Dietary Cumin (Cuminum cyminum) Seed Powder Supplementation Had No Adverse Effects on Growth Performance and Carcass Traits of Japanese quail, Coturnix coturnix japonica

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The present study was conducted to explore the usage of different levels of cumin (Cuminum cyminum) seed powder (CSP) in quail nutrition as a natural growth promoter. One hundred (one-day-old) unsexed quail chicks were randomly divided into five groups of similar mean weight (8.8 g), each with five replicates of four chicks. The control group received a basal diet. For the other groups, the basal diet was supplemented with 1, 2, 4 and 8 g/kg CSP. The observed variables included growth performance, carcass parts and internal organ weights. Results showed that CSP did not affect the observed variables statistically. However, the best FCR ratio was observed in an 8 g/kg CSP group. Similarly, the highest live weight among the animals slaughtered in all groups in the study was again in the same group (8 g/kg CSP: 304.9 g), but no statistical difference between was observed with all groups. There was no incidence of any mortality or any signs of the adverse effects of CSP during the experimental period. Dietary CSP supplementation had not any adverse effects on growth performance and carcass parts weight. Consequently, further studies are needed to investigate the effects of CSP on the meat quality and digestive system in poultry.

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Japon Bildircelere Rasyona Kimyon (Cuminum cyminum) Tohumu Tozu İlavisinin Büyüme Performansını ve Karksas Özelliklerini Üzerine Etkisi Yuktur

MAKALE BİLGİSİ

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Mevcut çalışmada, doğal büyüme teşvik edici japon bildircelere beslenmesinde farklı seviyelerde kimyon (Cuminum cyminum) tohum tozunun (CTT) kullanımı araştırılın makul olmuştur. Bir günlük yaşta benzer canlı ağırlık ortalamasına sahip (8,8 g), karışık cinsiyette 5 farklı grubu ayrılmış olup, her grupta 4 bildircin civcivi olan 5 paralelde ölmüştü. Kontrol grubu bazal yeme beslenmiş olup, diğer gruplar ise bazal yeme 1, 2, 4 ve 8 g/kg CTT ilave edilmişdir. Çalışmada performans parametreleri, karkas parçaları ve iç organ ağırlıkları belirlenmiştir. Kimyon tohumu tozunun bildircenin gelişimi ve karksas özellikleri üzerine istatistiksel olarak herhangi bir etkisi olmamıştır. Fakat çalışmamızda en iyi yemden yararlanma oranı bazal yeme 8 g/kg CTT ilave edilen grupta belirlenmiştir. Benzer şekilde çalışmada kesilen hayvanların içinde en yüksek canlı ağırlık yine aynı grupta gerçekleşmiş (8 g/kg CTT: 304,9 g), fakat istatistiksel olarak herhangi bir ölümlü gözelemelemeştır. Çalışma süresi içinde herhangi bir ölüm gözlemlememiştir. Bazal yeme CTT ilavesinin japon bildircenin büyüme performansını ve karksas parçalarının ağırlıkları üzerinde herhangi bir olumsuz etkisi olmamıştır. Sonuç olarak, CTT' nin kimes hayvanlarından et kalitesi ve sindirim sistemi üzerindeki etkilerini araştırarak için daha fazla çalışmaya ihtiyaç vardır.

