REPUBLIC OF TÜRKİYE
ERCIYES UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF AGRICULTURAL SCIENCES AND TECHNOLOGIES

EFFECTS OF PARSLEY (*Petroselinum crispum*) EXTRACT BY DIFFERENT WAYS IN DRINKING WATER AND STOCKING DENSITY ON GROWTH PERFORMANCE, SOME BLOOD PARAMETERS AND ANTIOXIDANT STATUS OF BROILER CHICKS

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Ph.D. Thesis

February 2025
KAYSERİ

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SCIENTIFIC ETHICS SUITABILITY

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

IHAB MOHAMMED ALI ALI

İmza

SUITABILITY FOR INSTRUCTION GUIDE

The Ph.D. thesis entitled "**Effects of Parsley (*Petroselinum crispum*) Extract by Different Ways in Drinking Water and Stocking Density on Growth Performance, Some Blood Parameters and Antioxidant Status of Broiler Chicks**" has been prepared in accordance with Erciyes University Graduate School of Natural and Applied Sciences Thesis Preparation and Writing Guide.

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IHAB MOHAMMED ALI ALI

February 2025, Kayseri

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IHAB MOHAMMED ALI ALI

Erciyes University, Graduate School of Natural and Applied Sciences
PhD Thesis, February 2025
Supervisor: Prof. Dr. Ali İrfan İLBAŞ

ABSTRACT

The present experiments were conducted to evaluate the effects of parsley (Petroselinum crispum) extract by different ways in drinking water and stocking density on growth performance, some blood parameters and antioxidant status of broiler chicks. Two different stocking densities (10 and 15 chicks / m²) and five additive levels (0 - control treatment without additives; 4a - addition of 4 millilitres of aqueous extract per litre of water; 4c - addition of 4 millilitres of alcoholic extract per litre of water; 8a - addition of 8 millilitres of aqueous extract per litre of water; 8c - addition of 8 millilitres of alcoholic extract per litre of water) were evaluated. The study included 375 one-day-old unsexed Ross 308 chicks arranged in a 2x5 factorial experiment (factor 1: two stocking densities; factor 2: five additive levels). The chicks were randomly assigned to ten distinct treatment groups, each further divided into three replicates. Five treatment groups contained ten chicks each (stocking density: 10 chicks / m²), while the remaining five groups contained fifteen chicks each (stocking density: 15 chicks / m²).

The results showed that treatment 8c was the most effective in improving weight gain, feed efficiency, mortality rates, and economic index across both stocking densities, with superior physiological performance. Treatments significantly enhanced heterophil (%) and lymphocyte (%) counts, with better responses at 10 chickens / m². Treatment 4c improved glucose levels at both densities, while treatments 4a, 4c, and 8c showed superior total protein and cholesterol levels. Treatments 4c and 8a at 15 chickens/m² exhibited higher GOT, GPT, and uric acid levels. Antioxidant indicators decreased in additive treatments, with better outcomes at 10 chickens /m². Treatments 4c and 8c were the most effective overall.

Keywords: Aqueous and Alcoholic Extract, Parsley, Stocking Density, Growth Performance, Some Blood Parameters, Antioxidant Status

MAYDANOZ (*Petroselinum crispum*) EKSTRAKTININ İÇME SUYUNA VE YERLEŞİM SIKLIĞINA FARKLI YOLLARLA KATILMASININ ETLİK PİLİÇLERDE BÜYÜME PERFORMANSI, BAZI KAN PARAMETRELERİ VE ANTİOKSIDAN DURUMU ÜZERNE ETKİLERİ

