

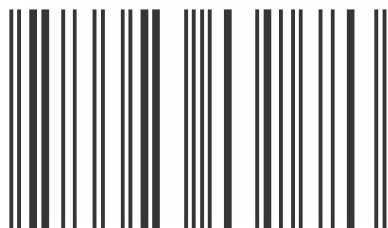
The experiments of the current study were carried out in the poultry scientific research house in Gardarasha/ Animal resource Dept.- College of Agricultural Engineering Sciences, Salahaddin University- Erbil Kurdistan region, Iraq. This study included two experiments, each of seven treatments with three replicates. Two stocking densities were applied in both experiments. The first experiment was for the broiler, 705 days-old chicks commercial Ross 308 were raised in 2m<sup>2</sup> in each pen for 35 days, the stocking density as follows; T0 (negative control, standard density) 75 chicks, 25 chicks (12-13 birds/ m<sup>2</sup>) per replicate. From T1 till T6 the chicks were reared under high stocking density 105 chicks for each treatment and each replicate was obtained 35 birds (17-18 birds/ m<sup>2</sup>). The second experiment was conducted for layer, from 10th August till 1st December, 240 (31) weeks-old commercial ISA-Brown layers were reared for 16 weeks in different conditions of the experiment and the stocking density was as follows; T0 (negative control, normal density) 8 layers/ 1.20 m<sup>2</sup> (7 layers/ m<sup>2</sup>). From T1 till T6 the layers were under stocking density 12 layers/ 1.30 m<sup>2</sup> (9 layers/ m<sup>2</sup>).



FOR AUTHOR USE ONLY



Tayeb, Dr. Ihsan Tawffiq, Professor, Male, Married, 1/10/1969, Amedy, Dohuk, Kurdistan Region, Iraq, Iraqi, Kurdish (mother tongue), English and Arabic (spoken and written), College of Agriculture Engineering Sciences- university of Duhok, Kurdistan Region, Iraq. Ph.D. University of Mosul, Iraq + AUB Lebanon.



Ihsan Tayeb, Alla Mustafa

Ihsan Tayeb  
Alla Mustafa

# Productive Performance of poultry Supplementation of Medicinal Plants

Productive Performance, Behavioral, Physiological of Broilers and Layers used Medicinal Plants under Stocking Density



FOR AUTHOR USE ONLY

FOR AUTHOR USE ONLY

FOR AUTHOR USE ONLY

!



## ***Dedication***

***I dedicate this book;***

*To the holly prophet Mohammed Mustafa (peace and blessing  
Allah be upon him) and his companions.*

*To my supervisor prof. Dr. Ihsan Tofeeq Tayeb.*

*To my mother, father, brother and sisters.*

*To all friends and people who supported and encouraged me  
during my Ph.D research.*

FOR AUTHOR USE ONLY

..... Alaa .....

## Acknowledgment

In the beginning I would like to gratitude **Allah the Lord of the world**, the most merciful, most gracious who was and always was with me during hurdles and difficulties in this research.

I would like to express my deep gratitude to my Ph. D research supervisor **Prof. Dr. Ihsan Towfeeq Tayeb** for giving me the opportunity to do research and providing invaluable guidance throughout working and writing this research. His dynamism, vision, sincerity and motivation have all left an indelible impression on me. He taught me the methodology for conducting the research and presenting the findings as clearly as possible. Working and studying under his supervision was a great privilege and honor.

Also, I send my thanks to **Salahaddin University- College of Agricultural Engineering Sciences** for providing us with the opportunity to complete this work, as well as the **heads of the Department of Animal Resources** for their support throughout the study by providing a poultry hall.

I am extremely grateful to my **family; parent, sisters and brother** for their prayers and continuous supporting and being with me during the research and without them it was difficult for me to finish this research well.

Special thanks to **Mr. Sartip the head of Al- Shimal company** for providing the layers and **Dr. Osman Ismail** the head of Evan company for providing the chicks and feed. And also thanks to **Mr. Fakhraddin** to facilitate the provision of hall necessities. Many thanks to **Mr. Ali Hamad** who did statistical analysis to my research data.

Finally, I would like to thank my friends and colleagues for supporting me and encouragement me during my study.

