder on some blood biochemical parameters. The results showed that the levels of total protein and albumin significantly increased (P≤0.05) in the diet containing ginger powder compared to the control treatment. These results are consistent with those recorded by [37] and align with [38, 39, and 40]. Additionally, the total protein and globulin levels significantly increased in the Moringa leaves group compared to the control group, indicating that the immunity of birds fed Moringa leaves improved compared to the control group. This result is consistent with what was mentioned by [41], who reported that Moringa leaves had a beneficial effect on immune response and gut health in broiler chickens. [42] Also stated that Moringa leaves enhance the immune system in birds. Conversely, [43] found that 0.2%, 0.4%, and 0.60% Moringa had no significant effect on the levels of total protein, albumin, and globulin in the blood. Birds fed on ginger powder and Moringa leaves showed an increase in blood globulin levels, which serves as an indicator of immune response and a source of antibodies [44], and the production of immunoglobulin. Therefore, the observed effect may be due to an increase in immunoglobulin concentration and improved immunity [23, 25, 26, and 28].

Table 2: Effect of adding *Moringa* leaves and ginger powder on the blood components of quails.

Blood Characteristics	T1	T2	T3	P.Value
Total protein (g/100 ml)	4.20±1.02 ^{c}	4.48±0.30 ^{b}	4.61±1.03 ^{b}	0.0001
Albumin (g/100 ml)	1.38±0.28 ^{c}	1.58±0.09 ^{b}	1.68±0.32 ^{b}	0.0001

Globulin (g/100 ml)	2.82±0.29 b	2.90±0.17 a	2.93±0.15 a	0.0001
Glucose (mg/100 ml)	175.15±1.50 a	173.60±1.41 b	131.10±2.67 c	0.0001
Cholesterol (mg/100 ml)	182.81±3.80 a	148.15±5.57 b	142.84±3.50 b	0.0001
HDL Cholesterol (mg/100 ml)	55.20±1.03 c	64.86±5.15 b	82.02±1.44 a	0.0001
LDL Cholesterol (mg/100 ml)	121.51±2.82 a	83.29±6.40 b	60.75±3.80 c	0.0001
Triglycerides (mg/100 ml)	475.40±3.62 a	405.05±1.42 b	407.15±4.25 b	0.0001
ALT (IU/L)	48.83±0.28 a	40.33±1.13 b	40.39±0.70 b	0.0001
AST (IU/L)	12.42±0.62 a	10.67±1.08 b	10.81±0.65 b	0.0001
TAC (mmol/L)	0.17±0.01 b	0.54±0.02 a	0.44±0.07 a	0.0001

Means within a row not sharing a common superscript are significantly different ($P \leq 0.05$).

HDL: High Density Cholesterol. LDL: Low Density Cholesterol. ALT: Alanine Transaminase AST: Aspartate Transaminase, and TAC: total antioxidant capacity.

