

## **Effect of Adding Different Levels of Maca Powder to Diets on Productive Performance, Physiological Traits and Duodenum Bacterial a Count in Broilers**

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### **Abstract:**

The research was conducted from 1/3/2025 to 5/4/2025 by the Department of Animal Production at the University of Baghdad's College of Agriculture and Engineering Sciences. We randomly assigned 200 male and female broilers (Ross 308) to one of five treatments; each treatment included four duplicates, and each replicate had ten birds. The broilers in the control group (T1) were fed a standard diet, while treatments T2, T3, T4, and T5 each received 0.4, 0.8, 1.2, and 1.6 percent maca powder per 100 kg of feed, respectively. The Scientific Committee of the Animal Production Department gave its approval to this project on 25/11/2024, as stated in letter No. 24 from 7/1/2026. There were no statistically significant differences in the cumulative feed conversion ratio (FCR) for any of the treatments when compared to the control group. However, T5 had a significant advantage ( $p < 0.05$ ) in terms of cumulative live weight and cumulative weight gain, while T3, T4, and T5 had a significant advantage ( $p < 0.05$ ) in intake feed consumption. A drop in *E. coli* count was seen ( $p < 0.05$ ) in T5 when maca powder was supplemented, while the addition of maca powder had no effect on *Lactobacillus* bacteria when compared to T1. A decrease in triglycerides and low-density lipoprotein (LDL-C) in the blood serum is seen as a favorable indicator, while T3, T4, and T5 all demonstrated a decline in glucose concentration, while T2 indicated a decrease in cholesterol. For T5, there was a rise in the concentration of HDL-C as well ( $p < 0.05$ ). In tests T3, T4, and T5, globulin and total protein levels dropped. While the concentration of liver enzymes (GOT) fell in T3 and T4, the concentration of enzymes (GPT) rose in T3. Maca powder supplementation levels were not significantly different from T1 in terms of albumin and uric acid concentrations. In conclusion,

broilers' physiological performance was improved by supplementing their diets with maca powder, which increased their productive performance by increasing their duodenal bacterial count and hematological parameters.

**Keywords:** Diets, Levels of Maca Powder, Physiological Traits, Broilers, Productive Performance.

### **Introduction:**

Using antibiotics to increase digestion by controlling the gut flora of poultry is a common practice, this reflects on the extent to which feed is utilized to achieve alive body weight, however this practice is fraught with public health risks, the search has begun for natural feed additive alternatives to create a similar effect to antibiotics within the digestive system (Korkmaz, 2018; Seidavi et al., 2020; Ali and Al-Shuhaib, 2021; Nariç and Aydemir, 2021). Many medicinal plants, herbs, and their extracts have proven to perform an effective part in enhancing the efficient performance of the poultry industry (Al-Masari and Al-Himdany, 2022; Ezzat, 2023; Al Mashhdani, 2025). Maca (*Lepidium meynii*) belonging to the Brassicaceae family, Native of south America (Gonzales, 2012). Maca roots has widespread medicinal uses, as it is used as a natural antioxidant (Qiu, 2016), participates in immune system stimulation (Gonzales, 2014), impacts sexual behavior, boosts fertility by influencing receptors for sex hormones (Del Prete et al., 2018), in addition to raising poultry's level of productivity (Korkmaz et al., 2016; Ali et al., 2021). Maca is considered rich of nutrients, including, Carbohydrates, polysaccharides, and protein (Wang and Zhu, 2019). The true effectiveness of maca plant lies in its content of active compounds, including: N-benzyl-palmitamide, glucosinolate, phenolics, benzyl-isothiocyanate, alkaloids, maca acids and macaridin (Tafari et al., 2019; Cetin et al., 2021; Tafari et al., 2021, Turgud and Narinc, 2022). Therefore, in line with one of the Sustainable Development Goals of utilizing natural resources to enhance food production, this research sought to employ maca powder at various levels in broilers diet and study the effect in the productive performance, hematological parameters and duodenum bacterial count at 35 days.