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ÖZET

Mevcut deneyler, maydanoz (Petroselinum crispum) ekstraktının içme suyuna ve yerleşim sıklığına farklı yollarla katılmasının etlik piliçlerde büyüme performansı, bazı kan parametreleri ve antioksidan durumu üzerine etkilerini değerlendirmek amacıyla gerçekleştirildi. İki farklı yerleşim yoğunluğu (10 ve 15 civciv/m²) ve beş farklı katkı seviyesi (0 - katkı içermeyen kontrol grubu; 4a - her litre suya 4 ml sulu ekstrakt ilavesi; 4c - her litre suya 4 ml alkollü ekstrakt ilavesi; 8a - her litre suya 8 ml sulu ekstrakt ilavesi; 8c - her litre suya 8 ml alkollü ekstrakt ilavesi) değerlendirildi. Çalışma, 2x5 faktöriyel deney düzeneğinde (faktör 1: iki farklı yerleşim yoğunluğu; faktör 2: bes katkı seviyesi) düzenlenen ve toplam 375 adet, bir günlük, cinsiyeti belirlenmemiş Ross 308 civcivini içermekteydi. Civcivler, rastgele on farklı muamele grubuna ayrıldı ve her grup üç tekrar halinde değerlendirildi. Beş muamele grubu on civciv içerecek şekilde (yerleşim yoğunluğu: 10 civciv/m²), diğer beş grup ise on beş civciv içerecek şekilde (yerleşim yoğunluğu: 15 civciv/m²) düzenlendi. Sonuçlar, 8c tedavisinin her iki kümes yoğunluğunda da ağırlık artışı, yem verimliliği, ölüm oranları ve ekonomik indeks açısından en etkili olduğunu ve üstün fizyolojik performans sergilediğini gösterdi. Uygulamalar, heterofil (%) ve lenfosit (%) sayılarını önemli ölçüde artırdı ve en iyi yanıtlar 10 tavuk/m² yoğunluğunda gözlendi. 4c uygulaması her iki yoğunlukta da glukoz seviyelerini iyileştirirken, 4a, 4c ve 8c uygulamaları toplam protein ve kolesterol seviyelerinde üstünlük sağladı. 15 tavuk/m² yoğunluğundaki 4c ve 8a uygulamaları, daha yüksek GOT, GPT ve ürik asit seviyeleri gösterdi.

Anahtar Kelimeler: Sulu ve Alkollü Ekstrakt, Maydanoz, Yoğunluk, Büyüme Performansı, Bazı Kan Parametreleri, Antioksidan Durumu

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EFFECTS OF PARSLEY (*Petroselinum crispum*) EXTRACT BY DIFFERENT WAYS IN DRINKING WATER AND STOCKING DENSITY ON GROWTH PERFORMANCE, SOME BLOOD PARAMETERS AND ANTIOXIDANT STATUS OF BROILER CHICKS

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INTRODUCTION

Poultry farming is significantly concerned with oxidative stress, which is a result of the high stocking density. This resulted in delayed avian growth, debris, and elevated humidity levels in the poultry fields. Furthermore, these conditions are the primary cause of respiratory diseases in poultry, such as air vasculitis, when there is a combination of insufficient ventilation and high population density. Pecking may also occur within the herd due to the high Density [1]. Antibiotics have traditionally been used to stimulate growth in poultry feed. Nonetheless, the growth of antibiotic-resistant microbes resulted in a restriction on the use of antibiotic compounds in poultry feed; furthermore, chicken diets mainly include maize and soybean meals [2]. Which are devoid of antioxidants; consequently, incorporating artificial antioxidants into poultry diets mitigates the adverse effects of rigorous environmental conditions. However, the study has demonstrated that synthetic antioxidant compounds may have mutagenic or detrimental effects on poultry[3]. As a result, there is an increasing fascination with natural chemicals that promote growth and antioxidants as alternative treatments [4]. The significance of nutrition research has escalated due to the rising need to boost the productive performance of hens and the prohibition on the use of antibiotics as growth stimulants [5], [6], [7]. Researchers have been intrigued by naturally occurring bioactive compounds because of the extensively established advantages of dietary supplements that include these organic constituents. The advantages include enhanced growth performance, digestive well-being, immunological reactivity, nutritional assimilation, and overall chicken health [8]. The therapeutic capabilities of medicinal plants are attributed to certain chemical compounds found in plant tissues, which profoundly impact the human body or animals. These substances may include alkaloids, aromatic oils, or similar compounds [9]. Medicinal plants include flavonoid compounds, which are highly acknowledged for their value and importance in improving overall health, reducing the risk of diseases, and acting as antioxidants that protect against harmful free