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Introduction

Antibiotics have not been used for more than two decades, especially as a growth-promoting agent in poultry nutrition. Besides, it is well known that it protects animals against diseases while creating resistance against antibiotics in people who consume their products. In general, natural herbal sources or extracts have a growth-stimulating or digestive system structure in animals (Granados-Chinchilla, 2017). After the banning of antibiotics, researchers are working on different alternatives. The importance of natural herbal resources has increased due to some different positive properties that encourage growth in poultry feed. The natural herbal plants were used in the nutrition of poultry as feed additives due to their antioxidant (Allaghahdadi et al., 2010), antimicrobial (Shalaby et al., 2006), antifungal (Khosravi et al., 2011), antipyretic (Ali et al., 2010), antidiabetic (Sowbhagya, 2013) and similar effects. Previous studies showed that plants took advantage of phytochemical compound(s) found in their leaves, flowers, seeds, stems, or roots, and their powder, oil, or aqueous extracts generally play an important role (Ali et al. 2010; Hajati et al., 2014; Aćimović et al., 2016). Several studies also, reported that the spices like black cumin or pepper, red pepper, mint, rosemary, sumac, and fenugreek improved health status, growth performance and/or disease resistance in poultry nutrition (Khosravifar et al., 2014; Hajati et al., 2014; Singh et al. 2015; Kheiри et al., 2015; Florana et al., 2017). Another of these spices is Cumin (Cuminum cyminum) from the Apiaceae family (Jang, 2011; Alimohamadi et al., 2013). According to 2017 data, cumin, which produces 300-400 thousand tons worldwide, exports $ 274.8 million (Arslan, 2019a). Cumin is mainly cultivated in Asia, especially Algeria, China, Japan, Indonesia, Iran, Morocco, southern Russia, and Turkey (Bettaieb et al., 2011). In Turkey, 72 kg/d animal yield of cumin production of 19.175 tons in 2017, while the price is around a 3 kg /$ (Arslan, 2019b). Cumin is widely used by the foods, beverages, liquors, medicines, toiletries and perfume industries (Kumar et al., 2015). 100 g cumin seed contains 93.9 g dry matter, 11.5 g crude fat, 37.2 g crude fiber, 9.3 g ash, 15.7 g crude protein, and 20.1 g crude fat, 37.2 g crude fiber, 9.3 g ash, 15.7 g crude protein, free extract (El Şinik, 2017). Another compound(s) found in their leaves, flowers, seeds, stems, or roots, and their powder, oil, or aqueous extracts generally play an important role (Ali et al. 2010; Hajati et al., 2014; Aćimović et al., 2016). Several studies also, reported that the spices like black cumin or pepper, red pepper, mint, rosemary, sumac, and fenugreek improved health status, growth performance and/or disease resistance in poultry nutrition (Khosravifar et al., 2014; Hajati et al., 2014; Singh et al. 2015; Kheiри et al., 2015; Florana et al., 2017). Another of these spices is Cumin (Cuminum cyminum) from the Apiaceae family (Jang, 2011; Alimohamadi et al., 2013). According to 2017 data, cumin, which produces 300-400 thousand tons worldwide, exports $ 274.8 million (Arslan, 2019a). Cumin is mainly cultivated in Asia, especially Algeria, China, Japan, Indonesia, Iran, Morocco, southern Russia, and Turkey (Bettaieb et al., 2011). In Turkey, 72 kg/d animal yield of cumin production of 19.175 tons in 2017, while the price is around a 3 kg /$ (Arslan, 2019b). Cumin is widely used by the foods, beverages, liquors, medicines, toiletries and perfume industries (Kumar et al., 2015). 100 g cumin seed contains 93.9 g dry matter, 11.5 g crude fat, 37.2 g crude fiber, 9.3 g ash, 15.7 g crude protein, and 20.1 g nitrogen-free extract (El-Ghorab et al., 2010). Cumin seed contains molecules such as alkaloid, anthraquinone, coumarin, flavonoid, glycoside, protein, resin, saponin, steroid, and tannin (Al-Harbi, 2019). In addition, cumin affects systems such as aldose reductase (Lee, 2005), analgesic (Bhat e Hameed, 2011), insecticidal (Negahban et al., 2010), gastroprotective (Sowbhagya, 2013) and similar effects. Previous studies also reported that cumin seed powder (CSP), its essential oil (CEO) and meal (CSM) were used to improve meat, egg or breeding performances during the feeding of poultry (Mansoori et al., 2006; Aami-Azghadi et al., 2010; Ali et al., 2011; 2012; Al-Anbair et al., 2013; Singh et al., 2015; Ali et al., 2018; Alkattan, 2019). Although cumin has an important place in human nutrition, cumin is generally among the spices studied by researchers in order to increase the performance of animals. However, there is no satisfactory source of CSP and doses added as a growth promoter and performance enhancer in quail nutrition, which is a model animal, during the depth literature review. Also, there have been no records whether the used dietary CSP doses had any adverse effects on growth and body components of quails or not. Therefore, this study was aimed to investigate the possibility of using the different doses of CSP as a natural growth promotion and its effects on some of the body components of quails.

Materials and Methods

Animals and Feeds

One-day-old, 100 Japanese quail chicks were divided into 5 treatment groups, according to 0, 1, 2, 4, or 8 g cumin seed powder (CSP) supplementation to basal diets. Each group included 20 birds kept in 5 cages each included 4 chicks. The supplemented doses were determined based on the previous studies. Basal diets were (a) starter (233.2 g crude protein (CP) and 3000 Kcal ME kg⁻¹), (b) grower (215.0 g CP and 3100 Kcal kg⁻¹), and (c) finisher (195.0 g CP and 3200 Kcal ME kg⁻¹) (Table 1). The quail diets were ordered to prepare by a local company according to NRC (1994) recommendations. CSP was obtained from a private species shop in Kayseri, Turkey. Feed and water were offered daily ad libitum.