### **Materials and Methods:**

#### **- Ethics Approval**

Research project proposal approved by the Animal Production Department's scientific ethical committee on 25/11/2024 at the University of Baghdad's College of Agriculture and Engineering Sciences. The use and care of animals was conducted in accordance with all relevant national and international regulations. Based on recommendation 24 from 7/1/2026.

### **- Experiment Design**

This research was performed at the poultry farm belongs to the Department of Animal Production, College of Agriculture Engineering Sciences, University of Baghdad during the timeframe from 1/3/2025 - 5/4/2025. Used to be two hundred broilers (Ross 308) in study unsexed weighing an average of 42.7 gm per bird at first day, distributed randomly into five treatments, with four replicates each replication had ten chicks. As follows: T1 Control (0%), T2, T3, T4, T5 were addition (0.4, 0.8, 1.2, and 1.6) % maca powder respectively. Diets were prepared freshly each week from (1-10 days) starter, (11-24 days) grower and (25-35 days) Finisher with protein content (%) and Represented energy (kcal/kg diet) (23-23.04 %) (3000.22-3003.87 kcal/kg), (21.5 %) (3100.17-3101.75 kcal/kg) and (20-20.02 %) (3200.01-3204.39 kcal/kg) respectively.

### **- Data collection on the active plant chemicals in maca powder, avian productivity, blood type, and small intestinal microbe count**

Maca powder was chemically analyzed using high-performance liquid chromatography (HPLC) in accordance with (Mradu et al., 2012) in order to determine the concentration of active plant compounds (Table 1).

At 35 days, the experimental birds were randomly selected from each replicate (2 birds/pen) to measure the number of microorganisms (*E. coli*, *Lactobacillus*) in the small intestine (duodenum) of the birds in the laboratories of the Animal Production Department. Cumulative production characteristics were recorded, including body weight, feed consumption, and feed conversion ratio (Al-Zubaidy, 1986). (Scotter et al., 2000; Gardiner et al., 2002). Blood is drawn from the left wing vein to measure the concentration were: Glucose according to (Trinder, 1969), cholesterol and triglycerides (TG) (Grundy et al., 2004), (HDL-C) and (LDL-C) (Warnick et al., 2001), total protein, albumin, globulin and uric acid (Doumas et al., 1971; Kaplan et al., 2003), in addition to liver enzymes Aspartate transaminase (GOT) and Alanine transaminase (GPT) (Bergmeyer, 2012).

**Table 1. Chemical analysis of *Lepidium meynii* tubers**

<b>Active compounds</b>	
phenolic (mg gallic per 100 g)	98.08
flavonoid (mg rutin per 100 g)	50.25
glycoside %	0.89
Gallic acid (ppm)	74.6
Ferulic acids (ppm)	36.9
Caffeic acids (ppm)	22.5
<b>Vitamins (ppm)</b>	
Vit.C	62.5
Vit.E	41.8
<b>Amino acids (<math>\mu\text{g/gm}</math>)</b>	
Methionine	19.08
Cysteine	17.80
Proline	15.88
Phenylalanine	12.65
Glycine	11.80
Histidine	11.24
Lucine	10.66

### **Analytical statistics**

Following a complete randomized design (CRD), the data were analyzed using analysis of variance (SAS, 2004). Duncan's multiple range test (Duncan, 1955) was used to differentiate significant treatment means at a 5% level.

### **Results and Discussion**

In comparison to the control group, treatments T2, and T3, as well as treatment T5, the inclusion of maca powder significantly improved the average live body weight and cumulative weight gain (gm) at 35 days of age for the birds in treatment T5, according to Table 2. However, there was no significant difference with treatment T4. The cumulative feed consumption rate (gm) was significantly higher in experimental treatments T3, T4, and T5 than in treatment T2 and the control group ( $P < 0.05$ ). In comparison to T1, the cumulative feed conversion efficiency (g feed/g weight gain) was unaffected by the addition of maca powder at all levels to the diet.