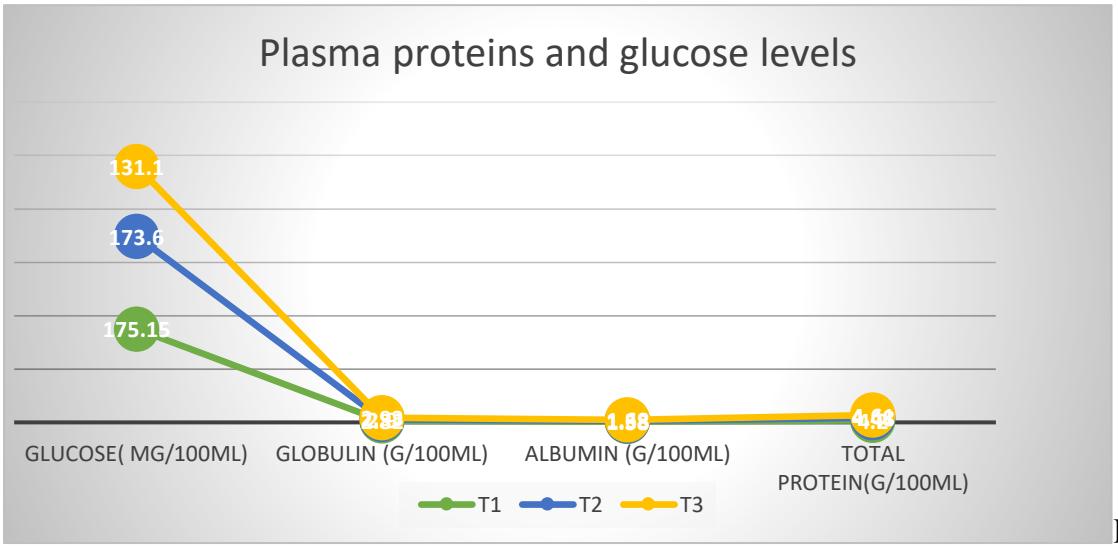

Figure 2: Effect of adding *Moringa* leaves and ginger powder on the plasma protein and glucose levels.

The identical table further delineates a notable reduction ($P \leq 0.05$) in glucose concentrations within the ginger powder intervention when juxtaposed with both the Moringa leaves and control interventions. These findings align with those documented by [58, 59] and may be attributed to the anti-diabetic properties inherent in ginger, which facilitate the reduction of blood glucose levels. It is posited that the anti-diabetic effects of ginger stem from the activation of AMP-activated protein kinase (AMPK), which plays a critical role in the cellular assimilation of proteins possessing lipid-lowering and anti-diabetic characteristics [45,46].

The findings presented in Table (2) elucidate that the dietary inclusion of ginger powder and Moringa leaves has significantly attenuated ($P \leq 0.05$) the total cholesterol levels in the bloodstream. Furthermore, a reduction in LDL and an elevation in HDL were observed in the cohorts administered ginger powder and Moringa leaves relative to the control group. These observations are corroborated by studies conducted by [27, 30], which reported substantial reductions ($P \leq 0.05$) in total cholesterol, HDL, LDL, and triglyceride concentrations. The observed decline in plasma cholesterol levels may be ascribed to the elevated levels of unsaturated fatty acids present in ginger, which may promote cholesterol secretion within the intestinal tract.

Ginger has demonstrated a pronounced anti-lipidemic influence on triglyceride and cholesterol concentrations [47]. The mechanism underlying this effect may be associated with the activation of cholesterol synthesis enzymes, including hydroxyl-methyl-glutaryl-CoA reductase (HMGR) [48]. In contrast, ginger serves as an efficacious inhibitor of HMGR, which is known to specifically enhance hepatic cholesterol synthesis [49]. Moreover, additional

investigations have indicated that insulin therapy for diabetes facilitates the reduction of triglycerides by modulating lipoprotein levels. Ginger exhibits insulin-like properties and stimulating effects that contribute to the amelioration of blood triglyceride levels. The data also indicated that total protein and albumin concentrations significantly augmented (P≤0.05) in diets incorporating ginger and Moringa leaves compared to the control treatment, paralleling the findings reported by [27].

Table (2) further elucidates that the incorporation of Moringa leaves and ginger powder into the diet of quails resulted in a statistically significant reduction (P≤0.05) in the serum activity levels of AST and ALT enzymes when compared to the control group. These findings are congruent with the observations made by [50], who reported notable decreases in ALT and AST enzyme levels in avian subjects that were administered a diet containing 0.4% Moringa. Consequently, the advantageous application of these dietary additives may reflect the biological efficacy of the tissues, attributable to the polyphenolic compounds present in Moringa leaves, in alignment with the assertions of [51, 52], who posited that Moringa leaves confer enhancements to hepatic health. This investigation also corroborates the findings of [49], who indicated that ginger exerts a diminishing effect on the levels of ALT and AST enzymes released into the bloodstream during instances of infection. Hence, the pronounced differences (P≤0.05) in AST and ALT enzyme levels across the experimental treatments in the present study may signify the normative hepatic functionality among avian groups that were provided diets enriched with ginger and Moringa leaves, thereby suggesting that these substances possess attributes conducive to the enhancement of liver health.