Experimental Conditions

The experiment was performed by using twenty-five 50×75 cm cages within the Poultry Unit of the Agriculture Faculty of Kırşehir Ahi Evran University. Artificial illumination was provided in the experimental room by white fluorescent lamps and a thermostatically controlled infrared electric heater for floor heating. Ambient temperature was maintained at 33°C during the first week of life and was then gradually reduced by 3°C weekly according to age until it reached 24°C between 21 to 42 days. The relative humidity was maintained at 55% throughout the rearing period. During the trial period, the animals were given a 23-hour light/1-hour dark schedule for the first three days in case of a power interruption during the trial, and 24 hours for the other 39 days according to commercial conditions.

Experimental Parameters

Apart from the initial and final body weight (BW), body weight gain (BGW) and feed intake (FI) were determined weekly. The feed conversion ratio (FCR) was determined by the ratio of total FI to the final BW. Before slaughtering, quails were fasted for 12 hours to empty their digestive tract. At the end of the experiment (42 days), four quails were taken from each treatment group and slaughtered to determine carcass traits heart, liver, thigh, breast, wing, back-neck, abdominal fat, carcass weights.
Table 1. Composition of the starter, grower, and finisher diet (g/kg)

| Parameters                        | Starter Diet 0 to 10 days | Grower Diet 11 to 24 days | Finished Diet 25 to 42 days |
|-----------------------------------|---------------------------|---------------------------|----------------------------|
| Maize (7.5% CP)                   | 467.2                     | 544.1                     | 584.8                      |
| Soybean meal (46% CP)             | 387.9                     | 366.1                     | 320.5                      |
| Sunflower seed meal (36% CP)      | 40.0                      | -                         | -                          |
| Soybean oil                       | 59.8                      | 49.5                      | 59.9                       |
| DL-methionine (99%)               | 3.5                       | 3.0                       | 2.7                        |
| Salt                              | 2.6                       | 2.3                       | 2.9                        |
| Marble powder                     | 11.8                      | 8.5                       | 7.6                        |
| DCP (18%)                         | 20.3                      | 18.3                      | 16.3                       |
| Vitamin Premix*                   | 2.0                       | 2.0                       | 2.0                        |
| Mineral Premix**                  | 1.0                       | 1.0                       | 1.0                        |
| L-Lysine HCl                      | 2.2                       | 3.2                       | 1.3                        |
| L-Threonine                       | 0.9                       | 0.6                       | 0.3                        |
| Sodium sulphate                   | 0.8                       | 1.4                       | 0.7                        |
| Total (kg)                        | 1000.0                    | 1000.0                    | 1000.0                     |

Calculated Analysis, g/kg

- Dry matter: 880.0, 876.8, 876.7
- Crude protein: 233.2, 215.0, 195.0
- ME (kcal/kg): 3000, 3100, 3200
- Crude fiber: 43.2, 36.9, 34.9
- Ether extract: 83.2, 75.2, 86.4
- Ash: 64.2, 56.8, 52.2
- Ca: 10.5, 8.7, 7.8
- P: 4.8, 4.4, 3.9
- Lysine: 12.8, 12.7, 10.2
- Methionine: 6.6, 5.8, 5.3

Table 2. The effect of added *Cuminum cyminum* seed powder to diet on quail performance

| Parameters                        | 0 CSP | 1 CSP | 2 CSP | 4 CSP | 8 CSP | SD  | P   | Effects |
|-----------------------------------|-------|-------|-------|-------|-------|-----|-----|---------|
| Initial body weight (g/bird)      | 8.8   | 8.8   | 8.7   | 8.8   | 8.8   | 0.01| 0.246| 0.275   |
| Final body weight (g/bird)        | 313.8 | 301.0 | 325.2 | 332.0 | 347.0 | 9.68| 0.649| 0.452   |
| Body Weight Gain                  | 305.0 | 292.2 | 316.5 | 323.2 | 338.2 | 9.68| 0.648| 0.451   |
| Feed Intake (g/42 days per bird)  | 1042.1| 1074.4| 1010.6| 1021.1|1051.6| 14.26|0.628|0.392    |
| Feed Conversion Ratio             | 3.4   | 3.7   | 3.2   | 3.2   | 3.1   | 0.07|0.186|0.127    |

Statistical Analysis

The data obtained in the experiment were analyzed by using General Linear Models (GLM), Duncan’s multiple range test procedures, and orthogonal polynomials in SAS Software (SAS, 1996). Means differences were considered significant at (P<0.05).

