International Research Journal of Pharmacy and Medical Sciences
ISSN (Online): 2581-3277

Effect of Adding Different Levels of Lemongrass (Cymbopogon citrates) and Wormwood Leaves (Artemisia herba alba) on the Productive Performance of Broilers Exposed to Heat Stress

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Abstract: *Heat stress factors are a major problem that negatively impacts agricultural animals, particularly broilers. Rapid growth disrupts their physiological stability, leading to a decline in physiological and productive characteristics and increased economic losses. This study investigated the physiological and productive performance and antioxidant status of 180 one-day-old Ross 308 broiler chicks randomly distributed among five treatments (36 birds/treatment) with 3 replicates each (12 birds/replicate). The chicks were raised under heat stress conditions in a semi-closed hall and fed diets containing different levels of raw lemongrass leaf powder and a synergistic mixture of lemongrass and wormwood powders. The treatments were: Treatment 1 (A1): Control treatment with no additives, Treatment 2 (A2): Diet supplemented with 1 g/kg of lemongrass leaf powder, Treatment 3 (A3): Diet supplemented with 1.5 g/kg of wormwood leaf powder, Treatment 4 (A4): Diet supplemented with a synergistic mixture of 1 g/kg lemongrass powder and 1 g/kg wormwood leaf powder, Treatment 5 (A5): Diet supplemented with 1.5 g/kg of lemongrass leaf powder and 1.5 g/kg of wormwood leaf powder, all birds were subjected to intermittent temperature increases throughout the rearing period (30 minutes every six hours). Productive traits (body weight, weight gain, feed consumption, feed conversion ratio). The results indicate that treatment with 1 g/kg of lemongrass leaf powder and the synergistic mixture significantly improved overall productive traits compared to the control treatment. Therefore, based on this study, adding raw lemongrass leaf powder and the synergistic mixture enhanced bird performance under heat stress conditions.*

Keywords: *Wormwood plant; lemongrass; broiler chickens; productive traits; physiological traits; heat stress.*

I. INTRODUCTION

The high level of environmental temperatures, particularly in Iraq, is a major problem for broiler breeders due to the significant economic losses it causes. It leads to delayed growth and high mortality rates (Al-Daraji and Al-Hasani, 2000). High temperatures cause heat stress, which is a major problem affecting the physiological and productive performance of broilers, especially due to their rapid growth, (Aswathi, et, al., 2019).

Therefore, protecting poultry birds from diseases and promoting safe growth and alternative feed options are crucial factors in animal production projects. This is especially important as international companies promote the concept of clean and green animal production, which emphasizes restricting the use of manufactured medicines, chemicals, and growth stimulants due to their negative effects on the deposition of residues in edible animal tissues. The focus is on reducing feed costs, promoting bird well-being, and minimizing deaths from diseases caused by artificial additives (Bickell, et al., 2010; Abd El-Hack, et al., 2022).

Following the direction of the Food and Drug Administration (FDA), World Health Organization (WHO), and European Medicines Agency (EMA), the use of chemical-origin antibiotics as growth stimulants is being severely limited due to the potential effects these compounds have on consumers after consuming animal products (Aćimović, et al., 2019; Puvača, et al., 2013; Si, et al., 2006).

Poultry breeders are searching for safe methods to reduce negative effects like diseases and stress on birds. One approach is using medicinal plant products, either as raw powder or extracted active ingredients added to feed or water. This can help birds cope with the problems associated with high temperatures (Borges, et al., 2004).

Lemongrass (Cymbopogon citratus), also known as citronella grass, is one such plant. It belongs to the Gramineae (grass) family, which includes many important economic crops. Most of its plants contain grass, making it one of the most well-known and important plant families (Barbosa et al., 2008). The chemical composition of lemongrass varies depending on the geographical location. It contains many chemical compounds with broad biological effects against various pathogens. The most important compound found in lemongrass is myrcene (Shah et al., 2011). The pharmacological effects are not limited to this, as the herb contains other chemical compounds with effective medicinal properties against most pathogens (Ojo, 2006). Danlami et al. (2011) explained that the effectiveness of lemongrass lies in its high concentrations of citronellal, geraniol, volatile oils, and fatty acids, which have a pronounced effect on lowering uric acid, cholesterol, and triglycerides.

Another plant of interest is wormwood (Artemisia absinthium), a genus of perennial wild plants with a rough

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texture. It is commonly found in desert areas and is drought-resistant (Setzer, et al., 2004). Wormwood is a unique source of artemisinin, a sesquiterpene lactone compound that is highly effective and active against cancer cells and acts as an immune system stimulant. Recent studies have examined its effectiveness as an antidote to the human immunodeficiency virus (HIV) (Sadiq, et al., 2013).

