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# COMPLEMENTARY EFFECT OF BLACK PEPPER AND TURMERIC ON PRODUCTIVE PERFORMANCE AND PHYSIOLOGICAL RESPONSES OF JAPANESE QUAIL

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**ABSTRACT:**The physiological effect of black pepper and turmeric are of great interest due to their antioxidant, nutritional and therapeutic properties. Therefore, the target of this study was to investigate the physiological and immunological effects of black pepper to enhance bioavailability of turmeric on productive performance of growing Japanese quail. A total of two hundred unsexed seven day-old from Japanese quail were divided into four groups, each group was distributed into five replicates, 10 birds in each replicate. All groups were fed the same basal diet supplemented with 0.0%,2% turmeric powder/ Kg diet,0.5 % black pepper powder/ Kg diet for the 1$^{st}$ , 2$^{nd}$ and 3$^{rd}$ groups, while the fourth group was given basal diet supplemented with a mixture of 2% turmeric powder + 0.5 % black pepper powder/ Kg diet. All quails were fed the experimental diets from 7 to 42 days of age. The results revealed that dietary supplements turmeric, black pepper either singly or in combination had significantly improved live body weight, weight gain and feed conversion ratio compared to control group. Additionally, results illustrated that combined black pepper + turmeric group had positive effect on protein fraction, globulin fractions(α, β, and γ-globulin), lipids profile, and immunoglobulin G (IgG) compared to other groups. Additionally, combined black pepper with turmeric group recorded highly significant values of thyroid hormones concentration, T3/T4 ratio and improvement SOD, MDA and GSH-Px concentration compared to other groups. Meanwhile, treated groups had no significant effect on feed consumption, liver functions markers (ALT, AST and ALP) and immunoglobulin A and M (IgA, IgM) compared to control group of growing quail. However, there were no significant differences between turmeric or black pepper groups on physiological and immunological responses of growing quails.

Conclusion: These results concluded that combining of 0.5% black pepper to 2% turmeric together may enhance productive performance and had significantly improved serum lipids concentration, thyroid hormones, antioxidant enzymes activity, immunoglobulin G of growing quail.

**Key Words:** quail, Piperine, curcumin, antioxidant, lipids profile

## INTRODUCTION

Recently, Japanese quail (*Coturnix Japonica*) has been considered of great economically significant as substitutional part to the chickens as a source of eggs and meat all-over the world including Egypt (El-Daly et al., 2014). Commercial quail production in Egypt is rapidly growing, due to the new selected strains which have higher body weight, rapid growth, require little space for growing and maintenance with a very low finance when compared to other birds (Abd El-Azeem et al., 2019). Quail meat is very delicious, healthful, and characterized by low fat content, therefore, It is better for the high blood pressure patients (Rogerio, 2009). Recently, use of some phytogenic growth promoters (spices) became extensive in poultry feed, due to their medicinal properties. Black pepper and turmeric have been known to have several biological effects *i. e.* exhibit anti-Inflammatory activity (Holt et al., 2005, Kim et al., 2012; Son et al., 2012 Wang et al., 2017), hypolipidaemic (Ramirez-Tortosa et al., 1999 and Vijayakumard et al., 2002),antioxidant (Pal *et al*., 2001; Iqbal et al., 2003 and Wang *et al*., 2017) and antimicrobial Properties against pathogenic microorganism(Menon et al., 2003; Liu et al., 2013 and Zengin and Baysal, 2014).

Turmeric (*Curcuma longa*) is a natural herbaceous of the *Zingiberaceae* family used as a food spice (HMPC, 2009) and for improving digestion and nutrient metabolism. Curcumin is the essential bioactive ingredient responsible for the biological activity of turmeric (Nouzarian et al., 2011). Turmeric role in improving the physiological condition and liver function of quail was reported to be due to its content of curcumin and phytoestrogens (Nouzarian et al., 2011andSaraswati et al., 2013b) that have the property of lowering levels of aspartate aminotransferase and alanine aminotransferase in the blood (Saraswati et al., 2013a) and increasing the ability to trap oxygen radical as an antioxidant (Metzler et al., 2013).