radicals [10]. Parsley, officially identified as *Petroselinum crispum*, is a prime example of a therapeutic plant or botanical species. The foliage of parsley has more significant amounts of volatile oils than the roots. The leaves include mineral salts, iron, calcium, phosphorus, and vitamins A, C, and K. Parsley is thought to possess antioxidant properties due to its many phenolic components and flavonoids. Additionally, it is regarded as advantageous for gastrointestinal well-being and has anti-inflammatory characteristics. Furthermore, it can enhance cardiovascular well-being [11]. The oil derived from the Petroselinum plant has antioxidant properties and serves as a suppressor of free radicals; not only does it help combat the harmful effects of free radicals on the body, but it also provides antioxidant benefits [12]. Parsley leaves have been discovered to contain an oil called myristicin, with apiole being the primary constituent in this oil [13]. The primary objective of this study is to conduct a comprehensive evaluation of the effects of parsley (*Petroselinum crispum*) extract by dıfferent ways ın drınkıng water and stockıng densıty on growth performance, some blood parameters and antıoxıdant status of broıler chıcks. This research aims to investigate the bioactive constituents within parsley and their potential mechanisms for modulating growth parameters and enzymatic antioxidant levels. By elucidating these effects, the study seeks to contribute to developing sustainable, plant-based additives that can enhance poultry health and productivity, potentially reducing the reliance on synthetic growth promoters.

CHAPTER 1

LITERATURE REVIEW

1.1. Oxidative Stress

Oxidation is when atoms, molecules, or ions lose electrons, increasing or decreasing the positive charge. Another definition of oxidation is a chemical process that leads to an increase in the oxygen content of a substance or a decrease in its hydrogen content. During this process, electrons are transferred from the substance to the oxidizing agent, leading to the release of free radicals that can cause damage to cells. Reactive oxygen species (ROS) generated within cells include hydrogen peroxide H_2O_2, hypochlorous acid HCIO, and free radicals such as hydroxyl OH and negative superoxide O-2 [14]. Oxidation is a critically important process in the natural dietary metabolism of animals. Nutrients obtained from food undergo controlled oxidation with precision. The body's tissues consume oxygen to generate heat and release the necessary energy for metabolic processes. Oxidation processes occur within cells, specifically in cellular organelles known as mitochondria.

The energy liberated from the fundamental oxidation process takes the form of adenosine triphosphate (ATP), utilized in numerous cellular processes and for energy transfer[15]. The state of equilibrium exists in producing free radicals and antioxidants within the body under normal conditions. However, oxidative stress occurs when there is excessive stress and strain on the body; this results in an overproduction of free radicals and a deficiency in antioxidants. Oxidative stress represents an imbalance between the production of free radicals and their elimination by antioxidants. This imbalance can lead to tissue damage and animal health problems, ultimately resulting in economic losses [16]. The cell can withstand certain levels of oxidative stress and overcome it by increasing the production of antioxidants within the body. However,

prolonged and excessive oxidative stress leads to continued oxidation and an infinite cascade of free radical reactions, ultimately resulting in oxidative damage to various body cells [15]. The oxidation process increases due to feeds containing rancid fats and an increased proportion of polyunsaturated fatty acids (PUFA), which are susceptible to oxidation.

Additionally, the absence of antioxidants in the diet contributes to increased oxidative processes induced by free radicals. These free radicals break down vital molecules within the body's cells, disrupting the natural balance between the production of free radicals and their neutralization by endogenous antioxidants in the body. This imbalance leads to oxidative stress, which damages DNA, proteins, carbohydrates, and vitamins and oxidizes unsaturated fatty acids in cell membranes [17]. As for oxidation in the diets provided to poultry, it is one of the deteriorating chemical changes that reduces the length of the diet storage period and thus reduces its palatability [18]. Indeed, an increase in free radicals within the human body is associated with a higher risk of certain diseases such as aging, cancer, atherosclerosis, and coronary heart disease. Cell damage due to oxidative stress is more likely when cells cannot effectively limit the production of free radicals. It underscores the importance of maintaining a balance between free radical production and the body's ability to counteract them with antioxidants to mitigate the risk of these diseases [19]. An increase in the production of free radicals within the human body can lead to various diseases, including Parkinson's disease, the progression of factors contributing to human diabetes, and rheumatoid arthritis. It can also result in varying degrees of kidney failure and muscle atrophy [20]. Additionally, continuous increases in free radical production have been found to lead to various forms of cancer. This is believed to result from the interaction of free radicals with DNA, which can lead to genetic mutations that play a significant role in cell dysfunction and the development of malignant diseases [21].