## Summary

The experiments of the current study were carried out in the poultry scientific research house in Gardarasha/ Animal resource Dept.- Collage of Agricultural Engineering Sciences, Salahaddin University- Erbil Kurdistan region, Iraq. The study duration was from 10<sup>th</sup> of June 2020 till 1<sup>st</sup> of December 2020 at the farm and three months more at a laboratory.

This study aimed to evaluate the influence of dietary medicinal herbs (sage and lavender and their combination powders) on performance productivity, some physiological, immunological, behavior parameters, as well as welfare and economical evaluation of broiler and layer under higher stocking density. This study included two experiment, each of seven treatments with three replicates. Two stocking densities were applied in both experiment. The first experiment was for the broiler, from 10 June till 15 July, 705 days- old chicks commercial Ross 308 were raised in 2m<sup>2</sup> in each pen for 35 days, the stocking density as followings; T0 (negative control, standard density) 75 chicks, 25 chicks (12-13 birds/ m<sup>2</sup>) per replicate. From T1 till T6 the chicks were reared under high stocking density 105 chicks for each treatment and each replicate was obtained 35 birds (17-18 birds/ m<sup>2</sup>). The second experiment was conducted for layer, from 10<sup>th</sup> August till 1<sup>st</sup> December, 240 (31) weeks- old commercial ISA-Brown layers were reared for 16 weeks in different conditions of the experiment and the stocking density was as the following; T0 (negative control, normal density) 8 layers/ 1.20 m<sup>2</sup> (7 layers/ m<sup>2</sup>). From T1 till T6 the layers were under stocking density 12 layers / 1.30 m<sup>2</sup> (9 layers/ m<sup>2</sup>). The herbs powder supplementations rate were the same in both experiments as following; T0 negative control and T1 positive control provided standard diet (no supplementations), T2 (0.7% sage powder+ standard diet), T3 (0.9% sage powder+ standard diet), T4 (0.7% lavender powder+ slandered diet), T5 (0.9% lavender powder+ standard diet), T6



(0.7% mixed (0.35 sage+0.35 lavender powder+ standard diet).The productive performance, some physiological, immunity, behavior, welfare and economic efficiency were studied. The results were summarized as the followings;

-A highly significant ( $P \leq 0.01$ ) increase of body weight gain (BWG) was observed in density groups with herbal treatments about 25% in T3, T4 and T6 led to be close T0 and compared to T1.

-A highly significant ( $P \leq 0.01$ ) increase of hen day egg production (HD%) about 40% and egg mass (g/hen/week) were noticed in density groups with herbal treatments T4, T5 and T6 and close to T0 while differences with T1.

-Significantly ( $P \leq 0.05$ ) improved by diet herb the weekly feed intake (FI), feed conversion ratio (FCR) for both broiler and layer, production index (PI), carcass characteristics, dressing percentage, lymphoid organs for broilers and egg quality traits for layers.

-Significantly ( $P \leq 0.01$ ) improved by dietary supplementation of sage and lavender powders the behavior traits particularly eating, laying, comfort behaviors, decreasing stress and aggressive behaviors.

-Significant ( $P \leq 0.05$ ) improvement was observed in herbal treatments of hematological parameters erythrocyte profile, thrombocyte, leukocyte profile, thyroid hormones, decreasing H/L ratio, cholesterol, glucose and cortisol as a (stress indicators). While there was no effect observed on layers.

-Antibodies titer against New castle disease virus (NDV) and Infectious bronchitis virus (IBV) were significantly ( $P \leq 0.01$ ) increased in herbs treatments.

-The welfare status of broilers and layers was improved according to the improvement of behavior and hematological traits.

- Significantly ( $P \leq 0.01$ ) increased economic profit due to increasing meat and egg production in herb treatments compared with control groups(T0 and T1).