Black pepper (*Piper Nigrum*) called the King of spices, this is one of the pungent or aromatic substances of vegetable origin used as food adjuncts and was used as stimulant of gastric secretion, raises the flow of digestive juice (Moorthy et al., 2009), and develops thermogenesis of lipid (Malini et al., 1999). Black pepper contains piperine, essential oils, piperettine, piperidine and chavicine (Vijayakumard et al., 2002).Besides, combining mixture *Curcuma longa*and *Piper Nigrum* enhanced the bioavailability of curcuminoids in animals (Sehgal et al., 2011, 2012 and Pawar et al., 2012) and improved the performance and health status of broiler chickens (Abou-Elkhair et al., 2014).

This study was conducted to elucidate the effects of mixture of black pepper and turmeric on growth performance, physiological and immunological responses in Japanese Quail.

## MATERIAL AND METHODS

This study was carried out from April to May 2020 at the Poultry Research Unit (El-Bostan Farm), Department of Animal and Poultry Production, Faculty of Agriculture, Damanhour University, Damanhour, Egypt.

### Experimental Procedures

Two hundred unsexed seven-day-old Japanese quail chicks were randomly assigned into four equal groups (50 birds / group) with five replicates/ group (10 birds each).All birds were raised for six weeks of age, wing banded and housed in wire cages (40×50×40 cm). Birds were fed the same basal diet (Table. 1) and submitted to the following dietary treatments: The 1st group was fed the basal diet without supplementation (control),the 2nd group was fed basal diet +20 g turmeric powder (TP) / Kg diet, 3rd group was fed the basal diet +5 gof black pepper/ Kg diet and the 4th group was fed same basal diet + combining mixture of 20 g turmeric and 5g black pepper/ Kg diet. All quails were fed the experimental diets from 7 to 42 days of age. Feed and water were always provided ad-libitum to birds. The birds were kept under the same environmental and managerial conditions. The light regime used was 20 L: 4D/day (artificial light). Composition and calculated analysis of basal diet is presented in (Table. 1) according to NRC (1994).

**Growth Performance**

Live body weight (LBW, g), weight gain (WG, g), and feed consumption (FC, g) were recorded weekly throughout the experimental period (7-42 d of age). For each replicate within treatment groups, feed conversion ratio (FCR) was calculated according to the equation: FCR = FC (g) / BWG (g).

**Blood Analysis:**

At the end of the experimental period (42 day), five fasted quails from each treatment were randomly taken for slaughter and were individually weighed. Five blood samples were collected in weatherman tubes from each group. After scalding, feather picking and evisceration, carcass and internal organs (i.e., liver, heart, spleen, bursa, and thymus gland) were weighed. Percentage of carcass and organs were calculated based on live body weights. Blood samples were centrifuged (3500 rpm) for 15 minutes then stored at -20˚C until biochemical analysis.

Serum total protein and albumin were measured by using a commercial kits according to guidelines of Grant et al. (1987) and Doumas et al. (1981), respectively. While globulin values were obtained by subtracting albumin values from the corresponding values of total protein (Sturkie, 1986) and then albumin (Alb) to globulin (Glob) ratio was calculated. In addition, biochemical determinations included different types of globulin (α-globulin, β-globulin and γ-globulin) were measured according to Bossuyt (2006). Also, total cholesterol (Chol.), triglycerides (TG), high density lipoprotein (HDL) and low density lipoprotein (LDL) were measured by commercial kits according to Stein (1986), Fossati and Prencipe (1982), Lopez-Virella et al.,(1977) and Friedewald et al. (1972). In addition, the activity of serum aspartate aminotransferase (AST),serum alanine aminotransferase (ALT) and alkaline phosphatase (ALP) concentrations were estimated according to Reitman and Frankel (1957) and Kind and King (1954) using commercial kits and then AST to ALT ratio was calculated. serum samples were assigned also for determination of superoxide dismutase (SOD) activity according to Misra and Fridovich (1972), glutathione peroxidase (GSH-Px) determined according to (Marzal et al. 2006) and malondialdehyde (MDA) according to the method of Buege (1978). Serum immunoglobulin's (IgG, IgM and IgA) were determined using ELISA kits according to Bianchi et al. (1995).Tri-iodothyronine (T3), thyroxin (T4) were determined in sera using ELISA technique according to Walker (1977) and Wisdom (1976), respectively, thenT3 and T4 ratio was calculated.