1.2. Free Radicals

A free radical is an expression that refers to any chemical species with a single electron from an electron pair in its outermost orbit [22]. Free radicals are characterized by their ability to initiate a series of reactions that amplify the reality of free radical activity, which leads to the destruction of the necessary macromolecules and cell components in

biological systems and their fragmentation by breaking chemical bonds and interacting with each other to form new compounds that differ from the original [23]. Free radicals are also characterized by irritation and instability. They are of high energy and interact with biological particles in the body quickly, which leads to the emergence of other types of free radicals that, in turn, interact with other cellular compounds like cell membranes, ribosomes, and enzymes [24]. Free radicals cannot be perceived because they are in contact with double polyunsaturated fatty acids (PUFA) and other cellular structures such as protein, fat, lipoprotein, and DNA [25]. Free radicals are classified into two main types. The first type is Reactive Oxygen Species (ROS), which include alkoxyl radicals (RO·), singlet oxygen ($^1O_2$), ozone (O_3), lipid peroxyl radicals (LOO·), hydrogen peroxide (H_2O_2), peroxyl radicals (ROO·), hydroxyl radicals (·OH), and superoxide anions ($O_2^{-}\cdot$). The second type is Reactive Nitrogen Species (RNS), which include hypochlorous acid (HOCl), dinitrogen trioxide (N_2O_3), peroxynitrite ($ONOO^-$), nitrous acid (HNO_2), nitrogen dioxide ($NO_2\cdot$), nitric oxide (NO·), and lipid hydroperoxides (LOOH) [26].

1.3. Generation of Free Radicals

Oxygen is essential for life and indispensable in all bodily cells. It serves as a fundamental oxidizing agent in metabolic reactions aimed at deriving energy from the oxidation of organic molecules. However, oxygen can destroy cells when it generates ROS, which causes cellular damage and ultimately leads to cell death [27]. In a living cell, oxygen undergoes complete reduction to form water by accepting four electrons. However, partially reducing oxygen by accepting two electrons forms hydrogen peroxide (H_2O_2). When oxygen accepts just one electron, it forms the superoxide radical (O-2). Both hydrogen peroxide and superoxide are highly toxic compounds to cells, as they attack the unsaturated fatty acid components of lipid membranes, leading to membrane damage. Aerobic cells protect themselves from the harmful effects of superoxide and hydrogen peroxide through the action of enzymes such as superoxide dismutase (SOD) and catalase (CAT). SOD is an enzyme that contains metal ions and converts superoxide radicals into hydrogen peroxide. CAT, on the other hand, converts hydrogen peroxide H_2O_2 into water and molecular oxygen. The reactions these enzymes catalyze are essential for safeguarding cellular structures from oxidative damage, as described by the equations [28].

$$O_2^- \xrightarrow{PXSOD} H_2O_2$$

$$H_2O_2 \xrightarrow{Catalase} H_2o$$

When cells consume oxygen to generate energy, their function is to generate free radicals as secondary products of ATP synthesis in the mitochondria. The aforementioned byproducts include ROS and reactive nitrogen species (RNS) [27].

1.4. Source of Free Radicals

Several sources generate free radicals, and among these sources are self-generated internal sources as byproducts generated during primary natural food metabolism, such as energy production in the mitochondria and lysosomes or by poisoning by the enzyme system of liver cytochrome [29]. Alternatively, immune cells, macrophage cells, and monocyte cells increase oxygen consumption when stimulated by large amounts produced from (O-2) and released to the extracellular fluid during the action of NADPH oxidase. Free radicals are generated by inflammation, cancer, stimulants, infections, mental stress, excessive exercise, anemia (localized anemia), and aging. Radical peroxide negative (O-2) can split in the presence of the iron and copper ions and then form large quantities of hydroxyl (OH) radicals, as these ions are catalytic energy when combined with reducing substances and then stimulate the oxidation process [30][30]. Free radicals can be generated by oxidative enzymes present in cells, such as xanthine oxidase, which oxidizes hypoxanthine to xanthine and then to uric acid, an enzyme complex of the Flavoenzymes group that also contains an atom of molybdenum and four concentrations of iron-sulfur [31]. NADH dehydrogenase is an enzyme that pulls hydrogen into hydrogen enzymes or electrons from NADH into the subsequent electron carrier. Ubiquinone is the second electron transporter in oxidative phosphorylation. It is found in the inner mitochondrial membrane and contains a linked group firmly attached to this enzyme: Flavin mononucleotide (FMN), the active form of vitamin B_2. Riboflavin is one of the enzymes associated with flavin, the so-called (flavoproteins), in addition to its related group; it contains non-heme iron atoms, which are found in the form of clusters where the iron atom is paired with an equal number of atoms of sulfur. These clusters are called iron-sulfur centers. Cytochrome oxidase, which receives