Discussion

CSP did not affect the health status of experimental animals, showing it has no adverse effects on their health since there was no any mortality or signs of illness at all. In the detailed literature review, positive and negative effects of increasing doses of cumin, which are investigated in a wide range of values between 0.01 and 50 g/kg, are given in Table 4. However, the effect of cumin addition in the range of 0.01 to 2 g/kg varied, including in our current study. The final body weight increased in the groups with 4 and 8 g/kg of CSP added to quail rations supports the results of (Alimohamadi et al., 2013). On the contrary, (Golian et al., 2010)’s study had a negative effect on the final body weight in the same groups. Contrary to our study, Retnani et al. (2010) reported that the use of 0.2, 0.4, and 0.6% CSP in the diet does not affect the health status of experimental animals, showing it has no adverse effects on their health since there was no any mortality or signs of illness at all. In their studies using 1 and 1.5 g/kg CSP. As can be seen in Table 4, cumin added to poultry feed in high amounts improved performance parameters (Mansoori et al., 2006; Golian et al., 2010; Jang, 2011; Elagib et al., 2013; Al-Anbari et al., 2012).
Table 3. The effects of added *Cuminum cyminum* seed powder to diet on the weights of carcass parts

| Parameters (g)                        | CSP (g/kg) | SD  | P          | Effects |
|---------------------------------------|------------|-----|------------|---------|
|                                       | 0          | 1   | 2          |         |
| BW                                    | 294.3      | 291.0 | 260.5   | 300.1   | 304.9 | 294.3 | 8.45 | 0.590 | 0.879 | 0.282 | 0.289 |
| Hot Carcass Weight                    | 164.3      | 175.0 | 160.9   | 176.8   | 188.5  | 3.88  | 0.245 | 0.553 | 0.773 | 0.200 |
| Cold Carcass Weight                   | 163.1      | 173.5 | 159.7   | 175.0   | 186.0  | 3.80  | 0.267 | 0.567 | 0.777 | 0.202 |
| Carcass Yield                         | 0.56       | 0.61  | 0.63    | 0.59    | 0.62   | 0.01  | 0.373 | 0.275 | 0.130 | 0.798 |
| Thigh                                 | 35.2       | 37.3  | 36.3    | 39.7    | 41.7   | 0.77  | 0.088 | 0.113 | 0.706 | 0.358 |
| Breast                                | 62.5       | 68.4  | 65.5    | 74.1    | 79.6   | 2.72  | 0.156 | 0.167 | 0.790 | 0.394 |
| Wing                                  | 7.6        | 9.4   | 8.4     | 9.9     | 8.7    | 0.39  | 0.354 | 0.117 | 0.852 | 0.216 |
| Back-Neck                             | 52.6       | 47.8  | 50.3    | 47.3    | 54.7   | 1.62  | 0.521 | 0.397 | 0.800 | 0.451 |
| Liver                                 | 7.7        | 8.2   | 7.0     | 7.7     | 6.7    | 0.50  | 0.867 | 0.809 | 0.925 | 0.489 |
| Heart                                 | 2.5        | 2.7   | 2.2     | 2.7     | 2.9    | 0.09  | 0.146 | 0.937 | 0.387 | 0.044 |
| Abdominal Fat Weight                  | 3.9        | 5.6   | 5.1     | 4.7     | 4.5    | 0.25  | 0.274 | 0.427 | 0.075 | 0.343 |