**Statistical analysis:**

The analysis of variance for completely randomized design experiments using general linear models procedure of (**SAS, 2006**) examined the effects of dietary treatments. The model used was:

$Yij = \mu + Ti + £_{ij}$

Where, Yij; Observation, µ is the general mean; $T_i$ is the effect of experimental treatments (i=1 to 4).; and $£_{ij}$ is the experimental random error. The differences among means were determined using Duncan's new multiple range test (**Duncan, 1955**).

## RESULTS AND DISCUSSION

### Growth performance

There were no statistically significant differences between all treatments in initial body weight (IBW) and feed consumption (Table 2). Nevertheless, there was obviously a higher significant improvement in live body weight (LBW), weight gain (WG) and feed conversion ratio (FCR) in combining mixture of turmeric and black pepper group than other groups. Additionally, results showed efficacy of turmeric or black pepper to increase live body weight and body weight gain in comparison versus untreated group. The significant decrease in FCR that was recorded for turmeric treatment is supported by the findings of Singh et al. (2017) and Hossen et al. (2018) reported that turmeric increase significantly growth performance in broiler compared to the control group.

Active materials (Curcumin and curcuminoids) found in turmeric causing an increase in the absorption of nutrients, enhance digestion, and greater efficiency in the utilization of feed, resulting in enhanced growth (Hussein, 2013). Similar results were recorded by Durrani et al. (2006) and Kumari et al. (2007), who reported that turmeric had a positive effects on growth performance of broiler might be due to effects of turmeric flavor on the chicks' appetite and improved secretions of proteolytic enzymes, lipase enzymes and amylase(Platel& Srinivasan, 2000) and enhance antioxidants and control hyperlipidemia (Hewlings and Kalman, 2017). Also, improvement of productive performanceas a result of black pepper treatment was similar to the results reported by Mansoub (2011) and Akbarian et al. (2012) because black pepper is rich with piperine which acts as a type of antioxidant and a bioavailability improver of phytochemicals through a number of mechanisms (Suresh and Srinivasan, 2006) e.g., elevates pancreatic digestive enzymes and a lowering in feed passage time in the digestive tract Platel and Srinivasan (2000; 2001).

### Blood Parameters:

Total serum protein, albumin and globulin concentration were significantly increased ($P \leq 0.05$)in turmeric or black pepper and their combination groups compared to control group (Table 3).No statistically significant differences among treatments was observed in albumin to globulin ratio. These results are in line with Qasem et al., 2015 who reported that turmeric Supplementation improved total protein, Alb and Glob. Values. There were statistically significant differences in the serum TG, total Chol., HDL, LDL concentrations in all treatments compared to control group. Significantly decreased serum TG, cholesterol and LDL were observed in group combining of turmeric and black pepper compared to other treatments. While HDL concentration was significantly higher in quail treated with turmeric, black pepper and their combination when compared to the control group. Moreover, Kumari et al. (2007); Al-Kassie et al. (2011) and Gandhi et al. (2011) indicated that turmeric significantly lower total cholesterol, this might attributable to reduction in hepatic 3-hydroxyl-3-methyglutaryl Co-A reductase, which have a role in the synthesis of cholesterol in the liver. Moreover, Vijayakumar et al. (2002) reported that supplementation black pepper or piperine elevated HDL-cholesterol concentration and reduced LDL-cholesterol concentrations as compared with untreated group by virtue of its hypolipidemic. Black pepper was significantly ($p \leq 0.05$) decreased TG, total cholesterol and LDL concentration in blood serum compared to untreated group.