electrons from cytochrome C and gives them to oxygen directly to complete the electron transfer process, is also a carrier of electrons in the respiratory chain [32].

1.5. Oxidative Damage of free Radicals

Free radicals can harm and destroy vital molecules in body cells, such as proteins, fats, carbohydrates, and nucleic acids. The damage caused by free radicals is of great importance in increasing the formation of these free radicals continuously and through a series of reactions that lead to the destruction of vital molecules in the cell [33]. Free radicals can attack the DNA, causing cell death, and the mutation develops and becomes carcinogenic. The radicals enter into cancer of the lungs, skin, stomach, colon, and esophagus. They attack the fats in the blood and thus lead to cardiovascular disease, as they combine with LDL cholesterol, causing its breakdown and leading to atherosclerosis. The processes that depend on these enzymes become slow or may stop and lead to cell damage and death, causing damage to the mitochondria and thus affecting the ability of the cell to produce the energy it needs to do several functions. Free radicals can liberate nerve toxicants, therefore causing nerve and brain damage that may ultimately result in Parkinson's disease and tremors. The detrimental effects of free radicals on sperm result in infertility and birth abnormalities. It has the potential to induce ulcers and disruptions in the gastrointestinal system, as well as impairment of the liver. It impairs the body's ability to defend against infection and illness. The mitigation of oxidative damage may be achieved by avoiding all forms of environmental pollution, pesticides, smoking, and consuming foods abundant in natural antioxidants [34].

1.6. Oxidation

Oxidation is a natural process in which oxygen combines with any substance, such as the browning of apple slices or the rusting of iron. Chemically, it is a reaction between oxygen and various elements and compounds in nature, during which one or more electrons are lost. We can also say that it is a process of loss of electrons by atoms, molecules, or ions, increasing positive charge or a decrease in negative charge, which means an increase in the percentage of oxygen in the substance or a decrease in the percentage of hydrogen in it, so an electron is transferred from the substance to the oxidizing agent, causing the release of free radicals that causes damage to cells [14]. Oxidation is often essential within the body through interactions in metabolic and

cellular pathways [35]. Alternatively, it may cause damage to it by attacking the molecular oxygen of the double bonds of unsaturated fatty acids in the cell membranes, causing damage to them and thus endangering public health. The oxidation process increases due to feeding on diets containing oxidized fats and increasing the proportion of polyunsaturated fatty acids. Mixed PUFA (Polyunsaturated fatty acids) and the absence of antioxidants in the diet lead to an increase in oxidation processes resulting from free radicals [36]. Moreover, we can say that oxidation is all reactions that use oxygen. It is a chemical process that occurs when electrons are lost from atoms or molecules. The opposite process, reduction, occurs when molecules or atoms gain electrons. Many factors affect the oxidation process, such as temperature, pressure, humidity, and chemical concentration of substances [37]. Oxidation in food means losing electrons from chemical compounds present in food. It can occur due to heat, light, oxygen, and exposure to air. Oxidation causes food spoilage and deterioration of its quality. Vitamins, minerals, amino acids, and essential fatty acids are affected, and thus, food loses its nutritional and health value, and control over food is no longer necessary. Oxidation in food is essential to maintaining food quality and thus benefiting from it. This can be done using natural or artificial antioxidants, which reduce food spoilage by preventing harmful oxidation reactions [38]. Free radicals are the main players in oxidative reactions, and their presence leads to self-perpetuating chain reactions that can inflict significant damage to biological molecules. Free radicals occur naturally and are volatile molecules formed during metabolism. Free radicals are characterized by their irritative nature and instability. This is due to their high energy and intense interaction with vital molecules within the body within a short period. The reason behind this is the high ability of these radicals to gain electrons from other cellular compounds, which leads to the formation of new types of free radicals that, in turn, interact with other cellular compounds such as cell membranes, ribosomes, enzymes, and nucleic acid [39]. Free radicals are divided into two main types. The first is ROS, which includes superoxide radicals (O^{-}_{2}), hydroxyl (OH^{0}), peroxyl (ROO0), hydrogen peroxide (H_2O_2), lipid peroxyl (Loo^{0}), and ozone (O_3), among others. The second type is RNS and includes nitric oxide (NO^{0}), nitrogen dioxide ((No_2^{0}), nitrous acid (HNo2), peroxynitrite (ONOO-), dinitrogen trioxide (N_2O_3), and others[40].

