Egypt. Poult. Sci. Vol. (39) (IV): (935-951) (2019) **(1911-1056)**

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

EFFECTS OF DIETARY TURMERIC AND HOT PEPPER POWDER SUPPLEMENTATION ON PRODUCTIVE PERFORMANCE OF LOCAL LAYING HENS

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Received: 16/11/2019 Accepted: 11 /12/2019

ABSTRACT: The objective of this study was to investigate the effect of dietary supplementation with turmeric (TU), hot pepper (HP), or a combination of them as a powder on productive performance and functional properties of table eggs local strain (Sinai strain) hens at late production phase . A total number of 105 Sinai hens, 59-wks-old were weighed individually and randomly distributed equally into seven experimental treatments of three replicates each. The experimental design consists of the following groups; the first group was fed the basal diet without studied supplements and served as a control. The second and third groups were fed the basal diet supplemented with 0.1 and 0.25 % turmeric powder , respectively. The fourth and fifth groups were fed on the basal diet supplemented with 0.1 and 0.2 % hot pepper, respectively. The sixth and seventh groups were fed the basal diet with 0.1 % TU + 0.1 % HP or with 0.1 % TU + 0.2 % HP, respectively. The results obtained could be summarized as follows: hen fed diet supplemented with 0.1 % TU + 0.2 % HP recorded significantly the best values of egg number / hen, the second sate achieved for birds fed on diet with 0.2 % HP. Laying rate % improved significantly by adding a mixture of turmeric and hot pepper during all experimental period. Hens received diets plus turmeric at 0.1 and 0.25 % achieved the highest egg weight. Diets supplemented with mixture of TU + HP achieved the supreme effects on egg mass g / hen at all experimental periods. However, there were no significant effect on feed intake was due to adding TU or HP or both together. While , FCR values were clearly improved significantly with added turmeric + hot pepper (T6 and T7) compared to the control group. A significant improvement was found in shell thickness and Haugh unit as affected by diet with turmeric and pepper, nevertheless, shell and yolk index and percentage didn't show a statistical change during the experimental period between treatments. Hen groups received pepper 0.2 % alone or plus 0.1 % turmeric attained the highest economic efficiency compared the rest of hen groups.

Conclusively, from the present study, it could be concluded that supplementing the elderly Sinai hen diets with turmeric, hot pepper or blender of both enhanced the bioavailability of turmeric also improved the liver functions as clearly exerted by enhancing egg production significantly especially, with 0.1 % TU + 0.2 % HP which improved reproduction performance, egg quality, FCR and EEF parameters during laying period.

Keyword: egg production ,aged hen, bioavailability , turmeric , hot pepper, egg quality.

INTRODUCTION

Phytogenics are a heterogeneous group of feed additives originating from plants and consist of herbs, spices, fruit, and other plant parts. These feed additives are reported to have a wide range of activities including antimicrobial, anti-thelminthic, antioxidant, growth promoting, and immune modulator (Kanda, 2019).

Many phytogenic plants have been studied recently as natural feed additives. It has distinguished effects such as growth enhancing effects, antioxidant, antimicrobial and anti-inflammatory activities of herbal products have been reported (Gheisar and Kim, 2017).

The future of these phytogenic feed additives depend on the characteristics of herbs, the knowledge on their major and minor constituents, the in-depth knowledge on their mode of action and their value based on the safety to animal and their products (Abou-Elkhair *et al.*, 2018).

Herein, we focus on studying the sole and synergistic effects of two different phytogenic feed additives in the diet of local aged laying hens. On improving local elderly laying hens performance due to the bioactive ingredients in turmeric powder and hot pepper and the bioavailability of turmeric due to the addition of turmeric and pepper together.

In East Asia, the rhizome turmeric used as traditional remedy and usually mixed with other herbs for various biological activities. Curcuminoid is the main compound of the turmeric; in which curcumin is the major component comprises the phenolic yellowish pigment (Rajesh and Devvrat, 2018).

Curcumin has been shown to have a wide spectrum of biological actions. This is because it contains many different bio-active ingredients such as alkaloids, bitters, flavonoids, polyphenols, terpenoids (Rajesh *et al.*, 2018).

These include its anti-inflammatory, antioxidant, anticarcinogenic, antidiabetic, anti-bacterial, antifungal, antiprotozoal, antiviral, antifibrotic hypo-cholesteremic and hepato-protective activities (Beevers and Huang, 2011).

Basically, egg production depends on the liver function in which most of the components are synthesized. There is an indication that liver function decreases with an increase in age and with an advance in egg production (Rahardja *et al.*, 2015)

On the other hands, curcumin modulates and speeds up the process of repair or regeneration of liver cells (Thaloor, 1999).

There was assumed that active compound of turmeric powder, curcumin stimulate hepatocyte growth and decrease hepatocyte destruction. This bioactive compound in turmeric powder has anti-hepatoxic effect, as the nature of the compound that inhibits lipid peroxidation in the cell membrane and protects hepatocytes by inhibiting NF-kappa-β, pro-inflammatory cytokines production and oxidative stress (Reyes-Gordillo *et al.*, 2007).