Results of present study are in accordance to Ghaedi et al., 2014 who reported that black pepper supplementation reduced TG and total chol., meanwhile, HDL concentration was increased compared to untreated group. This effect can be elucidated by inhibition syntheses of the Acetyl Co-A enzyme, which is vital for the synthesis of fatty acids. In addition, this effect can be clarified by the potential mechanism of antioxidant and anti-peroxide lowering action on LDL-cholesterol in the blood circulation (Kim et al., 2009). Furthermore, addition of black pepper and turmeric were improved activity of enzymes which are involved in the conversion of cholesterol to bilious acids thereafter will lead to lower cholesterol concentration of broiler (Al-Kassie et al., 2011; Gandhi et al., 2011 and Ghaedi et al., 2014).

There were no effects of treated groups on serum ALT, AST, ALP enzyme activity and AST to ALT ratio compared with the control group (Table 4). According to the findings of Sarfraz et al. (2017) who found that black pepper had no-significant effect on ALT and ALP levels. Also, Al-Jaff (2011) and Akbarian et al. (2012) observed an improvement of turmeric, black pepper and mixture groups, indicating better liver function, which work as a hepatoprotective substance.

Results presented in (Table 4) indicated that serum tri-iodothyronine (T3) and thyroxin (T4) levels were significantly higher in quail treated with turmeric or black pepper and the combination of them than control group. The results showed that quail from combining mixture turmeric + black pepper group was the best. Moreover, results illustrated that the serum T3, T4 levels, and T3/T4 were lower in quails within the turmeric or black pepper treatments when compared to combining the turmeric + black pepper group. These results may be due to that combining of turmeric and black pepper is necessary for the increased conversion of serum T4 to T3 for quail.

As reported in (Table 5) immunoglobulins' levels were partially influenced by different treatments especially IgG. It was observed that serum immunoglobulins' G concentration was higher in combining of turmeric and black pepper group compared to other groups. while, the results for IgM and IgA levels were unaffected for all the groups.

Additionally, black pepper combining with turmeric had significantly higher levels of serum globulin fractions ($\alpha$, $\beta$, and $\gamma$-globulin) of quails compared to the control group were illustrated in (Table 5).

Table 6. illustrated the effect of mixture black pepper and turmeric in serum antioxidant enzymatic activities. The results reported that significantly higher

SOD and GSH-Px activity in serum quail groups treated by black pepper or combining of black pepper+ turmeric compared to the other groups. Conversely, serum MDA concentration was significantly decreased in turmeric or black pepper and mixture their treatments as compared to untreated group. Turmeric has the ability to inhibit lipid peroxidation and scavenge the superoxide anion and hydroxyl radicals (Motterlini et al., 2000). These results are in line with Wang et al., 2015 who found that turmeric supplementation improvement (P≤0.05) the serum enzymatic activities of SOD and GSH-Px. Meanwhile, the serum malondialdehyde concentration was significantly decreased by dietary supplementation turmeric, as compared to control group.

The findings of the present study also in accordance with the results by Chattopadhyay et al. (2004) and Daneshyar (2012) demonstrated that turmeric supplementation could enhance the antioxidant capacity by rising SOD and GSH-Px activities and reducing serum MDA activity of broilers. It has been explained in previous studies that mixture black pepper and curcumin was related with improved curcumin bioavailability (Anand et al., 2007; Sehgal et al., 2011; 2012)through inhibition of MDA formation, decrease lipid peroxidation and enhancement antioxidant enzymes activity (Zhang et al., 2015).

Moreover, this in vivo effect is depended principally on the inhibition of the glucuronidase enzyme activity and inhibition of transport proteins by piperine from black pepper (Berginc et al., 2012).