**Table 2. The 35-day mean plus standard error of productive performance characteristics of broilers fed varying amounts of maca powder.**

Treatment	Average body weight (gm)	Average weight gain (gm)	Average feed intake (gm)	<sup>1</sup> Average FCR (gm/gm)
T1	1911.75± 3.61 d	1871.0± 3.18 c	2966.19± 3.17 b	1.58± 0.0
T2	1968.25± 3.44 c	1926.75± 4.09 b	2998.13± 13.43 b	1.55± 0.008
T3	1983.86± 2.54 bc	1940.73± 2.84 b	3084.72± 19.40 a	1.58± 0.01
T4	2001.42± 8.02 ab	1957.20± 7.92 ab	3093.05± 16.08 a	1.57± 0.01
T5	2019.64± 20.13 a	1975.74± 20.37 a	3121.88± 28.30 a	1.57± 0.02
Sign. levels	*	*	*	N.S

Mass of feed per unit of weight increase; average feed conversion ratio. There was a statistically significant difference of 0.4%, 0.8%, 1.2%, and 1.6% maca powder/100 kg diet between treatment T1 control, T2, T3, T4, and T5, denoted by different letters. Among the therapies, there is no discernible change (N.S.).

The importance of medicinal plants is due to their chemical compounds, known as secondary metabolites with multiple biological activities, which are studied in depth, such as alkaloids, phenols, flavonoids, glucosides and isothiocyanates (Sharma, 2018; Li *et al.*, 2022). The noticeable improvement shown by the addition of maca powder, especially with higher levels of use, on productive performance characteristics can be attributed to the plant's active compounds such as flavonoids, it is the primary cause of the increase in average body weight, which's primarily reflected in the average weight gain, as well as improving the utilization of provided feed, they do this by regulating hepatic growth hormone (GH) and its receptors in cells, which leads to an increased concentration of insulin-like growth factor-1 (IGF-1), ultimately resulting in higher growth rates (Hassan *et al.*, 2018; Garba *et al.*, 2023). The presence of phenolic

compounds, generally enhance the flavor which consequently results in higher feed consumption and enhanced productivity (Christaki *et al.*, 2020). It might be the small intestine's nutrition transporters' gene expression (jejunum and ileum) acts as digestive transporters for protein, fat and carbohydrates, this expression is influenced by maca powder due to its prominent role increasing their gene expression (Sahin *et al.*, 2021). The plant's content of essential amino acids (methionine and lysine) is also of great importance in meeting the bird's nutritional needs. These essential amino acids are considered nutritional supplements that can regulate intestinal processes and promote growth, as a deficiency in the amino acid methionine negatively affects the development of lymphoid organs, in addition to harming the growth process (Carew *et al.*, 2003; Vieira *et al.*, 2004). These amino acids are essential for bodily functions because they participate in many biological processes, they are classified as the building blocks of proteins (Wu *et al.*, 2007; He *et al.*, 2011; Blachier *et al.*, 2013). The addition level (1.6%) of maca powder to treatment (T5) showed a significant decrease ( $P < 0.05$ ) in *E. coli* counts in the duodenum compared to (T1, T4), but it did not differ significantly from (T2, T3) (Table 3).

**Table 3. Logarithmic counts of microorganisms in the duodenum at 35 days (mean + S.E.) as a result of introducing varying amounts of maca powder to the broiler diet.**

Treatments	Logarithmic numbers of microorganisms Log c.f.u / g	
	<i>E.coli</i>	<i>Lactobacillus</i>
T1	5.360 ± 0.14 a	5.203 ± 0.23
T2	5.069 ± 0.14 ab	5.754 ± 0.28
T3	5.229 ± 0.10 ab	5.328 ± 0.26
T4	5.408 ± 0.10 a	5.087 ± 0.11
T5	4.876 ± 0.12 b	5.528 ± 0.06
sign. levels	*	N.S

\*According to the different letters, there was a significant difference of 0.4%, 0.8%, 1.2%, and 1.6% maca powder/100kg diet between the T1 control, T2, T3, T4, and T5 treatments, respectively. No significant difference was seen between the treatments (N.S.).