Overall, curcumin is associated with a number of health claims, but its therapeutic use is limited due to its low bioavailability, poor aqueous solubility, instability at neutral and basic pH, poor absorption, rapid metabolism, and short half-life (Liu *et al*., 2016. and Her *et al*., 2018). Many strategies have been developed to counteract poor curcumin absorption and rapid elimination from the body such as the inhibition of curcumin metabolism, for enhancing the solubility, extending the residence in plasma, improving the cellular uptake (Serafini *et*

al., 2017; Adiwidjaja *et al*., 2017; Michele and Riccardo, 2019).

A natural product capable of modifying curcumin disposition and bioavailability is piperine, displayed a 3-fold increase (Radjaram *et al*., 2016), with respect to pure curcumin. Also, chili pepper, fenugreek and quercetin had the same.

Chili pepper (*Capsicum annuum* L.) is a rich source of carotenoids such as vitamin C, E and Provitamin A, with well-known antioxidant functions (Krinsky, 2001). The active compounds found in chili pepper have been noticed to have chemo-preventive and chemo-therapeutic effects (Jancso *et al*., 1997). Efficient chili pepper active compounds are capsaicin, capsisin and capsantine. Chili pepper fruits are used by broiler and layer producers for increasing chicken appetite (Ozer *et al*., 2005), darkening the yolk color and improving laying performance (Ozer *et al*., 2006).

Al-Kassie *et al*. (2012) indicated that dietary inclusion of hot red pepper decreased the heterophil/lymphocytes (H/L) ratio, indicating its role in the immune system of birds.

Capsaicin, the active component of hot red pepper, is efficient in augmenting nutrients and energy metabolism through enhancing the activities of glucose-6-phosphate dehydrogenase, lipoprotein lipase in adipose tissue, and pancreatic and intestinal enzymes (Reddy and Lokesh, 1992; Platel and Srinivasan, 2004).

In addition, Puva_ca *et al*. (2015) confirmed that hot red pepper supplementation decreased blood total cholesterol concentration. It has been suggested that lower level of blood cholesterol could be related to the inhibitory effects of chili pepper bio-active components on hepatic 3-hydroxy-3-methylglutaryl coenzyme A reductase activity (a critical enzyme in cholesterol biosynthesis), thereby reducing cholesterol synthesis (Crowell, 1999) and to the reduction in intestinal cholesterol resorption (Brunton, 1999).

The red pepper contains small amounts of red pigments and comparatively large amounts of yellow carotenoids which pass readily into the yolk thereby enhancing the intensity of the yellow color (González *et al*., 1999).

These results indicate that dietary red pepper has stimulating effect on intestinal villi and the structure of epithelial cells, and the 0.5% red pepper groups improved in egg yolk color (Lokaewmanee *et al*., 2009).

There is an indication that liver function decreases with an increase in age and with an advance in egg production. On the other hands, curcumin modulates and speeds up the process of repair or regeneration of liver cells (Thaloor, 1999).

This experiment was planned to investigate the efficacy of different levels of turmeric powder, hot pepper and both together supplement to the hens diet on feed consumption, feed conversion, egg production performance, egg quality and economic efficiency of old laying Sinai hens.

MATERIALS AND METHODS:

This study was conducted at El-Serw Poultry Research Station, Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt. It is started in 12/4/2018 and terminated in 1/8/2018. One hundred and five Sinai laying hens between 59^{th} to 74^{th} weeks of age were housed in laying pens in an open sided building. The birds were randomly assigned into seven treatments of equal

three replicates each. At the onset of the experiment, birds were weighed and assigned to treatments based on body weight so that mean body weight was similar for hens on all treatments and the average was nearly 1620 g/hen. The birds were kept on deep litter, naturally ventilated laying house and exposed to a daily photoperiod of 16 hr.

Layer's diet:

Hens were provided with feed and water *ad libitum* and were fed standard layer diet contained 2730 kcal/kg diet and 16 % crude protein. The diet was formulated according to the requirement recommended by Ministerial decision of the Ministry of Agriculture. The chemical analysis of layer diet was estimated according to Feed Composition Tables for animal and poultry feedstuffs used in Egypt (**2001**). Ingredients and chemical composition of the basal diet were shown in Table (1). All diets were isocaloric and isonitrogenous but it supplemented with gradually levels of turmeric and hot pepper powder where the experimental treatments were designed in a complete randomize design as follow:

T1: the basal diet (control group); T2: basal diet supplemented with 0.1% turmeric powder; T3: basal diet supplemented with 0.25% turmeric powder; T4: basal diet supplemented with 0.1% hot pepper powder; T5: basal diet supplemented with 0.2% hot pepper powder; T6: basal diet supplemented with 0.1% turmeric + 0.1 hot pepper powder; T7: basal diet supplemented with 0.1% turmeric+0.2 hot pepper powder.

Productive parameters measured:

Body weight of hens in each treatment was determined in the beginning. Egg production %, egg number/hen, egg weight, egg mass, feed consumption and feed conversion ratio through the experimental periods were recorded. In addition, three eggs per treatment were specialized to determine the external and internal egg quality.

Economic efficiency:

At the end of the study, economical efficiency for egg production was expressed as hen-production thought the study and calculated using the following equation:

Economic efficiency (%) = (Net return LE/Total feed cost LE) × 100.