Wormwood contains important flavonoids that act as effective antioxidants when combined with artemisinin. These flavonoids include tannins, glycosides, alkaloids, phenols, saponins, and resins (Ferreira, et al., 2010). Wormwood is considered safe up to a concentration of 30 grams of dry leaves per day, as the semi-lethal dose (LD50) for mice was set at 162.5 grams/kg of raw plant extract (Wall and Watson, 2017). Khouchlae et al. (2017) indicated that the most important active compounds in wormwood are volatile oils, artemisinin, camphor, codeine, copaene, and santonin. These compounds are very effective against oxidative stress and also play an important role as pain relievers. Wormwood also contains various amino acids (asparagine, methionine, glutamine) and essential mineral components like phosphorus, calcium, and sodium, in addition to some volatile oils (Al-Fahdawi, 2007; Kostadinović, et al., 2015).

Given the potential of various medicinal plants to alleviate the impact of heat stress, this study aimed to examine the impact of incorporating lemongrass powder, wormwood leaves, and their combined mixture into the diets of broilers under heat stress on their productivity and physiological performance..

II. Material and Methods

The study was carried out at a broiler chicken farm in the Jableh District to examine the impact of adding raw lemongrass powder, wormwood leaves, and their combined mixture to the diets of broilers under heat stress on their productivity and physiological performance. The experiment took place from May 4, 2023, to June 1, 2023.

The birds in the study were divided into five treatment groups:

1. Treatment One (A1): Given a basic diet without any supplements.
2. Treatment Two (A2): Given a diet with 1 g/kg of lemongrass powder.
3. Treatment Three (A3): Given a diet with 1 g/kg of wormwood powder.
4. Treatment Four (A4): Given a diet with a mix of 1 g/kg lemongrass powder and 1 g/kg wormwood powder.
5. Treatment Five (A5): Given a diet with a mix of 1.5 g/kg lemongrass powder and 1.5 g/kg wormwood powder.

All birds underwent heat stress at intermittent intervals for 30 minutes, four times a day. Three thermometers were positioned at the beginning, middle, and end of the hall to monitor the temperature. The temperatures were recorded daily at 8 a.m., 12 noon, and 8 p.m. Lemongrass powder, wormwood, and a synergistic mixture were added to the feed in specified proportions. Each treatment was mixed separately with a portion of the feed to ensure uniformity, then combined with the remaining feed for the birds. This process is repeated weekly to maintain the integrity of the powder. Production characteristics were assessed weekly using the equations outlined by (Akomah et al., 2021).

TABLE I. The composition of the diet used in the study is presented.

Feed material	Starter feed 1 day - 3 weeks	Final feed 4 - 6 weeks
Corn	.043	45
Wheat	17.5	17.5
Soybean	26.5	23
Protein concentrate*	.010	10
Table salt	0.4	0.4
Limestone	0.4	0.4
Vegetable oil	2.0	3.5
Lysine	0.1	0.1
Methionine	0.1	0.1
Total	100	100
** Chemical Analysis		
Crude protein%	22.27	20.87
Representative energy (kcal/kg feed)	2984.05	3103.6
Crude protein/energy ratio	133.99	148.71
Lysine%	1.23	1.14
Methionine + cysteine	0.84	0.80
Calcium%	1.03	1.02
Bio phosphorus	0.47	0.46
Crude fiber%	5.17	4.96

*Protein powder produced by a Jordanian company (Profemi), nutritional components: representative energy per kilocalorie/kg 2200, crude protein 45%, crude fiber 5.3%, crude fat 6%. available phosphorus 3%, lysine 2.75%, cysteine + methionine 2.30%, methionine1.8 %, ash 2.5 .
** Calculated chemical composition of the feed according to NRC tables (1994).

Each bird endured heat stress for thirty minutes four times a day at irregular intervals. The farm's temperature was monitored with three thermometers positioned at the beginning, middle, and end of the farm. Temperatures were recorded daily at three specific times: 8 AM, 12 PM, and 8 PM. Lemongrass powder, wormwood, and a synergistic mixture were added. A specified amount of feed was mixed separately for each treatment to ensure consistency. It was then blended with the remaining feed portions before being given to the birds. This process is repeated weekly to confirm the powder's safety. Productive traits were analyzed weekly using the equations from Akomah et al., 2021.

Weight of birds per replicate at the end of the week minus weight of birds per replicate at the beginning of the week

Feed consumption is determined by subtracting the remaining feed at the end of the week from the delivered amount at the beginning of the week.