A healthy gut with a balanced microbial community act as a barrier, preventing pathogens and their toxins from entering the bloodstream, in addition to being the part responsible for the metabolic processes in domestic birds and the absorption of its products (Ouyang *et al.*, 2024). Therefore, the broilers industry relies on antibiotics because of their effective role in promoting growth and reducing bacterial infections (Zhu *et al.*, 2021). Referring to the results of Table 3, the addition level (1.6%) maca powder of diets showed a clear decrease in the number of *E. coli* bacteria, which can be attributed to the content of maca tubers of organic acids such as (Gallic, ferulic, and Caffeic) (Table 1). Studies have shown the roles of organic acids in supporting intestinal functions, modifying the gut microbiome, and promoting growth (Stamilla *et al.*, 2020; Galli *et al.*, 2021; Ma *et al.*, 2021). Mustafa *et al.* (2021) They have demonstrated the ability of organic acids and divide it due to the alkalinity of the cytoplasm, which leads to the release of hydrogen and carboxyl ions, making the cytoplasm acidic, and thus hindering protein synthesis and bacterial reproduction. Likewise, Waghmare *et al.* (2025) indicated that these secondary metabolites (organic acids) have the ability to act selectively in inhibiting harmful types of microbes and supporting beneficial types. Treatment T4 resulted in a significantly lower glucose level ( $P<0.05$ ) compared to the control treatment and the remaining experimental treatments, according to the blood plasma tests conducted on broilers at 35 days of age (Table 4). The T2 therapy showed a noticeable drop in cholesterol levels ( $P<0.05$ ), although it was not statistically different from the control treatment or the levels of the other additives. In comparison to treatments T1 and T2, the experimental treatments T3, T4, and T5 had considerably reduced triglyceride levels ( $P<0.05$ ). Treatment T4 had the lowest result, at 72.79 mg/dl. Compared to T2 and T4, treatment T5 significantly improved HDL-C levels ( $P<0.05$ ), but it did not differ significantly from T3 or the control group. Levels of LDL-C reduced in the experimental treatments T3, T4, and T5, indicating a substantial improvement ( $P<0.05$ ) compared to treatments T1 and T2. In terms of total protein level, treatment (T2) was noticeably better than both the control treatment and the other treatments ( $P<0.05$ ). At 35 days of age, the blood plasma level of it was lowest in broilers treated with treatments (T4, T5). Treatment (T2) also shown the lowest amount of globulin, while treatment (T4) surpassed both the control and other treatments in this regard, with a significant difference ( $P<0.05$ ). The liver enzyme results demonstrated a notable improvement ( $P<0.05$ ) in treatments (T3, T4) as compared to treatments (T1, T2, T5),

due to the decrease in the (GOT) enzyme. There was a significant decrease ( $P<0.05$ ) in the level of GPT in the treatments (T2, T4) when compared to the (T3), but there was no significant difference when compared to the comparison group and (T5). On the 35th day of the broiler's life, blood plasma data showed no significant variations in (uric acid, albumin) levels between the control group and the groups that received varying amounts of maca powder supplements.