Table 4. Comparison of our study with the studies previously conducted

| Previous studies                       | Parameters | Supplemental Doses | E  | A/D |
|----------------------------------------|------------|--------------------|----|-----|
| Mansoori et al. (2006)                 | growth performance | 25 or 50 g/kg | I  | DA |
| Retnani et al. (2010)                  | fat content | 0.2, 0.4, and 0.6% | R  | DA |
| Aami-Azghadi et al. (2010)             | the relative organ weights, carcass yields | 2 g/kg | U  | A  |
| Al-Kassie (2010)                       | performance | 0.5 and 1% | IN | DA |
| Golian et al. (2010)                   | body weight | 10, 20, 30, 40 and 50 g/kg | IN | DA |
| Golian et al. (2010)                   | body weight, abdominal fat | 2, 4, 6, 8 and 10 g/kg | D  | DA |
| Jang (2011)                            | growth performance, feed intake | 2% | IN | DA |
| Amin (2011)                            | growth performance | 0.5, 1, and 1.5% | IN | DA |
| Shaban (2012)                          | growth performance | 0.15% | I  | A  |
| Elagib et al. (2013)                   | final body weight | 2% | IN | DA |
| Alimohamadi et al. (2013)              | final body weight | 4 and 8 g/kg | IN | DA |
| Sharifi et al. (2013)                  | final live weight | 15 g/kg | I  | DA |
| Al-Anbari et al. (2013)                | final live weight | 45% | I  | DA |
| Dawood and Al-Douri (2014)             | LBW, BW and FCR | 1 and 1.5 g/kg | IN | A  |
| Bhai sare et al. (2014)                | growth performance | 0.5% | U  | A  |
| Mousa (2014)                           | mortality | 1.25 ml/kg | D  | DA |
| Torki et al. (2015)                    | BW, BWG, FCR | 0.8 g/kg | IN | DA |
| Al-Mashhadani et al. (2016)            | final body weight and weight gain | 200, 400 and 600 mg/kg | IN | DA |
| Rafeeq et al. (2016a)                  | growth performance | 0.5 and 1% | IN | DA |
| Rafeeq et al. (2016b)                  | growth performance | 20 and 40 ml/L | I  | DA |
| Habibi et al. (2016)                   | performance, visceral weight and carcass properties | 100, 200, 300 ppm | U  | A  |
| Berrama et al. (2017)                  | carcass and viscera yields | 0.2% | U  | A  |
| Florana et al. (2017)                  | growth performance | 2% | IN | DA |
| Elradi et al. (2018)                   | growth performance | 0.25, 0.50, and 0.75% | U | A  |
| Ali et al. (2018)                      | final BW | 1% | IN | DA |

E: Effect, I: improved, R: reduced, U: unaffected, D: decreased, IN: increased, A/D: Agree/Disagree with the present study, A: Agree, DA: Disagree
Authors Contributions

Orhan Çetinkaya and Gökhân Filik designed and conducted the experiments. Orhan Çetinkaya conducted the laboratory analyses. Gökhân Filik supervised and coordinated the experiments. Orhan Çetinkaya and Gökhân Filik evaluated experimental data statistically. The manuscript was written and revised by Orhan Çetinkaya and Gökhân Filik.

Conflicts of Interest

There are no conflicts of interest to declare.

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Ethics in Animal Experiments Committee Approval

The study complied with an ethics document taken from the Animal Experiments Local Ethics Committee of Kırşehir Ahi Evran University, dated and numbered 02/10/2017 19-2.

References

Aami-Azghadi, M., Golian, A., Kermanshahi, H., Sedghi, M. 2010. Comparison of dietary supplementation with cumin essential oil and prebiotic fermented on rumoral immune response, blood metabolites and performance of broiler chickens. Global Veterinaria, 4(4), 380-387.

Aćimović, M.G., Kostadinović, L. M., Puača, N.M., Popović, S. J., & Urošević, M. I. 2016. Phytochemical constituents of selected plants from Apiaceae family and their biological effects in poultry. Food and Feed Research, 43(1), 35-41.

Al-Anbari, E. H., Abbas, A.A., Al-Samarai, F. R., Al-Shamire, J. S., Al-Zaidi, F. H. 2013. Effect of using cumin oil (Cuminum cyminum) as feed additives on profile analysis and growth curve of broiler. JIBB, 2(3), 326-330.

Al-Harbi, F.K. 2019. Antimicrobial activity of Cuminum cyminum extract against avian cholera in chicken embryo. International Journal of Research in Pharmaceutical Sciences, 10(1), 596-602.

Ali, M.N., Qota, E. M.A., Hassan, R.A. 2010. Recovery from adverse effects of heat stress on slow-growing chicks using natural antioxidants without or with sulphate. International Journal of Poultry Science, 9(2), 109-117.

Ali, M.N., Moustafa, K.E.K.M.E., Shabaan, M., Radwan, A.M., Sayed, M.A. 2011. Effect of using Cuminum cyminum L., Citric Acid and Sodium Sulphate for improving the utilization of low protein low energy broiler diets. Int J Poult Sci, 10, 514-522.