Statistical analysis:

Data were statistically analyzed using General Linear Models Procedure of the SPSS (2008), differences between treatments were subjected to Duncan´ s Multiple Range – test (Duncan, 1955).

The following model was used to study the effect of treatments on the parameters investigated as follows: $Yij = \mu + Ti + eij$ where:

Yij = an observation, μ = overall mean, Ti = effect of treatment (i = 1…and 7) and eij = Random error.

RESULTS AND DISCUSSION

Egg production:

1 – Egg Number/hen:

As shown in Table (2), results show the effect of dietary supplementation with turmeric, hot pepper and mixture of them on laying performance of local Sinai hens.

Hens fed diet containing 0.2 % HP (T5) or 0.1 TU + 0.2 HP % (T7) recorded the highest egg number for hen during the 59: 62 wks of age. While, at period of 63: 66 wks and 67: 70 wks of age, and overall the experimental period, hens given diet with 0.1 TU + 0.2 HP % (T7) achieved the highest egg number per hen followed by T5 and T6, respectively.

It could be seen that hen treatments fed diets with hot pepper (0.1 and 0.2%) and turmeric plus hot pepper had significant

effect on increasing egg laying number per hen.

These results are in agreement with that reported by Abou-Elkhair *et al*. (2018) noticed that the best laying performance were obtained by dietary inclusion hot red pepper. So, hot red pepper is recommended to improve the performance of laying hens and egg quality traits. But , Paguia *et al.* (2011) noticed that egg production and egg weight of layers from 54- 70 weeks of age fed diets supplemented with capsicum frutescens were similar. Conflicting results found by Kanagaraju *et al.* (2017) who revealed that the supplementation of turmeric powder in layer diets significantly increased hen day and hen housed egg production. Also, Park *et al*. (2012) reported that hen layers at 60-wk-old, fed diet with 0.10, 0.25 or 0.50% turmeric egg production in the all groups were significantly higher than that in control (P<0.05).

Meanwhile, Rahardja *et al*. (2015) found that egg production performance of old laying hens (80 weeks of age), given diets with 1, 2 and 4 % oven dried turmeric powder egg production (% hen day) and feed intake of the 4 treatment groups at the commencement of the experiment were not significantly different.

2 – Laying Rate:

It is apparent from data of this experiment that supplementation the diets with HP as for T5 represented highest record (P < 0.05) of laying rate followed by diet supplemented with TU + HP as for T7 in the period of 59: 62 wks for age . Also, there was a significant improvement in laying rate by adding TU with HP (T7) to hen diet, at period 63: 66 wks of age and the entire the experimental period.

Overall, formulated feed together with HP or TU plus HP had positive effect on laying rate and egg number / hen.

The current findings are supported by Park *et al*. (2012) who observed that the addition of 0.50 or 1.0% turmeric increased egg weight, egg mass and egg production significantly (P<0.05) .

Also, Abou-Elkhair *et al*. (2018) indicated that dietary inclusion of red pepper improved (P < 0.05) egg production compared with control. Moreover, Valizadeh *et al*. (2018) revealed that dietary inclusion of red pepper improved (P < 0.05) egg production, egg mass compared with control. Same result in laying hens in post-molting phase (78 weeks), also found the interaction effects of red pepper and ginger levels were significant on egg production and egg mass.

On the other hand, inclusion of turmeric root at level of 2% in the diet did not affect egg mass significantly (Malekizadeh *et al.,* 2011). Also, turmeric at 10.0 or 30.0 g/kg did not influence egg production, egg weight and egg mass of single comb white leghorn laying hens (Riasi *et al.,* 2012). The same for Rossi *et al*. (2015) who reported that hen day egg production and egg mass not significantly affected by the addition of sweet green pepper to the diets.

3 – Egg weight (g):

Results in Table (3) point out that hen group received diet with 0.25 % TU significantly achieved the best egg weight (g) during 59: 62 wks and 63: 66 wks of age and through the whole experimental period which were 52.9, 52 and 52.1 g , respectively compared to those for other groups.

However, from the results obtained in the Table (3) there were a significant decrease in egg weight by adding HP

(0.1 and 0.2 %) to laying diets, on the contrary were happened by turmeric supplementation (0.25 and 0.1 %) .

Bird treatment fed 0.1 % TU (T2) produced the best egg weight (g) in the period 71: 74 wks for age, followed by treatment with 0.25% TU (T2) and sharing with T7 group which given (0.1 TU + 0.2 HP) .

The results are in harmony with findings of Gumus *et al*. (2018) who stated that addition of turmeric increased egg production and egg weight, but reduced the feed conversion ratio compared with the control group. As well, egg weight increased significantly after feeding turmeric at 0.50 or 1% as compared to the control diets (Radwan *et al.,* 2008; Malekizadeh *et al.,* 2011; and Rahardja *et al.,* 2015). Also, dietary inclusion of red pepper improved ($P < 0.05$) egg weight compared with control (Abou-Elkhair *et al*., 2018).