Measurements (mg/dl)	Treatment					sign. levels
	T1	T2	T3	T4	T5	
Glucose	137.44 $\pm$ 0.71 ab	183.54 $\pm$ 8.77 b	214.39 $\pm$ 7.71 a	140.19 $\pm$ 9.28 c	178.49 $\pm$ 2.88 b	*
Cholesterol	137.44 $\pm$ 0.71 ab	116.79 $\pm$ 1.32 b	131.39 $\pm$ 11.72 ab	125.89 $\pm$ 5.29 ab	126.67 $\pm$ 2.64 ab	*
TG	169.31 $\pm$ 6.62 a	160.76 $\pm$ 29.9 a	101.13 $\pm$ 3.42 b	72.79 $\pm$ 8.90 b	98.86 $\pm$ 11.18 b	*
HDL-C	55.51 $\pm$ 0.93 ab	51.93 $\pm$ 4.40 bc	57.79 $\pm$ 2.85 ab	44.1 $\pm$ 1.13 c	60.18 $\pm$ 2.13 a	*
LDL-C	33.08 $\pm$ 1.32 a	35.65 $\pm$ 5.98 a	20.62 $\pm$ 0.68 b	15.6 $\pm$ 1.78 b	21.08 $\pm$ 2.23 b	*
Total protein g/dl	4.49 $\pm$ 0.007 b	4.85 $\pm$ 0.07 a	3.93 $\pm$ 0.02 c	3.23 $\pm$ 0.12 d	3.56 $\pm$ 0.21 d	*
Albumin g/dl	1.78 $\pm$ 0.03	1.78 $\pm$ 0.07	1.83 $\pm$ 0.02	1.83 $\pm$ 0.06	1.87 $\pm$ 0.008	N.S
Globulin g/dl	2.70 $\pm$ 0.03 b	3.06 $\pm$ 0.14 a	2.09 $\pm$ 0.008 c	1.40 $\pm$ 0.18 d	1.94 $\pm$ 0.05 c	*
Uric acid	5.37 $\pm$ 0.12	4.95 $\pm$ 0.15	5.08 $\pm$ 0.35	5.42 $\pm$ 0.08	5.180 $\pm$ 0.15	N.S
GOT (u/l)	13.34 $\pm$ 2.85 a	6.68 $\pm$ 0.99 a	5.05 $\pm$ 1.61 c	5.66 $\pm$ 0.49 c	11.30 $\pm$ 0.12 ab	*
GPT (u/l)	6.35 $\pm$ 0.86 b	8.43 $\pm$ 0.99 b	29.69 $\pm$ 8.81 a	11.82 $\pm$ 0.66 b	17.19 $\pm$ 5.83 ab	*

\*different letters indicated to the significantly different between the treatment T1 control, T2, T3, T4 and T5 were 0.4%, 0.8%, 1.2% and 1.6% maca powder/100kg diet respectively. N.S refers to no difference among the treatments.

Maca glucosinolates work to regulate glucose metabolism by promoting the P13k/Akt pathway of insulin-resistant Hep62 cells, so they can work to correct metabolic disturbances of glucose and fats (Wan *et al.*, 2018; Olofinnade *et al.*, 2021). Weinbrenner *et al.* (2004) and Xie *et al.* (2023) they suggested that the mechanism for reducing high cholesterol could be achieved by

decreasing its biosynthesis. The key enzyme in its synthesis HMG-CoA is reduced by NADPH, and by lowering its levels with the help of antioxidant compounds, LDL-C cholesterol (bad cholesterol) decreases and HDL-C cholesterol (good cholesterol) increases. Furthermore, vitamins (such as ascorbic acid) have an effect on fat metabolism when included in the diets of broiler (Habibian *et al.*, 2014, Ahmadipour *et al.*, 2015). The decrease in the total blood protein level due to increased pancreatic enzyme secretion activity, in addition to a balance of intestinal microbial content, which helps in better absorption of metabolic byproducts. Also, an increase in globulin is an indicator of enhanced immune status in the bird (Afifi, 2001; Windisch *et al.*, 2008). The addition of plants rich in phenols has vital roles in protein metabolism as well as a protective role for liver cells, thus limiting the elevation of its enzymes GOT and GPT (Al-Khalaifah *et al.*, 2022; Abou-Kassem *et al.*, 2025).

### **Conclusions:**

Maca contains a group of active compounds (shown by chemical analysis of plant powder) with antioxidant properties that can enhance the productive performance of broiler. The increased usage also improved some of the properties of blood plasma, in addition to its effective role in reducing the increasing number of harmful microbial species (*E. coli*) in the intestine, which can cause competition with the host body for nutrients. Based on these results, we recommend the use of maca powder at a level of (1.6%) in broiler feed. This supports the Sustainable Development Goals by turning to natural resources to enhance food security requirements through the use of medicinal plants with biologically active compounds, thus reducing the use of artificial growth stimulants in poultry feed.

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