## Table of contents

Page Number	Title	No.
	Dedication	
	Acknowledgment	
	Summary	
	List of contents	
	List of tables	
	List of figures	
<b>1-2</b>	<b>CHAPTER ONE INTRODUCTION</b>	
<b>3-28</b>	<b>CHAPTER TWO LITERATURE REVIEW AND THEORETICAL BACKGROUND</b>	
3	Poultry stress management	2.1
3	Definition of stress, stocking density, heat and cold stress	2.1.1
4	Stages and mechanisms of stress	2.1.2
5	Previous studies of stocking density management in different conditions with natural supplementations in poultry	2.1.3
5	Effect of medicinal herbals on reducing stress in poultry management	2.1.4
6	Medicinal plant sage ( <i>Salvia officinalis</i> )	2.2
6	Historical origin distribution	2.2.1
7	Plant description	2.2.2
7	Botanical name and species	2.2.3
8	Chemical composition and bioactive compounds.	2.2.4
9	Medicinal plant lavender ( <i>Lavandula angustifolia</i> )	2.3
9	Historical origin distribution	2.3.1

10	Plant description	2.3.2
10	Scientific classifications and species	2.3.3
11	Chemical composition and bioactive compounds	2.3.4
11	Adverse effects of sage and lavender	2.3.5
12	Health benefits and medicinal uses of sage and lavender	2.4
12	Anti-depressant, anxiolytic and antistress	2.4.1
12	Antioxidant activity	2.4.2
13	Antimicrobial activity	2.4.3
13	Antibacterial	2.4.3.1
14	Antifungal	2.4.3.2
14	Antiviral activity	2.4.3.3
15	Antiparasitic activity	2.4.3.4
15	Anti-allergic and anti-inflammatory effects	2.4.4
16	Digestion treatments	2.4.5
17	Anti-diarrhea	2.4.6
17	Natural pain killer	2.4.7
18	Antidiabetic	2.4.8
19	Cholesterol level	2.4.9
19	Stimulant	2.4.10
19	Coolant (antipyretic)	2.4.11
20	Effect of stocking density in different conditions and adding medicinal herbals (Sage and Lavender) in broiler and layer diets	2.5
20	Meat production live body weight (LBW), body weight gain (BWG) and hen day egg production HD%	2.5.1
21	Feed intake (FI) and feed conversion ratio (FCR)	2.5.2
22	Production index (PI) and growth rate.	2.5.3
23	Mortality	2.5.4
23	Carcass characteristics	2.5.5
24	Egg quality characteristics	2.5.6
24	Behavior parameters	2.5.7
25	Hematological whole blood cells	2.5.8
26	Serum biochemical	2.5.9
27	Hormones	2.5.10

27	Immune response	2.5.11
28	Welfare status	2.5.12
28	Economic Efficiency (profit)	2.5.13
<b>29-54</b>	<b>CHAPTER THREE METHODOLOGY AND EXPERIMENTAL DESIGN</b>	
29	Location of the experiments	3.1
29	Medicinal herbals chemical compound and source	3.2
30	First experiment (Broilers)	3.3
30	Source of chick and feed	3.3.1
30	House management	3.3.2
31	Health program	3.3.3
	Feeding program	3.3.4
33	Experimental design (broilers)	3.3.5
34	Studied traits	3.3.6
35	Productive performance	3.3.6.1
35	Live body weight (LBW), body weight gain (BWG)	3.3.6.1.1
35	Feed intake (FI) and feed conversion ratio (FCR)	3.3.6.1.2
36	Relative growth and Production index (PI)	3.3.6.1.3
36	Mortality	3.3.6.1.4
36	Carcass characteristics	3.3.6.2
36	Measurement of body portions and cuts	3.3.6.2.1
36	Carcass weight	3.3.6.2.2
37	Dressing percentage	3.3.6.2.3
37	Relative lymphoid organs weights (Thymus, Spleen and Bursa)	3.3.6.2.4
38	Second experiment hens (Layers)	3.4
38	Source of hens (layers) and feed	3.4.1
38	House management	3.4.2
39	Health program	3.4.3
39	Feeding program	3.4.4
41	Experiment design	3.4.5
43	Studied traits	3.4.6
43	Egg productive traits	3.4.6.1