On the contrary, supplementation of turmeric at level 10.0 or 30.0 g/kg diet. (Moeini *et al.,* 2011; Laganá *et al.,* 2011;), or 2%. (Hassan *et al.,* 2016), and up to 4% of the hen diets. (Saraswati *et al.,* 2016) had no significant effect on egg weight in laying hens as compared to control groups. The same trend with, addition of 225 ppm of sweet green pepper decreased egg weight, it may be of interest to producers and industry to control egg size in old layers and possibly improve shell quality(Rossi *et al.,* 2015).

4 – Egg mass, g / hen:

The mixture of turmeric and hot pepper supplementation showed that, hen fed diet containing 0.1 TU with 0.2 HP% (T7) recorded the highest egg mass at period of 59: 62 wks , 63- 66 wks and 67- 70 wks of age which were 888.2, 900.5 and 897.1, respectively , while recorded 3313.4 g / hen over the experimental period .

However hen received TU 0.25% or 0.1 HP% without mixing the two additives recorded the lowest egg mass which were 2732.1 and 2879.8 g / hen, respectively.

It is evident from the results of this study that, supplementation the diet with 0.1 TU + 0.2 HP % significantly improved egg number, laying rate and egg mass at most periods of the experiment, the effect of adding 0.2% HP comes after them.

Moreover, adding turmeric (0.1 and 0.25 %) in hen diet at later (at elderly hens) stage of egg production has statistical changes effect on the egg weight not on egg number. Contrary, adding HP increased egg numbers and decreased egg weight at the whole experimental period.

It could be concluded that hot red pepper with turmeric supplementation to hen diet improved the laying performance more than adding each one alone. This so because adding them together increased their effect together, also improved turmeric bioavailability and absorption, also increased turmeric effects in the body.

This was agreement with those obtained by Park *et al.* (2012) reported that supplementation of turmeric at 10.0 or 30.0 g/kg did not influence egg mass of laying hens. Riasi *et al.* (2012) reported that different levels of turmeric powder had no effect on egg mass production in separate weeks. The same with dietary inclusion of red pepper improved ($P < 0.05$) egg mass compared with control (Reham Abou-Elkhair *et al.,* 2018). While , Lokaewmanee e*t al.* (2012) showed that no significant difference in hen-day production and egg mass was observed among the experimental groups fed on 0.5 % red pepper.

Laying performance:

1 – Feed intake:

Results in Table (4) show that hen fed diet containing 0.2 % HP (T5) recorded the lower feed intake (99.7 g / hen / day) during the 63- 66 wks of age. Also, it registered the lower feed consumption during the period 71- 74 wks for age and the entire experiment all period.

However, for the whole experiment, there was not significant effect for turmeric, HP and their mixtures on daily feed consumption among treatments.

Similarly, Park *et al.* (2012) mentioned that feed intake was not changed by the dietary treatments, suggesting that dietary addition of turmeric powder did not affect palatability (Laganá *et al.,* 2011; Riasi *et al.,* 2012; and Rahardja *et al.,* 2015). The same effect with adding red or sweet pepper to laying diets, where Lokaewmanee *et al.* (2012) reported that no significant difference in feed consumption and final body weight between the experimental groups fed on red pepper (Rossi *et al.,* 2015 and Abou-Elkhair *et al.,* 2018).

In contrast, Dalal and Kosti (2018) reported that increasing supplementation of turmeric for layers diets resulted in a significant lower feed intake. Also, Hermogenes *et al.* (2011) revealed that inclusion capsicum frutescens powder in the layer diets gave significant reduction of layers feed consumption.

2 – Feed conversion ratio: The best feed conversion ratio was recorded by hen given diet with mixture of 0.1 TU + 0.2 HP % (T7) was 3.3 g feed / g egg at period 59: 62 wks of age. Also, T7 enrolled the same trend of supreme for FCR at periods 63: 66, and 67: 70 and through the whole experimental period which were 3.2, 3.5 and 3.6, respectively. The worst FCR were recorded for T3 and T4 which recorded 3.4 and 4.2 g feed / g egg , respectively. FCR improved significantly by adding feed additives, turmeric, hot pepper and mixture of them, the worst FCR was recorded with 0.25% TU diet. In this regard , Dono (2018); Riasi *et al.* (2012); Moeini *et al.* (2011); and Radwan *et al.* (2008) reported that hen layers received diet containing turmeric powder showed the lowest feed conversion ratio. As well, Abou-Elkhair, *et al.* (2018) seen that dietary inclusion of red pepper improved ($P < 0.05$) feed conversion ratio compared with control. Also, Hermogenes *et al.* (2011) revealed that treated diets with capsicum frutescens significantly influenced feed efficiency ($P<0.05$) of layers compared with the control group.While, Laganá *et al.* (2011) reported that FCR, body weight gain and average daily feed intake were not affected by 0.50% turmeric powder. Rossi *et al.* (2015) found that feed conversion per dozen were not significantly affected by the addition of green pepper to the diets. Also, Lokaewmanee *et al.* (2012) observed that no significant difference in feed efficiency was observed among the experimental groups fed on 0.5 % red pepper.

While, Dalal and Kosti (2018) reported that the dietary supplementation of turmeric powder at 4 % significantly ($P<0.05$) increased the feed conversion ratio in laying hens as compared to hens fed turmeric powder at 2% level and control group.