Ali, M.N., Hassan, M.S., Abd El-Ghany, F.A., Awadein, N.B. 2012. Using natural antioxidants with or without sulphate to improve productive and reproductive performance of two local strains at late egg production period. International Journal of Poultry Science, 11(4), 269-282.

Ali, H.A.M., Hussein, A.S., Al-Shamire, J.S.H., Hamodi, S.J. 2018. Effect of Interaction Between Dietary Two Levels of Cumin (Cuminum cyminum) and Ginger (Zingiber officinale) on Japanese Quail performance. Euphrates Journal of Agriculture Science, 10(3), 11-19.

Alimohamadi, K., Taherpour, K., Ghasemi, H.A., Fatahnia, F. 2013. Comparative effects of using black seed (Nigella sativa), cumin seed (Cuminum cyminum), probiotic or prebiotic on growth performance, blood haematology and serum biochemistry of broiler chicks. Journal of animal physiology and animal nutrition, 98(3), 538-546.

Al-Kassie, G.A. 2010. Effect of feeding cumin (Cuminum cyminum) on the performance and some blood traits of broiler chicks. Pakistan Journal of nutrition, 9(1), 72-75.

Alkattan, M.M. 2019. Effects of Cumin Seeds in some physiological characteristics of quail. In Journal of Physics: Conference Series (Vol. 1294, No. 6, p. 062084). IOP Publishing. doi:10.1088/1742-6596/1294/6/062084

Allaghadri, T., Rasooli, I., Owlia, P., Nadooshan, M.J., Ghazanfari, T., Taghizadeh, M., Astaneh, S.D.A. 2010. Antimicrobial property, antioxidant capacity, and cytotoxicity of essential oil from cumin produced in Iran. Journal of Food Science, 75(2): H54-H61.

Al-Mashbadani, E.H., Al-Shamire, J.S., Al-Mashhadani, H.E. 2016. Effect of supplementing different levels of cumin oil (Cuminum cyminum) to diet on broiler performance and some physiological traits. Al-Anbar Journal of Veterinary Sciences, 9(2), 1-6.

Amin, L. 2011. The effect of cumin (Cuminum cyminum) in feed for quail egg production. Journal Agrisains, 2: 29-39.

Anu, G., Ahmad, A.H., Kumar, N., Disha, P., Munish, B. 2016. Modulation of Apoptotic Pathways by Hydroethanolic Extract of Cuminum Cyminum in 7, 12-Dimethylbenz [a] Anthracene Induced Mammary Tumours in Wistar Rats. College of Veterinary Science and Animal Husbandry Navsari Agricultural University, Navsari, 229.

Arslan, N. 2019a. Dünyada Kimyon Üretimi ve Ticareti. TÜRKTOB Türkiye Tohumcular Birliği Dergisi. Jan-Feb 2019, Volume:29, Pages:52-55. https://www.turktob.org.tr/dergi/dergi29/mobile/index.html [Access Date: 06.05.2020].

Arslan, N. 2019b. Türkiye'de Kimyon Üretimi ve Ticareti. TÜRKTOB Türkiye Tohumcular Birliği Dergisi. Apr-Jun 2019, Volume:30, Pages:30-33. https://www.turktob.org.tr/dergi/dergi30/mobile/index.html [Access Date: 06.05.2020].

Berrama, Z., Temim, S., Souames, S., Aïnbaziz, H. 2017. Growth performance, carcass and viscera yields, blood constituents and thyroid hormone concentrations of chronic heat stressed broilers fed diets supplemented with cumin seeds (Cuminum cyminum L.). Kafkas Univ Vet Fak Derg, 23 (5): 735-742, 2017. DOI: 10.9775/kvd.2017.17663

Bettaieb, I., Knoui, S., Hamrouni, I., Limam, F., Marzouk, B. 2011. Water-deficit impact on fatty acid and essential oil composition and antioxidant activities of cumin (Cuminum cyminum L.) aerial parts. Journal of agricultural and food chemistry, 59 (1), 328-334.

Bhaisare, D.B., Thyagarajan, D., Churchil, R.R., Punniamurthy, N. 2014. Effect of dietary supplementation of herbal seeds on carcass traits of turkey pouls. Veterinary World, 7(11): 938-942.

Bhat, S.P., Rizvi, W., Kumar, A. 2014. Effect of Cuminum cyminum L. seed extracts on pain and inflammation. Journal of Natural Remedies, 14(2), 186-192.