43	Feed intake (FI)	3.4.6.2
43	Feed conversion ratio FCR (g feed/ g egg)(g feed/1egg)	3.4.6.3
43	Egg weight (g)	3.4.6.4
44	Egg mass (g/egg/hen/week)	3.4.6.5
44	Egg Quality Characteristics	3.4.6.6
44	External egg characteristics	3.4.6.6.1
44	Egg shape index	
44	Egg Shell Strength	
45	Egg Shell Thickness (mm)	
45	Egg Shell Weight (g)	
45	Internal Egg Characteristics	3.4.6.6.2
45	Albumin (white) percentage	
46	Haugh Unit	
46	Yolk index	
46	Yolk Weights (g)	
46	Yolk color score	
47	Behavior parameters determination	3.5
49	Hematological sample preparation	3.6
49	Whole blood determination automatically by (Hematology analyzer)	3.6.1
50	Whole blood determination traditionally(manually)	3.6.2
50	Total account of (Erythrocyte) red blood cells (RBCs) sample preparation.	3.6.2.1
50	Packed cell volume (PCV), Hematocrit sample preparation	3.6.2.2
50	Hemoglobin sample preparation.	3.6.2.3
50	Mean corpuscular volume (MCV) determination	3.6.2.4
50	Mean corpuscular hemoglobin (MCH)	3.6.2.5
51	Mean Corpuscular Hemoglobin Concentration (MCHC)	3.6.2.6
51	Total number (Leucocytes) of white blood cells (WBCs)	3.6.3
51	Differential count of leukocyte white blood cells (WBCs)	3.6.3.1
51	Heterophil/ Lymphocyte ratio H/L ratio	3.6.3.2
51	The total number of thrombocyte	3.6.3.3

51	Serum biochemical test	3.6.4
52	Immunity test (Newcastle ND and Infectious bronchitis virus (IBV) ELISA test (Enzyme-Linked Immune Sorbent Assay)	3.6.5
52	Welfare indicators estimation	3.7
53	Economic efficiency (profit)	3.8
54	Statistical analysis	3.9
<b>55-127</b>	<b>CHAPTER FOUR RESULTS AND DISCUSSIONS</b>	
55	Effect of medicinal herbals powder (sage and lavender) on broiler under high stocking density	4.1
55	Productive performance	4.1.1
55	Live body weight (LBW)and body weight gain (BWG)	4.1.1.1
60	Feed intake (FI) and feed conversion ratio (FCR)	4.1.1.2
64	Relative growth rate % and production index (PI)	4.1.1.3
66	Mortality %	4.1.1.4
67	Carcass characteristic	4.1.1.5
70	Lymphoid organ	4.1.1.6
72	Behavior parameters	4.1.2
75	Physiological parameters (Hematology)	4.1.3
75	Erythrocyte profile, red blood cells (RBCs) and thrombocyte	4.1.3.1
78	Leukocyte profile, white blood cells (WBCs) and H/L ratio.	4.1.3.2
81	Serum biochemical	4.1.3.3
84	Hormones	4.1.3.4
86	Immune response	4.1.3.5
87	Welfare status	4.1.4
89	Economic efficiency (profit)	4.1.5
91	Effect of medicinal herbals powder (sage and lavender) on layers under high stocking density in different conditions	4.2
91	Productive performance	4.2.1
91	Hen-day egg production (HD%)	4.2.1.1
94	Feed conversion ratio FCR (g feed/g egg) and FCR	4.2.1.2

	(g feed/ 1 egg)	
99	Egg weight and egg mass	4.2.1.3
102	Egg quality characteristics	4.2.2
108	Behavior parameters	4.2.3
115	Physiological parameters (Hematology)	4.2.4
115	Erythrocyte profile, red blood cells (RBCs) and thrombocyte	4.2.4.1
120	Serum biochemical	4.2.4.2
122	Hormones	4.2.4.3
124	Immune response	4.2.4.4
125	Welfare status	4.2.5
127	Economic efficiency (profit)	4.2.6
<b>128 - 129</b>	<b>CHAPTER FIVE CONCLUSIONS, RECOMMENDATIONS AND FUTURE WORK</b>	
128	Conclusions	<b>A</b>
129	Recommendations	<b>B</b>
	<b>CHAPTER SIX</b>	
	<b>REFERENCES AND BIOGRAPHY</b>	
	<b>Appendix</b>	
	Abstract in Kurdish (متخوێ)	