Egg quality:

Data illustrated in Table (5) display the effect of supplemented feed additives on some parameters of egg quality. It can be noticed that the supplementation the diet with hot pepper for group of T2 represent the highest shell thickness percentage

followed by group supplemented by the mixture of turmeric plus hot pepper (T7), whereas control group T1 were the lowest However, control group scored high shell index (0.82), while T3 group recorded the lowest shell index (0.77) without statistical change.

Birds groups given diets with TU 0.1 % + HP 0.1 % T6 and 0.2 TU % T3 represented high value of albumen (54.8 and 54.3) compared the other groups with no statistical change with the rest groups .

Also, yolk index was not statistically affected by supplementation treatments. Most of hen groups recorded the some yolk index value (0.27), while number two hen groups scored yolk index value (0.26), the lowest value for T6 which written down (0.24). However, with respect to yolk percentage, hen group given diet with turmeric or HP solely T2 and T5 recorded (35.7 and 34.7) compared hen group fed on additives mixture T7 which were (31.8) or hen received the basal diet T1 (32.7).

Furthermore, the highest significant value of shell thickness were observed for egg of T7 group (0.35) compared to other hen groups .

Regarding the effect of supplementation diet with 0.2% HP (T5) and 0.1 TU + 0.2 HP % (T7) achieved the highest significant record of haugh unit which were 92.6 and 91 respectively.

The results obtained during this experiment are in harmony with those reported by Abou-Elkhair *et al.* (2018) who found that hot red pepper are recommended to improve the egg quality traits. While, Rossi *et al.* (2015) noticed that, Haugh unit, yolk weight, albumen weight, albumen percentage, and yolk yellowness were not significantly affected by the addition of sweet green pepper. As well, Dalal and Kosti (2018) reported that supplementation of turmeric powder had no significant effect on external and internal egg qualities in laying hens as compared to control groups.

Park *et al.* (2012) showed that supplementation of turmeric at of 10g/kg increased the yolk index. Also, Lokaewmanee *et al.* (2012) reported that capsanthin improved egg yolk color and was responsible for the deep red color of the egg yolk. As well, red pepper fruits are used to darken the color of the egg yolk and improve performance (Ozer *et al.*, 2006). The red pepper contains small amounts of red pigments and comparatively large amounts of yellow carotenoids which pass readily into the yolk thereby enhancing the intensity of the yellow color (González *et al.*, 1999).

However, Saraswati *et al.* (2013) found that turmeric powder administration and ration quality did not affect yolk index, egg shell index and haugh unit.

Abou-Elkhair, *et al.* (2018) demonstrated that no significant effect on yolk weight percentage was observed with the addition of hot red pepper to the diets of laying hens. Also, Hermogenes *et al.* (2011) stated that laying hens fed diets with capsicum frutescens were not affected statistically by dietary treatments of yolk color intensity.

Malekizadeh *et al.* (2011) observed that the highest numerical value in shell weight and egg shape index were for 1% Curcuma longa. And, Radwan et al. (2008) noticed that addition of 0.50-1% turmeric to hen's diet numerically increased the percentage of egg shape index, shell weight and shell thickness.

Whereas, Curvelo *et al.* (2009) reported that feeding different levels (0.50, 1.0, 1.5 and 2.0 g/kg turmeric powder of feed) to the laying hens had no significant effect on egg shell thickness, egg shell weight

and eggs shell weight to egg weight ratio. No differences in eggshell qualities were observed between the treatments, but Roche color fan number (yolk color) in group fed diet with 0.5% turmeric was significantly ($P<0.05$) higher than in control (Park *et al.* 2012).

Lokaewmanee *et al.* (2012) reported that there was no significant difference in shell thickness, shell ratio, albumen ratio, yolk ratio and Haugh units was observed between the experimental groups fed on 0.5 % red pepper (Hermogenes *et al.*, 2011; and Abou-Elkhair, *et al*., 2018).

Park *et al*. (2012) found that dietary turmeric in layer fed has beneficial effect in the change of haugh unit during storage. (Radwan *et al.*, 2008; and Hassan *et al.*, 2016). Red pepper fruits are used to darken the color of the egg yolk and improve performance (Ozer *et al*., 2006). Whereas, Lokaewmanee *et al*. (2013) found that Haugh unit was not influenced by dietary supplementation of 0.5% red pepper in laying hen diets.

Economic efficiency:

The data obtained in Table (6) represent the economic efficiency (EEf) of egg production in response to the dietary supplementation with turmeric, hot pepper or a combination them together. The results illustrate that there were significant effect on EEf of egg production due to phytogenic supplementation, adding hot pepper (5) or hot pepper + turmeric both (7) improved significantly compared to the control group or hen groups fed on turmeric supplemented diets. However, the results clearly observed that the hen group given diet contained 0.1 TU + HP % produced the highest value of EEf of egg production, compared the other treatments, followed by hen group fed diet contained 0.2 % HP which recorded 41.83 and 40.91 %. In contrast, turmeric treatments were lower than control treatment. On the other hand, adding hot pepper to turmeric powder enhanced the availability of turmeric and improved the EEf for these treatments ingest diet with mixture of TU plus HP compared other treatments.