Statistics analysis: The data were analyzed according to the Complete Randomize Design (CRD), to study the effect of different parameters on the studied traits. The significant differences between the means were compared with the Duncan (1955) multinomial test, and the statistical program SAS (2012) was used in the statistical analysis.

III. Results and Discussion

Effect of adding raw powder of lemongrass, wormwood leaves, and their synergistic mixture on the average body weight and weight gain of broilers exposed to heat stress:

Table 2 shows the effect of lemongrass, wormwood leaves,

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and their synergistic mixture on the body weight and body weight gain of broilers exposed to heat stress.

Body Weight at Three Weeks: Treatment A5 had a significantly higher ($p \leq 0.01$) average body weight at three weeks of age compared to all other treatments.

Body Weight at Five Weeks: Treatment A5 had a significantly higher ($p \leq 0.05$) average body weight at five weeks of age compared to treatments A3, A2, and A1. There was no significant difference compared to treatment A4.

Cumulative Weight Gain (0-3 Weeks): Treatment A5 showed a significantly higher rate of cumulative weight gain ($p \leq 0.01$) compared to treatments A3, A2, and the control (A1). Treatments A4 and A3 also exhibited significant weight gain compared to the control.

Cumulative Weight Gain (4-5 Weeks): The table indicates no significant difference in the rate of cumulative weight gain between weeks 4 and 5 for any treatment groups.

Total Weight Gain (0-5 Weeks): Treatment A5 showed a significant advantage ($p \leq 0.05$) in total weight gain over the 0-5 week period compared to all other treatments, including treatment A4. There was no significant difference in weight gain between treatments A3, A2, and A1. In TABEL II.

TABLE II. The effect of adding raw powder of lemongrass and wormwood leaves and the synergistic mixture between them on the average body weight and weight gain of broilers exposed to heat stress (mean ± standard error).

Studied Indicated	**Body Weight**		**Weight Gain**		
Treatment	5 Weeks	3 Weeks	0-5 Weeks	4-5 Weeks	0-3 Weeks
A1	bc2184.96±31.82	d860.04±3.82	bc2142.97±31.81	1324.91±34.23	d818.04±3.28
A2	c2169.42.42±11.72	c867.71±7.67	c2127.40±11.71	1301.71±5.14	cd825.71±7.67
A3	bc2194.23±4.91	bc885.56±9.64	bc2152.23±4.91	1308.66±9.54	cb843.56±9.64
A4	ab2229.70±6.38	b894.66±3.84	ab2187.70±6.38	1335.03±10.14	b852.66±3.84
A5	a2260.55±19.09	a915.74±4.96	a2218.53±19.10	1344.81±23.82	a873.74±4.96
significance level	*	**	*	N.S	**

*Different letters within one column indicated the presence of significant differences between the treatments and for each period of the study. *Treatments T1, T2, T3, T4, and T5 consumed a control feed to which raw lemongrass powder, wormwood leaf raw powder, and their synergistic mixture were added in proportions (1g/kg feed wormwood leaf powder, 1g lemongrass+1g wormwood powder/kg feed, 1.5g lemongrass+1.5g wormwood leaf powder/kg feed). (**) represents the significant differences between the parameters at the significance level of P≤0.01. (*) represents the significant differences between the experimental parameters at the significance level of P≤0.05. N.S represents there is no significant difference between the experimental parameters.

TABEL III. Effect of Lemongrass, Wormwood, and their Synergistic Mixture on Feed Consumption and Feed Conversion Ratio (FCR) in Broilers Exposed to Heat Stress (Mean ± Standard Error).

Studied Indicated	**Feed Consumption**			**Feed Conversion Ratio (F.C.R.)**		
Treatments	0-5 Weeks	4-5 Weeks	0-3 Weeks	0-5 Weeks	4-5 Weeks	0-3 Weeks
T1	e5473.58±12.37	d3936.05±9.96	d1537.52±11.26	c2.55±0.03	b2.97±0.08	d1.87±0.01
T2	d5579.26±21.11	dc3974.01±9.01	c1605.25±16.74	bc2.62±0.008	ab3.05±0.009	c1.94±0.01
T3	c5733.09±4.42	c4039.04±29.55	b1694.05±13.29	ab2.66±0.01	ab3.08±0.02	b2.00±0.02
T4	b5984.41±21.61	b4187.93±23.44	a1760.49±4.54	a2.71±0.01	a3.13±0.03	a2.06±0.008
T5	a6064.66±3.66	a4293.22±24.14	a1753.44±17.76	a2.72±0.02	a3.19±0.04	b2.00±0.01
significance level	**	**	**	**	*	**

*Different letters within one column indicated the presence of significant differences between the treatments and for each period of the study.*Treatments T1, T2, T3, T4, and T5 consumed a control feed to which raw lemongrass powder, wormwood leaf raw powder, and their synergistic mixture were added in proportions(1g/kg feed wormwood leaf powder, 1g lemongrass+1g wormwood powder/kg feed, 1.5g lemongrass+1.5g wormwood leaf powder/kg feed). (**) represents the significant differences between the parameters at the significance level of P≤0.01. (*) represents the significant differences between the experimental parameters at the significance level of P≤0.05. N.S represents there is no significant difference between the experimental parameters.