Results in (Table 7) illustrated that carcass yield and the relative weight of lymphoid organs (Bursa and thymus) and liver of the turmeric and black pepper mixture group significantly increased than the other groups followed by black pepper group then turmeric treatment. On the other hand, the heart and spleen relative weights weren't significantly different between all groups. Similar results were

obtained by Al-Kassie et al. (2012) and Abou-Elkhair et al. (2014) who reported that the use of herbal plants hadn't statistically significance effect on relative weight of heart and spleen. On the other hand, there was no significant effect between turmeric or black pepper groups on relative weights of carcass, liver, heart and lymphoid organs. These results are supported by Mansoub (2011) who found an increase in the percentage of relative weight of liver in broilers on dietary supplementation black pepper. Additionally, Saeid and AL-Nasry (2010) observed that turmeric increased relative liver weight compared to other groups. Therefore, the improvement of quail growth performance by treatment of combinations black pepper and turmeric may be due to piperine is the main active ingredient of black pepper, which when combined with turmeric it has been shown to enhance bioavailability by 2000%. This effect was elucidated out of the ability of piperine inhibition of intestinal and hepatic glucuronidation of curcuminoids and to inhibit releasing of curcuminoid into the intestine may result in improved bioavailability(Berginc et al., 2012) and facilitates the passage of curcumin through the intestinal wall, slows down the breakdown of curcumin by the liver (Prasad et al., 2014 and Hewlings and Kalman, 2017) and boosts the activity of digestive enzymes such as lipase, amylase, and proteases Platel and Srinivasan (2000; 2001).

## CONCLUSION

It could be concluded that mixture of 2% turmeric and 0.5% black pepper / kg diet had significantly increased body weight gain, HDL, SOD, GSH-Px, serum protein fraction, immunoglobulin G and thyroid hormones. Meanwhile, significant decreased in serum TG, LDL, cholesterol and MDA were observed on combining of black pepper and turmeric group compared to other groups of growing Japanese quail.

**Table (1):** Ingredients and calculated analysis (%) of the basal diet of quails from 7 to 42 days of age

| **Ingredients, (g/kg)** | ***%*** |
|---|---|
| Yellow corn | 45.00 |
| Soybean meal (44%CP) | 47.20 |
| Wheat bran | 1.40 |
| Sunflower oil | 3.00 |
| Limestone | 0.45 |
| Dicalcium phosphate | 2.05 |
| Vit+Min mix[1] | 0.30 |
| NaCl | 0.30 |
| DL-methionine | 0.30 |
| **Total** | **100.00** |
| ***Calculated analysis*** | |
| ME kcal/kg diet | 2979 |
| Crude protein,% | 24.99 |
| Methionine,% | 0.67 |
| TSAA, % | 1.06 |
| Lysine,% | 1.40 |
| Ca,% | 1.06 |
| Available P, % | 0.50 |
| Selenium, mg/kg | 0.172 |

[1] Vitamins and minerals mixture provide per kilogram of diet: Vitamin E (all rac-$\alpha$-tocopheryl acetate); 10 IU; $k_3$ 3mg; riboflavin, 10 mg; Vitamin $B_{12}$, 10µg; Vitamin $B_6$, 1.5 mg; Vitamin A (as all-trans-retinyl acetate); 12000 IU; Vit.$D_3$, 2200 ICU; niacin, 20 mg; Ca pantothenate,10 mg; Thiamine (as thiamine mononitrate); 2.2 mg; pantothenate,10 mg; ; Choline chloride, 500 mg; D-biotin, 50µg and ; Folic acid, 1 mg. Trace mineral (milligrams per kilogram of diet) Cu, 10; Mn, 55; Fe, 30; Se, 0.1; Zn, 50 and Ethoxyquin 3mg.

**Table (2):** Effect of turmeric, black pepper and their combination both on growth performance of growing quail.

| Items | T1 | T2 | T3 | T4 | SEM | P-Value |
|---|---|---|---|---|---|---|
| IBW (g) (7d) | 41.22 | 41.26 | 40.89 | 40.78 | 2.11 | 0.85 |
| LBW (g)(42d) | $199.11^{b}$ | $228.33^{a}$ | $225.89^{a}$ | $239.29^{a}$ | 7.34 | 0.009 |
| WG (g) (7-42d) | $157.89^{b}$ | $187.07^{a}$ | $185.00^{a}$ | $198.51^{a}$ | 8.48 | 0.024 |
| FC (g/ bird) | 681.0 | 714.8 | 680.0 | 687.0 | 11.65 | 0.159 |
| FCR | $4.32^{b}$ | $3.86^{a}$ | $3.69^{a}$ | $3.50^{a}$ | 0.136 | 0.004 |

a,b,c Means in the same row followed by different superscripts are significantly different at ($p \leq 0.05$); SEM= Standard error of means, T1: control, T2: 2% turmeric, T3: 0.5% black pepper, T4: mixture 2&turmeric+0.5% black pepper, IBW: initial body weight, LBW, live body weight, WG: weight gain, FC: Feed consumption, FCR: feed conversion ratio.