Bokaeian, M., Shiri, Y., Bazi, S., Saeidi, S., Sahi, Z. 2014. Antibacterial Activities of Cuminum Cyminum Linn Essential Oil against Multi-Drug Resistant Escherichia coli. Int J Infect. 2014 June; 1 (1): e18739.

Boskabady, M.H., Kiani, S., Azizi, H. 2005. Relaxant effect of Cuminum cyminum on guinea pig tracheal chains and its possible mechanism(s). Indian J Pharmacol 2005; 37:111-5

Chauhan, P.S., Satti, N.K., Suri, K.A., Amina, M., Bani, S. 2010. Stimulatory effects of Cuminum cyminum and flavonoid glycoside on Cyclosporine-A and restraint stress induced immune-suppression in Swiss albino mice. Chemico-biological interactions, 185(1), 66-72.
Dawood, A.A., Al-Douri A.A.A. 2014. Effect of adding (cuminum cyminum) seeds in diet on production performance for broiler chickens (Ross 308). Euphrates Journal of Agriculture Science, 6(3): 85-92.

Elagib, H.A.A., Abbas, S. A. & Elamin, K. M. 2013. Effect of different natural feed additives compared to antibiotic on performance of broiler chicks under high temperature. Bull. Environ. Pharmacol. Life Sci., 21(11), 139-144.

El-Ghorab, A.H., Nauman, M., Anjum, F.M., Hussain, S., Nadeem, M. 2010. A Comparative Study on Chemical Composition and Antioxidant Activity of Ginger (Zingiber officinale) and Cumin (Cuminum cyminum). Journal of Agricultural and Food Chemistry,58(14), 8231–8237. doi:10.1021/jf101202x

Elradi, A.E.A., Alamin, A. M., Alkhdirey, M.A.M., Abdallah, M.A.A., Abaker, M.A.A. 2018. The Effect of adding graded levels of Coriandrum sativum and Cuminum-cyminum mixture on broiler performance (Doctoral dissertation, Sudan University of Science and Technology).

Florana, B., Dihanshi, E., Handarini, R. 2018. The Performance of Quail Starter-Grower Who Were Rations Additional Containing Garlic (Allium sativum) and Caraway (Cuminum cyminum). Jurnal Peternakan Nusantara, 3 (2), 95-102.

Golian, A., Aami-Azghadi, M., Sedghi, M. 2010. The comparison of supplemental cumin seed and cumin seed meal with prebiotic ferment on blood metabolites and performance of broiler chickens. J. Anim. Vet. Adv, 9, 2546-2551.

Granados-Chinchilla, F. 2017. A review on phytochemicals (including essential oils and extracts) inclusion in feed and their effects on feed producing animals. Dairy and Vet Sci J 3 (4); JDVMS.IS.555620 (2017)

Gupta, R.S., Saxena, P., Gupta, R., Kachhawa, J. B. 2011. Evaluation of reversible contraceptive activities of Cuminum cyminum in male albino rats. Contraception, 84(1), 98-107.

Habibi, R., Jalilvand, G., Samadi, S., Azipour, A. 2016. Effect of Different levels of essential oils of Wormwood (Artemisia absinthium) and Cumin (Cuminum cyminum) on growth performance carcass characteristics and immune system in broiler chicks. Iranian Journal of Applied Animal Science, 6(2), 395-400.

Hajati, H., Hasanabadi, A., Ahmadian, F. 2014. Application of medicinal plants in poultry nutrition. Journal of Medicinal Plants and By-products (2014):1-12

Jang, J.P. 2011. Comparison of effect of Cuminum cyminum and Probiotic on Performance and serum composition of broiler chickens. Ann Biol Res, 2(6), 630-634.

Kheiri, M., Rahimian, Y., Nasr, J. 2015. Application of sumac and Caraway (Cuminum cyminum mixture on broiler performance (Doctoral dissertation, Sudan University of Science and Technology).

Moslehi, D., Kesejini, T. S., Aliakbari, F., Karami-osboo, R., Shabakbaei, M., Marvian, A. T., Khalifeh, M., & Soroosh, M. 2014. Identification and characterization of a compound from Cuminum cyminum essential oil with antifibrilation and cytotoxic effect. Research in pharmaceutical sciences, 9(6), 431–443.