## List of tables

Page Number	Titles	No. of table
8	Sage bioactive compounds	<b>2.1</b>
11	Lavender bioactive compounds	<b>2.2</b>
29	Chemical analysis of medicinal herbs (sage and lavender) powder / 100 g dried herbals	<b>3.1</b>
31	Broiler (Ross-308) vaccine program	<b>3.2</b>
32	Broiler (Ross 308) diet Ingredients and chemical compositions	<b>3.3</b>
39	Layers (Isa-Brown) vaccine program	<b>3.4</b>
40	Layers (Isa-Brown) diet Ingredients and chemical compositions	<b>3.5</b>
48	Behavior parameters and description of behavior patterns	<b>3.6</b>
49	Others layer behavior patterns and descriptions	<b>3.7</b>
53	Total cost and revenue in the broiler and layer experiment (Economic efficiency)	<b>3.8</b>
58	Effect of medicinal herbals on broilers weekly live body weight (LBW) under high stocking density	<b>4.1</b>
59	Effect of medicinal herbals on broilers weekly body weight gain (BWG g) under high stocking density	<b>4.2</b>
62	Effect of medicinal herbals on broilers weekly feed intake (FI g) under high stocking density	<b>4.3</b>
63	Effect of medicinal herbals on broilers weekly feed conversion ratio (FCR) under high stocking density	<b>4.4</b>
65	Effect of medicinal herbals on broilers weekly Relative growth rate (RG%) under high stocking density	<b>4.5</b>
66	Effect of medicinal herbals on broilers mortality under high stocking density	<b>4.6</b>
69	Effect of medicinal herbals on broilers carcass traits cuts portions and dressing% under high stocking density	<b>4.7</b>
70	Effect of medicinal herbals on broilers carcass traits relative internal organs% under high stocking density	<b>4.8</b>
71	Effect of medicinal herbals on broilers lymphoid organs under high stocking density	<b>4.9</b>
74	Effect of medicinal herbals on broilers behavior parameters under high stocking density (percentage of	<b>4.10</b>



	observations during the experiment (1-5 weeks)	
77	Effect of medicinal herbals stocking on broiler erythrocyte or Red Blood Cells profile and thrombocyte under high stocking density	<b>4.11</b>
80	Effect of medicinal herbals on broilers leukocyte or white blood cells (WBCs) under high stocking density	<b>4.12</b>
83	Effect of selected medicinal herbs' on broilers serum biochemical tests under high stocking density	<b>4.13</b>
85	Effect of medicinal herbals on broilers Thyroid hormones (T3 and T4) and Cortisol under high stocking density	<b>4.14</b>
87	Effect of medicinal herbals on broilers on immune response against diseases Newcastle disease virus (NDV) and Infectious bronchitis (IBV) under high stocking density	<b>4.15</b>
90	Effect of medicinal herbals on broilers economic efficiency estimated by (ID) under high stocking density	<b>4.16</b>
93	Effect of medicinal herbals on layer hen day egg production (HD%) under high stocking density in different conditions	<b>4.17</b>
97	Effect of medicinal herbals on the layer feed conversion ratio FCR g feed/egg under high stocking density in different conditions	<b>4.18</b>
98	Effect of medicinal herbals on layers feed conversion ratio FCR g feed/egg under high density in different conditions	<b>4.19</b>
101	Effect of medicinal herbs on layer egg weight (g), egg mass g/egg/ hen/ week under high stocking density in different conditions	<b>4.20</b>
105	Effect of medicinal herbals on layers external egg quality characteristics under high stocking density in different conditions	<b>4.21</b>
106	Effect of medicinal herbals on layer internal egg quality characteristics under high stocking density in different conditions	<b>4.22</b>
107	Effect of medicinal herbals on layer yolk color score under high stocking density in different conditions	<b>4.23</b>
112-114	Effect of medicinal herbs on layers behavior parameters under high stocking density during different conditions	<b>4.24</b>

116	Effect of medicinal herbs on layers erythrocyte profile and thrombocyte under high stocking density during different conditions	<b>4.25</b>
119	Effect of medicinal herbs on layers on leukocyte profile under high stocking density during different conditions	<b>4.26</b>
122	Effect of medicinal herbs on layers serum biochemical under density	<b>4.27</b>
123	Effect of medicinal herbs on layers hormones under high stocking density	<b>4.28</b>
125	Effect of medicinal herbs on layers immune response against NDV and IBV under high stocking density	<b>4.29</b>
127	Effect of medicinal herbs on layers economics efficiency during 16 weeks under stocking density	<b>4.30</b>