Hermogenes *et al.* (2011) confirmed that treated groups with capsicum frutescens gave the highest income over the control group and significantly reduced the cost of egg production .

GENERAL CONCLUSION

In summary , from the present study, it could be concluded that supplementing the elderly Sinai hen diets with turmeric, hot pepper or blender of both enhanced the egg production significantly especially, with 0.1 % TU + 0.2 % HP which improved reproduction performance, egg quality, FCR and EEF parameters during laying period. This is because adding them together increased their effect together, it could be by improving the bioavailability and absorption of turmeric and thus increasing turmeric effects in the body.

Table (1): Ingredients and calculated chemical analysis of the basal diet.

Ingredients	**%**
Yellow corn	64.00
Soy bean meal (44 %)	22.50
Corn gluten (60%)	1.58
Wheat bran	1.68
Di-calcium phosphate	1.40
Limestone	8.14
Vit. & Min. premix [1]	0.30
Sodium chloride	0.30
DL- Methionine (99%)	0.10
Total	100
Calculated Analysis [2]	
Crude protein %	16.10
ME (kcal / kg)	2730
Crude fiber %	3.30
Ether extract %	2.87
Calcium (%)	3.43
Av. Phosphorus (%)	0.39
Methionine %	0.40
Lysine	0.84
Methionine + Cystin %	0.68
Price (LE/kg diet)	5.02

1-Each 3 kg of vitamins and Minerals premix contains 10 million IU vitamin A; 2 million IU Vit.D3;10 g vitamin E; 1 g Vit.K_3; 1 g vitaminB1; 5 g vitamin B2 ;10 mg vitamin B12 ; 1.5 g vitamin B6; 30 g Niacin ; 10 g Pantothenic acid ;1g Folic acid; 50 mg Biotin ; 300 g Choline chloride; 50 g Zinc; 4 g Copper; 0.3 g Iodine ; 30 g Iron; 0.1 g Selenium; 60g Manganese ;0.1 g Cobalt; and carrier $CaCO_3$ to 3000 g . 2- According to Feed Composition Tables for animal and poultry feedstuffs used in Egypt (2001).

Table (2): Effect of dietary turmeric and hot pepper supplementation on laying performance of local Sinai hens.

Age (wks.)	dietary turmeric(TU) and hot pepper (HP)%							Pooled SEM	*Sig.*
	Control	0.1TU	0.25TU	0.1HP	0.2HP	0.1TU +0.1HP	0.1TU +0.2HP		
Egg number/ hen									
59-62	15.3^{ab}	15.4^{ab}	13.7^{b}	16.1^{ab}	17.7^{a}	15.3^{ab}	17.2^{a}	1.11	0.05
63-66	15.6^{ab}	14.5^{bc}	13.3^{c}	16.0^{ab}	16.7^{ab}	16.0^{ab}	17.5^{a}	0.36	0.05
67-70	14.6^{ab}	14.8^{ab}	13.2b	15.2^{ab}	16.1^{a}	15.7^{ab}	17.4^{a}	0.39	0.05
71-74	13.7	13.5	12.3	12.1	12.4	14.8	12.0	0.35	NS
59-74	59.2^{ab}	58.3^{ab}	52.5^{b}	59.5^{ab}	62.9^{a}	61.9^{ab}	64.1^{a}	1.25	0.05
Laying rate, %									
59-62	54.5^{ab}	55.0^{ab}	49.1^{b}	57.6^{ab}	63.3^{a}	54.8^{ab}	61.4^{a}	1.34	0.05
63-66	55.7^{ab}	51.9^{bc}	47.4^{c}	57.1^{ab}	59.5^{ab}	57.1^{ab}	62.6^{a}	1.27	0.05
67-70	52.1^{ab}	52.9^{ab}	47.1^{b}	54.3^{ab}	57.6^{a}	56.2^{ab}	62.1^{a}	1.38	0.05
71-74	49.1	48.3	43.8	43.3	44.3	52.9	42.9	1.27	NS
59-74	52.9^{ab}	52.0^{ab}	46.9^{b}	53.1^{ab}	56.2^{a}	55.2^{ab}	57.3^{a}	1.11	0.05

a,b,.. :means in the same row bearing different superscripts are significantly different ($P \leq 0.05$).

Table (3): Effect of dietary turmeric and hot pepper supplementation on laying performance of local Sinai hens.