**Table (3):** Effect of turmeric, black pepper and their combination both on serum protein fractions and lipids concentration of growing quails.

| Items. | T1 | T2 | T3 | T4 | SEM | P-Value |
|---|---|---|---|---|---|---|
| T. protein (g/dl) | $5.48^{b}$ | $6.40^{a}$ | $6.41^{a}$ | $6.62^{a}$ | 0.25 | 0.022 |
| Albumin(g/dl) | $3.27^{b}$ | $3.74^{a}$ | $3.67^{ab}$ | $3.78^{a}$ | 0.14 | 0.050 |
| Globulin(g/dl) | $2.21^{b}$ | $2.66^{a}$ | $2.74^{a}$ | $2.84^{a}$ | 0.13 | 0.015 |
| A/G ratio | 1.49 | 1.43 | 1.34 | 1.34 | 0.05 | 0.107 |
| TG (mg/dl) | $88.60^{a}$ | $77.80^{ab}$ | $74.00^{b}$ | $69.20^{b}$ | 3.61 | 0.011 |
| Chol. (mg/dl) | $200.80^{a}$ | $191.40^{ab}$ | $190.80^{ab}$ | $178.00^{b}$ | 4.53 | 0.022 |
| HDL (mg/dl) | $56.40^{b}$ | $62.40^{b}$ | $70.00^{a}$ | $71.20^{a}$ | 2.24 | 0.001 |
| LDL (mg/dl) | $126.68^{a}$ | $113.44^{ab}$ | $106.00^{bc}$ | $92.96^{c}$ | 5.01 | 0.002 |

a,b,c Means in the same row followed by different superscripts are significantly different at($p \leq 0.05$); SEM= Standard error of means, T1: control, T2: 2% turmeric, T3: 0.5% black pepper, T4: mixture 2&turmeric+0.5% black pepper, TG= triglycerides; Chol.= total cholesterol; HDL=high-density lipoprotein; LDL=low-density lipoprotein

**Table (4):** Effect of turmeric, black pepper and their combination both onserum liver function and thyroid hormonesof growing quails.

| Items. | T1 | T2 | T3 | T4 | SEM | P-Value |
|---|---|---|---|---|---|---|
| AST(IU/L) | 39.82 | 40.25 | 42.08 | 41.69 | 2.99 | 0.481 |
| ALT (IU/L) | 19.85 | 20.85 | 21.38 | 22.20 | 1.20 | 0.518 |
| AST/ALTratio | 2.01 | 1.93 | 1.97 | 1.88 | 0.33 | 0.430 |
| ALP (U/10ml) | 11.86 | 12.54 | 12.84 | 12.42 | 0.75 | 0.906 |
| T3 (ng/ml) | $3.24^{b}$ | $3.48^{b}$ | $3.81^{b}$ | $5.88^{a}$ | 0.22 | 0.001 |
| T4(ng/ml) | $16.00^{b}$ | $17.80^{ab}$ | $20.00^{a}$ | $20.20^{a}$ | 1.07 | 0.042 |
| T3/T4 ratio | $0.202^{b}$ | $0.196^{b}$ | $0.193^{b}$ | $0.292^{a}$ | 0.01 | 0.003 |

a,b,c Means in the same row followed by different superscripts are significantly different at($p \leq 0.05$); SEM= Standard error of means, T1: control, T2: 2% turmeric, T3: 0.5% black pepper, T4: mixture 2&turmeric+0.5% black pepper, AST=aspartate amino transferase; ALT=alanine amino transferase; AlP =Alkaline phosphatase, T3= triiodothyronine, and T4=thyroxine.