Effect of adding raw powder of lemon grass, wormwood leaves, and their synergistic mixture on the rate of feed consumption:

Table III shows that feed consumption for all treatment groups with added supplements was significantly higher ($p \leq 0.01$) throughout the study period compared to the control treatment, which had the lowest feed intake, For the feed conversion ratio (FCR), the control treatment outperformed all supplemented groups. The control group had a significantly lower ($p \leq 0.01$) FCR for both the 0-3 week and 0-5week periods, and a significantly lower ($p \leq 0.05$) FCR for the 4-5week period, when comparing the feed conversion ratio among the supplemented groups, treatment A2 showed a decrease (improvement) for both the 0-3 week and 0-5week periodsclearances. In TABELIII

Preventing diseases that affect poultry birds and improving their health condition to enhance feed consumption and achieve optimal weights within a short breeding period are crucial factors in any broiler breeding project. With increasing production by international companies and concerns over the use of antimicrobial growth promoters in poultry, recent studies have turned to medicinals and their by-products as nutritional sources alternatives. These plants are favored for their components that are safe and benefit both birds and consumers.

Therefore, most of the changes occurring in all productive characteristics of broilers exposed to heat stress and fed with diets containing different concentrations of Lemongrass, wormwood leaves, and a mixture between them may be limited to this because this plant contains many biologically active compounds called Phytobiotics. These are a group of natural substances found in the plant and have high biological activity that has an enhancing effect on animal health, such as essential oils and herbal extracts (Kostadinović and Lević, 2018). The improvement in productive characteristics in the current study may be attributed to the addition of Lemongrass, wormwood leaf powder, and the mixture between them added to broiler feeds. Lemongrass contains many active substances

that have a clear effect in stimulating the digestive process in birds, such as essential oils and fatty acids found in this herb, like citronellal and geraniol, which have an effective effect in increasing the number of microflora in the intestines of birds (Garg, et al., 2012). The addition of wormwood to broiler diets may also be beneficial, as it contains substances and aromatic oils that increase the bird's ability to eat feed and its palatability.

This is what was observed in the birds of the experimental treatments, where the feed consumption rate increased compared to the control treatment (Beigh and Ganai, 2017). Meanwhile, (Kim et al., 2002; Kim et al., 2006; Kim et al., 2012) confirmed that drying, grinding, and adding leaves to feed enhances their effectiveness and improves the general health condition of the animal. Lemongrass also contains fragrant chemical compounds and essential oils that may play an effective role in increasing feed consumption with food addition treatments. These findings are consistent with the results of the current study, which showed the superiority of the addition treatments over the control treatment. These results align with the findings of this study, indicating that adding raw powder to wormwood leaves significantly enhanced the overall productive characteristics, reflecting the bird's economic performance. Kostadinović and Lević, 2018, explained that the biological effects of many medicinal plants, including wormwood, are mainly due to their high content of phenolic compounds, aromatic essential oils, and saponins. These secondary compounds have the potential to inhibit the growth of pathogenic bacteria, thus improving the bird's health condition, or act as active antioxidant agents. Especially fat oxidation, in addition to being a stimulating factor for appetite and growth, may play an effective role in reducing oxidative damage that can impact the cell. This positive effect on the bird's overall health is due to feed additives containing compounds, particularly aromatic oils from herbs and spices, which help enhance the bird's health and productivity by stimulating feed consumption. Nutritional supplements are also known to promote growth and offer various health and nutritional benefits (Ozturk et al., 2012). However, the findings of the current study contrast with those of Thayalini et al. (2011), who found that adding lemongrass to broiler diets at a 2% concentration did not significantly affect the studied productive traits. Similarly, Sariözkan et al. (2016) reported no significant differences in the productive characteristics of quail birds when given lemongrass supplements.

IV. Conclusion

The results of this study indicate a clear improvement in the overall productive and physiological characteristics of broilers as a result of feeding diets containing different proportions of lemongrass and wormwood, which led to a reduction in the effect of heat stress on birds.

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