Age (wks.)	dietary turmeric(TU) and hot pepper (HP)%							Pooled SEM	Sig.
	Control	0.1TU	0.25TU	0.1HP	0.2HP	0.1TU +0.1HP	0.1TU +0.2HP		
Egg weight, g									
59-62	52.7^{ab}	51.1^{b}	52.9^{a}	47.1^{d}	49.1^{c}	51.4^{ab}	51.6^{ab}	2.11	0.05
63-66	51.0	51.2	52.0	49.7	50.0	51.8	51.3	0.32	NS
67-70	51.1^{a}	51.4^{a}	51.4^{a}	48.5^{b}	50.4^{a}	51.9^{a}	51.6^{a}	0.28	0.05
71-74	50.6^{b}	52.8^{a}	52.2^{ab}	48.3^{c}	50.4^{b}	51.4^{ab}	52.2^{ab}	0.37	0.05
59-74	51.4^{a}	51.6^{a}	52.1^{a}	48.4^{c}	50.0^{b}	51.6^{a}	51.7^{a}	0.29	0.05
Egg mass, g/ hen									
59-62	805.7^{ab}	787.5^{ab}	725.4^{b}	759.5^{ab}	870.2^{a}	787.4^{ab}	888.2^{a}	17.55	0.05
63-66	794.8^{abc}	743.6^{bc}	689.5^{c}	796.6^{abc}	832.4^{ab}	828.6^{ab}	900.5^{a}	18.05	0.05
67-70	745.9^{b}	760.6^{b}	678.4^{b}	736.6^{b}	813.4^{ab}	815.2^{ab}	897.1^{a}	19.45	0.05
71-74	695.1^{ab}	714.1^{ab}	638.9^{ab}	585.1^{b}	623.3^{b}	759.7^{a}	625.5^{b}	17.80	0.05
59-74	3040.5^{ab}	3007.4^{ab}	2732.1^{b}	2879.6^{ab}	3142.4^{ab}	3190.7^{ab}	3313.4^{a}	61.18	0.05

a,b,c,d.. :means in the same row bearing different superscripts are significantly different ($P \leq 0.05$).

Table (4): Effect of dietary turmeric and hot pepper supplementation on feed intake and feed conversion of local Sinai hens.

Age (wks.)	dietary turmeric(TU) and hot pepper(HP) %							Pooled SEM	Sig.
	Control	0.1TU	0.25TU	0.1HP	0.2HP	0.1TU +0.1HP	0.1TU +0.2HP		
Feed intake (g/hen/d)									
59-62	104.8	104.1	103.2	104.2	106.1	104.3	104.0	0.59	NS
63-66	108.4^{a}	104.5^{ab}	104.3^{ab}	103.6^{ab}	99.7^{b}	107.7^{a}	102.4^{ab}	0.91	0.05
67-70	108.2^{bc}	111.1^{abc}	111.1^{abc}	111.3^{abc}	114.0^{a}	107.4^{bc}	113.0^{ab}	0.68	0.05
71-74	108.7	109.8	110.7	110.3	107.3	110.5	109.9	0.73	NS
59-74	107.5	107.4	107.4	107.4	106.8	107.5	107.3	0.52	NS
Feed conversion ratio (g feed/g egg)									
59-62	3.7^{abc}	3.7^{abc}	4.0^{a}	3.9^{ab}	3.4^{abc}	3.7^{abc}	3.3^{c}	0.07	0.05
63-66	3.8^{b}	3.9^{ab}	4.2^{a}	3.7^{bc}	3.4^{cd}	3.6^{bc}	3.2^{c}	0.08	0.05
67-70	4.1^{abc}	4.1^{abc}	4.6^{a}	4.3^{ab}	3.9^{bc}	3.7^{bc}	3.5^{c}	0.10	0.05
71-74	4.4^{bc}	4.3^{bc}	4.9^{ab}	5.3^{a}	4.9^{ab}	4.1^{c}	4.9^{ab}	0.11	0.05
59-74	4.0^{abc}	4.0^{abc}	4.4^{a}	4.2^{ab}	3.8^{bc}	3.8^{bc}	3.6^{c}	0.07	0.05

a,b,c,d.. :means in the same row bearing different superscripts are significantly different ($P \leq 0.05$).

Table (5): Effect of dietary turmeric and hot pepper supplementation on egg quality traits of local Sinai hens.

Traits	dietary turmeric(TU) and hot pepper(HP) %							*Pooled SEM*	*Sig.*
	Control	0.1TU	0.25TU	0.1HP	0.2HP	0.1TU +0.1HP	0.1TU +0.2HP		
Sh. I[1]	0.82	0.80	0.77	0.79	0.80	0.78	0.79	0.01	NS
Yolk I[2]	0.27	0.26	0.27	0.27	0.27	0.24	0.26	0.02	NS
Yolk %	32.7	35.5	32.0	33.4	34.7	32.0	31.8	0.47	NS
Alb. %[3]	54.2	51.2	54.3	53.3	51.1	54.8	54.2	1.10	NS
Shell %	13.1	13.3	13.6	13.3	14.2	13.5	14.0	0.23	NS
Sh. th.[4]	0.30^{b}	0.31^{b}	0.31^{b}	0.30^{b}	0.32^{b}	0.30^{b}	0.35^{a}	0.01	0.05
H.U.[5]	87.9^{ab}	82.1^{b}	85.4^{ab}	87.4^{ab}	92.6^{a}	87.4^{ab}	91.0^{ab}	1.14	0.05

[1]= Shell index; [2]= Yolk index; [3]= Albumin %; [4]= Shell thickness; [5]= Haugh units; a,b,.. :means in the same row bearing different superscripts are significantly different ($P \leq 0.05$).