Mousa, G. R. 2014. Effect addition of cumin oil to the diet on performance of ross broilers. Foundation of technical education. Year: 2014 Volume: 27 Issue: 3 Pages: A12-A23.ISSN:1816653X. https://www.ijsi.net/ijsi/?func=article&aid=136473

National Research Council (NRC). 1994. Nutrient requirements of ring necked pheasants, Japanese quail and bobwhite quail. 9th Revised Edition. 4445, National Academy Press, Washington,D.C.,USA. 1994. http://www.nap.edu/openbook/0309048923/44.html Accessed November 25, 2018.

Negahban, M., Moharramipour, S., Zandi, M., Hashemi, S. A., Ziaee, F. 2012. Nano-insecticidal activity of essential oil from Cuminum cyminum on Tribolium castaneum. In Proc 9th. Int. Conf. on Controlled Atmosphere and Fumigation in Stored Products, Antalya, Turkey. 15– 9 October 2012, ARBER Professional Congress Services, Turkey pp: 63-68

Rafeqz., M., Rashid, N., Tariq, M. M., Tareen, R. B., Shahzad, I., Ullah, A., Hilal, B.,Mustafa, Z. 2016a. Culinary and medicinal herbs as feed additives, effect on performance, serum biochemical parameters and microbial population of broiler chickens. Animal Biology & Animal Husbandry Bioflux, 2016, Volume 8, Issue 1.

Rafeqz., M., Rashid, N., Tariq, M. M., Tareen, R. B., Bukhari, F., Sheikh, I. S., Taj, K. 2010b. The effect of aqueous herbal infusion in drinking water on broiler performance and intestinal microflora status. ARPN Journal of Agricultural and Biological Science. Vol. 11, No. 12, December 2016

Retnani, Y., Kurniawan, D., Yusawisana, S., Herawati, L. 2010. Lipid deterioration in broiler ration containing crude palm oil (CPO) with addition of garlic (Allium sativum) and cumin (Cuminum cyminum Linn), as natural antioxidant during the storage. Jurnal Ilmu dan Teknologi Peternakan, 1(1), 1-11.

Samani, K.G., Farrokhi, E. 2014. Effects of cumin extract on oxidl, paraoxonase 1 activity, FBS, total cholesterol, triglycerides, HDL-C, LDL-C, apo A1, and apo B in in the patients with hypercholesterolemia. International Journal of Health Sciences, 8: 39–43.triglycerides, HDL-C, LDL-C, apo A1, and apo B in in the patients with hypercholesterolemia. International Journal of Health Sciences, 8: 39–43.

SAS. 1996. User’s Guide: Statistics. Institute, Inc. Cary, NC, USA 1996.

Shabaan, M. 2012. Effect of using thyme (Thymus vulgaris) and cumin (Cuminum cyminum) seeds for improving the utilization of low energy broiler diet. Egypt Poult Sci, 32(3), 579-591.

Shalaby, M. E., Ismail, A. A., Darbalah, A. S., Eid, Y. Z. 2006. Antifungal Activities of Some Plant Extracts against Some Mould Fungi and Their Toxicological Effect on Japanese Quail (Coturnix Coturnix). https://www.researchgate.net/publication/236941557_Antifungal_activities_of_some_plan t extracts_against_some_mould_fungi_and_their_toxicologi cal_effect_on_Japanese_Quail_coturnix_coturnix

Sharifi, S.D., Khorsandi, S.H., Khadem, A. Sharifi, S.D., Khorsandi, S.H., Khadem, A. 2013. The cytotoxic effect. Research in pharmaceu...
Singh, H. O., Singh, H. N., Singh, V. P., Kumar, A. 2015. Microbiological stability of aerobically packaged quail meat (bone-in) pickle at room temperature (30±2°C). J. Livest. Sci, 6, 16-22.

Sowbhagya, H.B. 2013. Chemistry, technology, and nutraceutical functions of cumin (Cuminum cyminum L): an overview. Critical reviews in food science and nutrition, 53(1), 1-10.

Srinivasan, K. 2018. Cumin (Cuminum cyminum) and black cumin (Nigella sativa) seeds: traditional uses, chemical constituents, and nutraceutical effects. Food quality and safety, 2(1), 1-16.

Torki, M., Soltani, J., Mohammadi, H. 2015. Effects of adding ethanol extract of propolis and cumin essential oil to diet on the performance, blood parameters, immune response and carcass traits of broiler chicks. Iranian Journal of Applied Animal Science, 5(4), 911-918.