Oxidative reactions can occur in two main areas when producing poultry. The first occurs when feed is oxidized, and the second is during oxidative stress in vivo. Both forms of oxidation can harm the health and performance of birds, leading to a decrease in production and, thus, an economic loss of the product. Moreover, a lack of provision of high-quality meat to consumers, as oxidative reactions in feed mixtures provided to broilers, lead to unpleasant odors and reduced palatability. In vivo, oxidative stress negatively affects the bird's performance, makes it vulnerable to many diseases, and reduces immunity and resistance to infection, such as the phenomenon of wood breast and the associated muscle deterioration in bird muscle meat. In addition, it has been widely proven that oxidative Stress damages tissues, fats, and DNA. Therefore, dietary antioxidants have been used to protect feed from oxidation and reduce some damage associated with oxidative stress in birds [39].

1.6.1. Auto Oxidation

Self-oxidation occurs spontaneously in the living cell, and oxidation is the process of removing hydrogen atoms or electrons by attacking molecular oxygen of the double bonds, such as the fatty acids in the triglycerides that possess one or more double bonds to produce complex products responsible for an unacceptable odor in fats called off-taste. Self-oxidation does not occur in cells for obnoxious fats because they are protected by inhibiting antioxidants or various enzymes (that protect fats). However, this process occurs in some diseases, and this is due to the formation of unusual fatty deposits in the body. The oxidative damage and its products depend mainly on self-oxidation reactions, oxidation products, and the extent to which the food contains unsaturated fatty acids, especially essential fatty acids such as linolenic acid. The oxidation rate increases if unsaturated fatty acids are available because they are susceptible to oxidation due to oxidizing factors or enzymatic systems [36].

1.6.2. Photo Oxidation

It is an alternative method that leads to the formation of hydroperoxides instead of the free radical mechanism through optical oxidation. In this case, light stimulates lipid oxidation or oxygen oxidation. It occurs in sensitizers such as riboflavin and is characterized by hydrogen or electron transfer to produce ionic free radicals [41].

1.6.3. Enzymatic Oxidation

The enzymatic oxidation occurs under the activity of oxidative enzymes such as lipoxygenase (LOX), which controls the peroxidation reaction of polyunsaturated fatty acids forming ROOH, which reacts with oxygen to give the ROO^0 root, which has a strong affinity for interaction with biomolecules [42].

1.7. Antioxidants

Antioxidants are substances that can prevent or delay oxidative damage to proteins, lipids, and genetic material, thereby protecting proteins, genetic material, pigments, carbohydrates, vitamins, and PUFA in cell membranes from damage and harm caused by free radicals within the body [43]. Antioxidants are also known as substances whose function is to scavenge free radicals and remove toxicity from living organisms, or they are materials found in low concentrations that inhibit oxidative and chemical reactions involving oxygen [44]. Alternatively, they are substances whose function is to donate hydrogen to saturate free radicals or any chemical compound capable of accepting the electrons produced from oxidation reactions or oxidative agents [45]. Antioxidants can be known as substances that can prevent or delay oxidative damage to proteins, fats, and genetic material, thus protecting proteins, genetic material, pigments, carbohydrates, vitamins, fats, and PUFA in cell coatings from damage and damage to the body by free radicals inside the body The effect of antioxidants on the living body is not only to promote the overall health of poultry but also to enhance the productivity and meat quality of poultry, especially in intensive production systems and under conditions of oxidative stress, Enhancing antioxidant levels is crucial for mitigating financial losses in the poultry sector and ensuring the production of superior meat suitable for human consumption [18]. Antioxidants also prevent the formation of breakdown products from free radical reactions, which include aldehydes, ketones, alcohols, and acids. They inhibit the oxidation of fats by preventing the initiation of free radical formation, either by breaking or binding those radicals, activating auxiliary factors, or increasing the use of hydrocarbon antioxidants to protect oils, fats, and high-fat foods from oxidation-induced changes in color, taste, odor, and loss of nutritional value. This is especially important due to the high usage of plant oils, primarily PUFAs, in poultry diets. High consumption of these fats increases the need to add antioxidants to the diets[46].In