**Table (5):** Effect of turmeric, black pepper and their combination both on serum immunoglobulins of growing quails.

| **Items.** | **T1** | **T2** | **T3** | **T4** | **SEM** | **P-Value** |
|---|---|---|---|---|---|---|
| α–globulin, (mg/10ml) | 53.75$^{b}$ | 66.31$^{a}$ | 65.15$^{a}$ | 70.29$^{a}$ | 1.99 | 0.002 |
| β -globulin (mg/10ml) | 68.23$^{b}$ | 94.19$^{a}$ | 92.84$^{a}$ | 97.21$^{a}$ | 3.45 | 0.001 |
| γ -globulin, (mg/10ml) | 87.66$^{b}$ | 103.90$^{ab}$ | 112.72$^{a}$ | 116.86$^{a}$ | 6.38 | 0.024 |
| IgG(mg/dl) | 602.60$^{b}$ | 650.80$^{ab}$ | 679.60$^{ab}$ | 727.20$^{a}$ | 28.55 | 0.046 |
| IgM (mg/dl) | 234.80 | 245.04 | 240.20 | 241.15 | 3.21 | 0.495 |
| IgA(mg/dl) | 71.00 | 72.80 | 73.04 | 75.85 | 2.60 | 0.695 |

$^{a,b,c}$ Means in the same row followed by different superscripts are significantly different at($p \leq 0.05$); SEM= Standard error of means, T1: control, T2: 2% turmeric, T3: 0.5% black pepper, T4: mixture 2&turmeric+0.5% black pepper, IgA= Immunoglobulin A; IgG= Immunoglobulin G; IgM= Immunoglobulin M.

**Table (6):** Effect of turmeric, black pepper and their combination both onantioxidant enzymes activityof growing quail

| **Items** | **T1** | **T2** | **T3** | **T4** | **SEM** | **P-Value** |
|---|---|---|---|---|---|---|
| MDA (ɱg/ml) | 0.698$^{a}$ | 0.622$^{b}$ | 0.536$^{b}$ | 0.404$^{c}$ | 0.03 | 0.001 |
| SOD (U/ml) | 168.40$^{b}$ | 177.00$^{ab}$ | 180.80$^{ab}$ | 201.20$^{a}$ | 7.91 | 0.047 |
| GSH-Px(U/ml) | 31.60$^{b}$ | 39.00$^{ab}$ | 41.60$^{a}$ | 45.40$^{a}$ | 2.55 | 0.011 |

$^{a,b,c}$ Means in the same row followed by different superscripts are significantly different at ($p \leq 0.05$); SEM= Standard error of means, T1: control, T2: 2% turmeric, T3: 0.5% black pepper, T4: mixture 2&turmeric+0.5% black pepper, TAC=total antioxidant capacity; ; GSH-Px =glutathione peroxidase; SOD=superoxide dismutase, MDA= malondialdehyde .

**Table (7):** Effect of turmeric, black pepper and their combination both oncarcass and some lymphoid organs weightof growing quail.

| **Items** | **T1** | **T2** | **T3** | **T4** | **SEM** | **P-Value** |
|---|---|---|---|---|---|---|
| Carcass (%) | 66.57$^{b}$ | 68.45$^{ab}$ | 67.47$^{ab}$ | 70.51$^{a}$ | 1.15 | 0.030 |
| liver (%) | 2.18$^{b}$ | 2.35$^{b}$ | 2.55$^{ab}$ | 2.79$^{a}$ | 0.12 | 0.016 |
| Heart (%) | 1.04 | 1.11 | 0.97 | 1.02 | 0.05 | 0.317 |
| Spleen (%) | 0.065 | 0.081 | 0.085 | 0.095 | 0.02 | 0.622 |
| Thymus gland (%) | 0.301$^{b}$ | 0.299$^{b}$ | 0.341$^{ab}$ | 0.372$^{a}$ | 0.02 | 0.013 |
| Bursa of Fabricius(%) | 0.106$^{b}$ | 0.149$^{a}$ | 0.156$^{a}$ | 0.173$^{a}$ | 0.01 | 0.006 |

$^{a,b,c}$ Means in the same row followed by different superscripts are significantly different at ($p \leq 0.05$); SEM= Standard error of means, T1: control, T2: 2% turmeric, T3: 0.5% black pepper, T4: mixture 2&turmeric+0.5% black pepper.