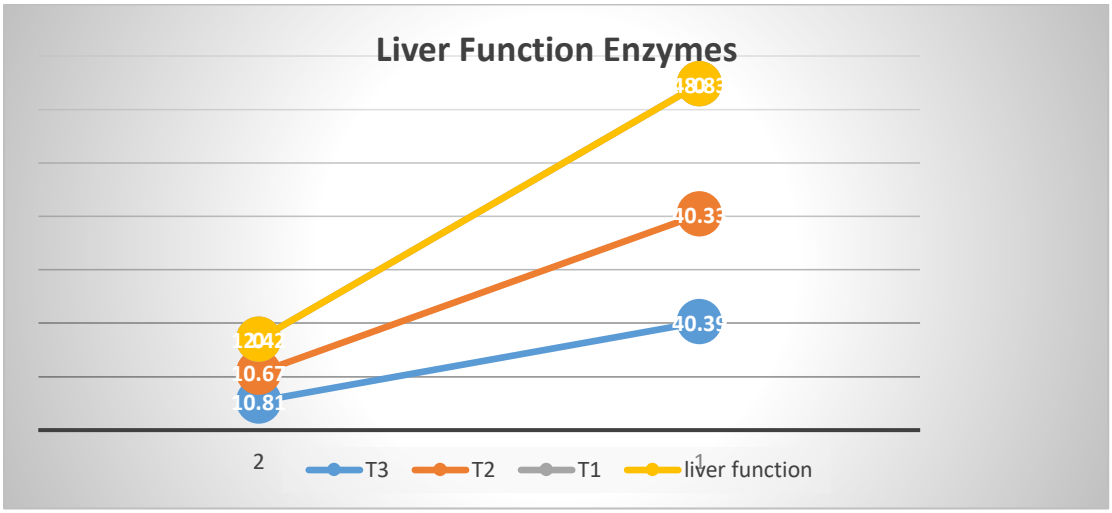

Figure 3: Effect of adding *Moringa* leaves and ginger powder on the liver function enzymes.

The addition of Moringa leaves and ginger powder resulted in a substantial elevation ($P \leq 0.05$) of the total antioxidant capacity (TAC) in comparison to the control group. The observed TAC results align with the findings of [52]. The notable augmentation in TAC may be attributable to the antioxidant enzymes inherent in Moringa and ginger, which contribute to the mitigation of lipid peroxidation and the neutralization of free radicals [53]. Furthermore, these substances have been shown to decrease malondialdehyde production in laying hens [54]. The efficacy of Moringa is ascribed to the presence of anthocyanins, polyphenols, and glycosides, which collectively scavenge free radicals and activate antioxidant enzymatic pathways [55], thereby obstructing the generation of reactive oxygen species [56].

4. CONCLUSION

In conclusion, supplementing Japanese quail diets with *Moringa* leaves and ginger powder markedly enhanced growth performance and improved key biochemical parameters. The observed increases in body weight, weight gain, and FCR, coupled with beneficial shifts in serum profiles—such as elevated albumin, globulin, HDL, and total antioxidant capacity, along with reductions in glucose, triglycerides, plasma cholesterol, LDL, ALT, and AST—underscore the potential of these natural additives as effective dietary enhancers. These findings suggest that integrating *Moringa* leaves and ginger powder into quail nutrition could serve as a promising strategy to boost productivity and promote overall health, paving the way for innovative applications in the poultry industry. However, authors suggesting further investigation is needed with large scale and more diet treatments with different addition ratio of moringa leaves and ginger for precise results.

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