addition, a diet rich in PUFAs leads to increased levels of these fatty acids in eggs and meat, making them more susceptible to oxidative damage. The oxidation of fats has adverse effects on nutritional and sensory qualities. It reduces the shelf life of meat due to oxidative rancidity, which hurts consumer acceptance of these products [47].

1.8. Mechanism of Antioxidant Action

Antioxidants work according to two main mechanisms. The first mechanism works to break the chain of the free radicals generated by the oxidation of biological components interact by donating a hydrogen atom to the free root in the system, such as the lipid radical, and turning it into a new, more stable root [48]. The second mechanism contributes to the removal of active oxygen and nitrogen initiators by suppressing the triggers to initiate the chain reaction by inhibiting the activity of free radicals (suppressing the activity of active oxygen over ionic oxide O-2) or restricting mineral ions (Gu+, Fe+) Inducing a free radical reaction or inhibition of peroxidase, such as NADPH-oxidase and lipoxygenase [49]. Many phenolic compounds act as hydrogen donors to break the lipid oxidation reaction, and their ability to restrict metal ions stimulates oxidation and thus inhibits the final free radical chain [48]. Antioxidants work in multiple mechanisms, including suppressing free radicals, giving a hydrogen atom or an electron, and decomposing peroxides, thus inhibiting specific enzymes, synergistic reactions, and mineral-holding agents [32].

1.9. Systems of Antioxidants

Antioxidants are generally classified into enzymatic and non-enzymatic antioxidants according to (Figure 1-1) [50].

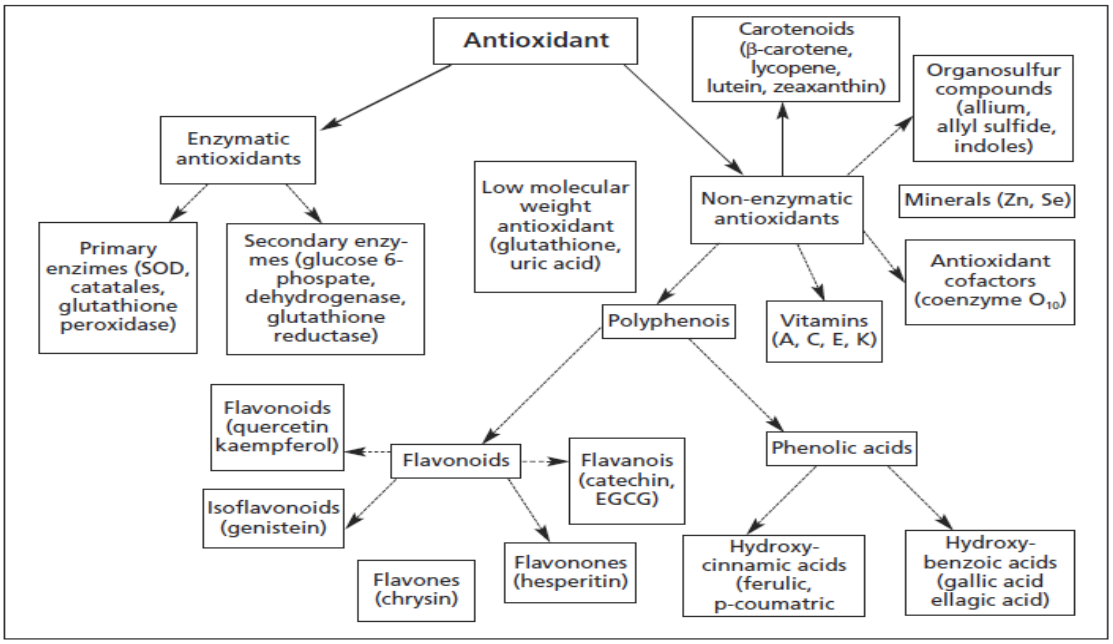


Figure 1.1. Antioxidant classification[50].