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**quail, Piperine, curcumin, antioxidant, lipids profile**

## الملخص العربى

## التأثير التكميلي للفلفل الأسود والكركم على الأداء الإنتاجي والاستجابات الفسيولوجية للسمان الياباني


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فى الآونة الأخيرة بدأ الاهتمام لحد كبير بالفلفل الأسود والكركم نظراً لأهميتهم الفسيولوجية والمناعية بسبب خصائصهم الغذائية ومحتواهم من مضادات الأكسدة وتأثيرهم العلاجى. لذلك كان الهدف من هذه التجربة هو دراسة الفعل التكميلى للفلفل الأسود لتعزيز الاستفادة الحيوية للكركم على الأداء الإنتاجى والاستحابة الفسيولوجية والمناعية للسمان اليابانى.

استخدم فى هذه التجربة عدد ٢٠٠ كتكوت غير مجنس من السمان اليابانى بعمر ٧أيام، وتم تقسيمهم عشوائياً لأربع مجموعات . كل مجموعة بها ٥ مكررات كل مكررة بها ١٠ طيور. تم تغذية جميع طيور السمان على العليقة التجريبية من عمر ٧ إلى ٤٢ يومًا.وإستخدمت المجموعة الأولي للمقارنة ولم يتم معاملتها بأى اضافة بينما المجموعه الثانية تم اضافة ٢٪ مسحوق كركم / كجم عليقة المجموعه الثالثة تم اضافة ، ٠.٥٪ مسحوق فلفل أسود/كجم عليقة ، بينما المجموعة الرابعة تم تغذيتها على العليقة مضاف إليها مزيج من مسحوق الكركم ٢٪ + ٠.٥٪ أسود مسحوق الفلفل / كجم عليقة.

أظهرت النتائج أن سواء اضافة الكركم أوالفلفل الأسود منفصلاً أو مخلوطهما أدى إلى تحسن معنوي في وزن الجسم الحي والزيادة الوزنية والكفاءة التحويلية للغذاء مقارنة بمجموعة الكنترول. بالإضافة إلى ذلك ، أوضحت النتائج أن مجموعة خلط الفلفل الأسود مع الكركم لها آثار إيجابية على مستوى الجلوبيولينات المناعية (IgG) ومستوى البروتين و الدهون بالدم حيث أدى لانخفاض الجلسريدات الثلاثية والكوليسترول الكلى والكوليسترول منخفض الكثافة كما أدى لارتفاع الجلوبيولين بالدم (α, β, and γ-globulin)، مقارنة بالمجموعات الأخرى. كما أدى خلط الفلفل الأسود بالكركم لتحسين نشاط إنزيمات الأكسدة (SOD, MDA and GSH-Px) ورفع تركيز هرمونات الغدة الدرقية مقارنة بالمجموعات الأخرى. على الجانب الآخر، لم يكن للمعاملات سواء بالكركم أو الفلفل الأسود بصورة منفصلة أو كمخلوط أى تأثير معنوى سلبى على استهلاك العلف أو الجلوبيولينات المناعية ( IgM and IgA) وأيضاً على ظائف الكبد بالمقارنة بمجموعة الكنترول. كما لوحظ عدم وجود فروق معنوية بين معاملات الفلفل الأسود والكركم منفصلين على الصفات الفسيولوجية والمناعية للسمان اليابانى.

الخلاصة: خَلصت النتائج إلى أن خلط الفلفل الأسود بنسبة % 0.5+ الكركم بنسبة %2.0 حسن من الاستفادة الحيوية للكركم حيث أدى إلى تحسين الأداء الإنتاجي وانخفاض تركيز الدهون في الدم ، ويحسن من تركيز هرمونات الغدة الدرقية ، ونشاط انزيمات مضادات الأكسدة ، والغلوبولين المناعي G للسمان النامي.