Table (6): Effect of dietary turmeric and hot pepper supplementation on economic efficiency of local Sinai hens

Items Treatments	Total feed intake/ hen (kg)	Feed layer cost/ kg (EGP) [1]	Total feed intake cost/ hen (EGP)	Egg number/ hen	Price of one egg (EGP)	Total return (EGP)	Net return (EGP)	EEF (%)[2]
control	12.04	5.02	60.42	59.20	1.35	79.92	19.05	32.08[a]
0.1TU	12.00	5.04	61.51	58.20	1.35	78.66	18.15	29.84[b]
0.25TU	12.00	5.10	61.17	52.47	1.35	70.83	9.66	15.68[b]
0.1HP	12.00	5.04	60.44	59.47	1.35	80.28	19.84	32.69[a]
0.2HP	11.91	5.06	60.24	62.93	1.35	84.96	24.72	40.91[a]
0.1TU+0.1HP	12.02	5.06	60.84	61.87	1.35	83.52	22.68	37.16[a]
0.1TU+0.2HP	12.00	5.08	61.00	64.13	1.35	86.58	25.58	41.83[a]
SEM								2.36
Sig.								*

[1]EGP= Egyptian pound. 7 According to price at the experimental time.

[2] EEf (%) = economic efficiency (%) = (Net return LE /Total feed cost LE) × 100. [a,b,] :means in the same row bearing different superscripts are significantly different (P≤0.05)

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egg production ,aged hen, bioavailability , turmeric , hot pepper, egg quality

الملخص العربي

تأثر إضافة الكركم والفلفل الحار علي الأداء الإنتاجي والتناسلي للدجاج البياض المحلي

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أجريت هذه الدراسة لمعرفة مدي تأثير أضافة كل من الكركم (TU) ، الفلفل الحار (HP) ، كأضافات غذائية أو كليهما معًا على الأداء الإنتاجي و جودة البيض في سلالة الدجاج المحلي البياض سيناء ، خلال مراحل أنتاجية متأخرة . تم أستخدام عدد 105 دجاجة سيناء بياضة علي عمر 59 أسبوعاً . تم وزنها بشكل فردي و توزيعها عشوائيا بالتساوي على سبعة معاملات تجريبية ،لكل منها ثلاث مكررات. و قد أحتوي تصميم التجربة علي النحو التالي: أستخدمت المجموعة الأولي كمجموعة مقارنة و تم تغذيتها علي العليقة الأساسية بدون إضافات (الكنترول) . تم تغذية المجموعتين الثانية والثالثة علي العليقة الأساسية مع إضافة مسحوق الكركم بنسبة 0.1 و 0.25 ٪ على الترتيب . وتم تغذية المجموعتين الرابعة والخامسة علي العليقة الأساسية مع إضافة 0.1 و 0.2 ٪ فلفل حار على الترتيب . تناولت المجموعتان السادسة والسابعة العليقة الأساسية بـأضافة 0.1٪ كركم + 0.1 ٪ فلفل حار أو 0.1٪ كركم + 0.2 ٪ فلفل حار على التوالي. و يمكن توضيح النتائج التي تم الحصول عليها كالتالي: أوضحت نتائج التجربة أن الدجاج المغذى على الأضافات بنسبة 0.1 ٪ كركم + 0.2 ٪ فلفل حار سجلت أعلي قيم لعدد البيض / الدجاجة ، بينما تحقق المركز الثاني للدجاج المغذي علي عليقة بها 0.2 ٪ فلفل حار .أيضا تحسن معدل انتاج البيض ٪ بشكل ملحوظ عن طريق إضافة الكركم والفلفل الحار خلال الفترة التجريبية. أضافة الكركم بنسبة 0.1 و 0.25 ٪ إلي العليقة حققت وزن بيض أعلي بالمقارنة بالمعاملات الأخري. الدجاج المغذي علي خليط من الكركم + الفلفل الحار أعطي أعلي كتلة بيض للدجاجة خلال الفترة التجريبية. ومع ذلك ، لا يوجد تأثير معنوي على كمية العلف المستهلك نتيجة إضافة TU أو HP أو كليهما معا. بينما حدث التحسن في الكفاءة التحويلية للعلف بشكل ملحوظ مع إضافة الكركم + الفلفل (T6 و T7) مقارنة بالكنترول .

يوجد تحسن في سمك القشرة ووحدات Haugh نتيجة أضافة الكركم والفلفل إلي عليقة الدجاج البياض ، أما مؤشر القشرة والصفار لم يحدث بهم تغيير معنوي خلال الفترة التجريبية بين المعاملات التجريبية. و قد سجلت حسابات الكفاءة الأقتصادية أن الدجاج البياض المغذي علي عليقة تحتوي علي الفلفل الحار بنسبة 0.2 ٪ وحده أو معه 0.1 ٪ الكركم قد سجل أفضل عائد و أعلي كفاءة أقتصادية مقارنة بتلك الخاصة بالمجموعات التجريبية الأخري .

و قد خلصت الدراسة إلي أن أضافة مسحوق الكركم ، الفلفل الحار أو كلاهما معا يؤدي إلي تحسن في الصفات الأنتاجية و صفات جودة البيض و معامل التحويل الغذائي للعلف فضلا عن الكفاءة الأقتصادية لدجاج سيناء في مراحل الأنتاج المتأخرة و هو ما يشير إلي حدوث تحسن في وظائف الكبد نتيجة التوافر البيولوجي للكركم كما هو واضح من خلال زيادة إنتاج البيض .