### List of figures

Page Number	Titles	No. of figure
4	Stages of stress in birds body	<b>2.1</b>
7	<i>S. officinalis</i> Sage herb	<b>2.2</b>
10	Lavender herb & <i>L. angustifolia</i>	<b>2.3</b>
37	Broiler experimental design and studied traits	<b>3.1</b>
42	Layer experimental design and studied traits	<b>3.2</b>
59	Effect of medicinal herbals on broilers total body weight gain (BWG g) during 1-5 weeks under high stocking density	<b>4.1</b>
63	Effect of medicinal herbals on broilers average feed conversion ratio(FCR) during 1-5 wks. under high stocking density	<b>4.2</b>
65	Effect of medicinal herbals on broiler total Relative growth rate under high stocking density% during 1-5 wks.	<b>4.3</b>
66	Effect of medicinal herbals on broilers on production index (PI) during 1-5 wks. under high stocking density	<b>4.4</b>
81	Effect of medicinal herbals on broilers H/L ratio under high stocking density	<b>4.5</b>
119	Effect of medicinal herbs on layers on H/L ratio under high stocking density	<b>4.6</b>

FOR AUTHOR USE ONLY

**CHAPTER ONE****INTRODUCTION**

In response to the rising population and the demand for poultry products. Poultry production is expanded and more projects are continuously establishing all over the world. Poultry meat and eggs are always in the human meal as a source of animal protein (Guardia *et al.*, 2011). Therefore effects are spending to increase such main protein sources. Increasing the stocking density is the most possible method to increase poultry production. However overcrowding is one of the most critical stress factors in poultry farming in terms of production and yield ( Kakkal *et al.*, 2018).

For both meat and egg production, stocking density can be defined as the mass or number per square meter of floor surface area (Tayeb *et al.*, 2011, Berg and Yngvesson, 2012). Stocking density is really important in all conditions, mostly in summer, due to higher mortality, lower quality of meat, immunosuppression occurring in broilers at greater stocking densities (Türkyilmaz, 2008). In addition, crowding stress changes in behavior, reduce production and loss of yield (Elitok and Bingüler, 2018). Furthermore, broilers treated with stocking density showed an increase in both the H/L ratio and glucose (Kridtayopas *et al.*, 2019, Sugiharto, 2022).

The negative impact of stocking density could get decreased by some modifications in nutrition and management. So new nutritional strategies should get applied. Nowadays, antibiotics have been prohibited as growth promoters by the European Union because antibiotic strains have caused severe problems in public health and livestock productivity (El-Garhy, 2018, Daramola, 2019 and Torki *et al.*, 2021). Accordingly, using of herbs and phytogetic products as potential alternatives to antibiotic has growing interests by researchers. Several herbs such as clove, lavender, moringa, green

tea and garlic have been used in poultry as an alternative to antibiotics and growth promoters. These herbs are also used as antimicrobials, antioxidant and immunomodulatory agents (Pliego *et al.*, 2020).

The sage plant (*Salvia officinalis*) and Lavender (*Lavandula angustifolia*) are used as feed additives to reduce the effect of stocking density and heat stress. These two herbs are belonging to the *Lamiaceae* family used as important medicinal plants because its content of strong active compounds. The sage plant contains phenolic acids, flavonoids and the active ingredient that caused by the compounds of the volatile oil (Al-Sherify, 2015). On the other hand, lavender plant contains linalool, which has appetizing properties due to a desirable smell and stimulating the digestion processes (Lipiński *et al.*, 2019, Turki *et al.*, 2021).

These two plants are powerful aromatic herbs that could use as a feed additives can influence on physiological activities in broilers and layers, as well as help to maintain good health, welfare and boost performance productivity (Jalali-Heravi *et al.*, 2015, Salajegheh *et al.*, 2018). Furthermore, Sage also helps to improve blood profile by lowering the H/L ratio and glucose levels. Immunity titers was increased against Newcastle disease and avian influenza viruses (Farhadi *et al.*, 2020). Lavender aromatherapy's significance in anxiety and stress relief (Suyono and Wijaya, 2020). In addition, including medicinal herbs, particularly lavender, in poultry promotes calm, reduces aggressive behavior and alleviates depression (Abo Ghanima *et al.*, 2021).

The objective of this study was to evaluate the effects of two medicinal plants (sage and lavender) powder and their combinations on performance productivity, some physiology, immunity, behavior, welfare and economic efficiency of broiler and layer.