1.9.1. Enzymatic Antioxidants

1.9.1.1. Catalase Enzyme (CAT)

This enzyme stimulates the decomposition of hydrogen peroxide, the product of oxidative metabolism, which is given by binding to the free radicals of oxygen, hydroxyl, and oxygen. The CAT enzyme is found in almost all animal tissues, although its most prominent activity is in the liver and red blood cells. This enzyme is also found in mitochondria and the cytoplasm. A molecular weight of 225 kilodaltons. It is a heme protein that contains four iron atoms in four binary units (peptide chains).

Thus, it has a high speed in breaking down H2O2 into water and oxygen,

$$2H_2O_2 \xrightarrow{CAT} 2H_2o + O_2$$

[51].

1.9.1.2. Superoxide Dismutase (SOD)

It is widely distributed in tissue cells characterized by high aerobic metabolism. It stimulates the conversion of free oxygen radicals into partial oxygen and H_2O," and it has a major role in protecting the cell from oxidative stress caused by free radicals."

$$2O^{-}_{2} + 2H \xrightarrow{SOD} 2H_2O_2 + O_{2.}$$

Two types of SOD enzymes have been identified; the first is insensitive to inhibition by cyanide, which reacts with the negative superoxide radical, converts it to H_2O_2 and oxygen, and is found in mitochondria. The second is Cu, Zn-SOD, which is sensitive to cyanide inhibition and is found in the cytoplasm [52].

1.9.1.3. Glutathione peroxidase (GSH-PX)

This enzyme contains an iron protein with a partial weight of 4400 daltons. It contains selenium and is found in the mitochondria and cytoplasm. It has a vital role in inhibiting the formation of hydroperoxides resulting from the action of free radicals with lipids in cellular membranes and protecting DNA from oxidative damage. This enzyme has a role. It is vital to remove H_2O_2 by oxidizing GSH to the recipient H_2O_2 or hydroperoxides, which results in oxidized glutathione (GSSG) and water. Thus, H_2O_2 and hydroperoxide radicals are eliminated, as in the following equation[29].

$$2GSH + R\text{-}O\text{-}OH \xrightarrow{GSH\text{-}} GSSG + H_2o + ROH$$

$$2GSH + H_2O_2 \xrightarrow{GSH\text{-}PX} H_2o + O_2 + GSSG$$

1.9.1.4. Glutathione Reductase (GSH-RD)

This enzyme reconstitutes GSH by reducing oxidized glutathione (GSSG), and a reducing agent is NADPH [52].

1.9.2. Non Enzymatic Antioxidants

1.9.2.1. Antioxidants of Bodily Origin

1.9.2.1.1. Glutathione (GSH)

It is considered one of the most active enzymatic antioxidants and is the primary substance in insulin's oxidative and reductive reactions. It is an important factor in preventing damage resulting from oxidative catabolism. GSH is one of the most widespread sulfur-containing peptides in the cells of the body and consists of three

amino acids: glycine, cysteine, and glutamine, which are a peptide. A triplet containing a Gamma bond between the first and second amino acids (Figure 1-2). GSH resists hydrolysis by peptidase enzymes inside the cell [29]. GSH works as an antioxidant to remove the toxicity of foreign compounds with the help of the enzymes GSH-PX, which maintain the protein thiol state in the cells and help form other antioxidants. Glutathione has a vital role in many reactions, such as the synthesis of proteins and DNA, the growth and reproduction of cells, the regulation of the functioning of the immune system, and the transfer of amino acids. The presence of the sulfur group in its composition is the basis for its biological and biochemical effectiveness, as it interacts directly with many free radicals such as OH, O-2, H_2O_2, and hydroperoxide radicals. Thus, it is considered a scavenger of free radicals, especially the OH radical [53].

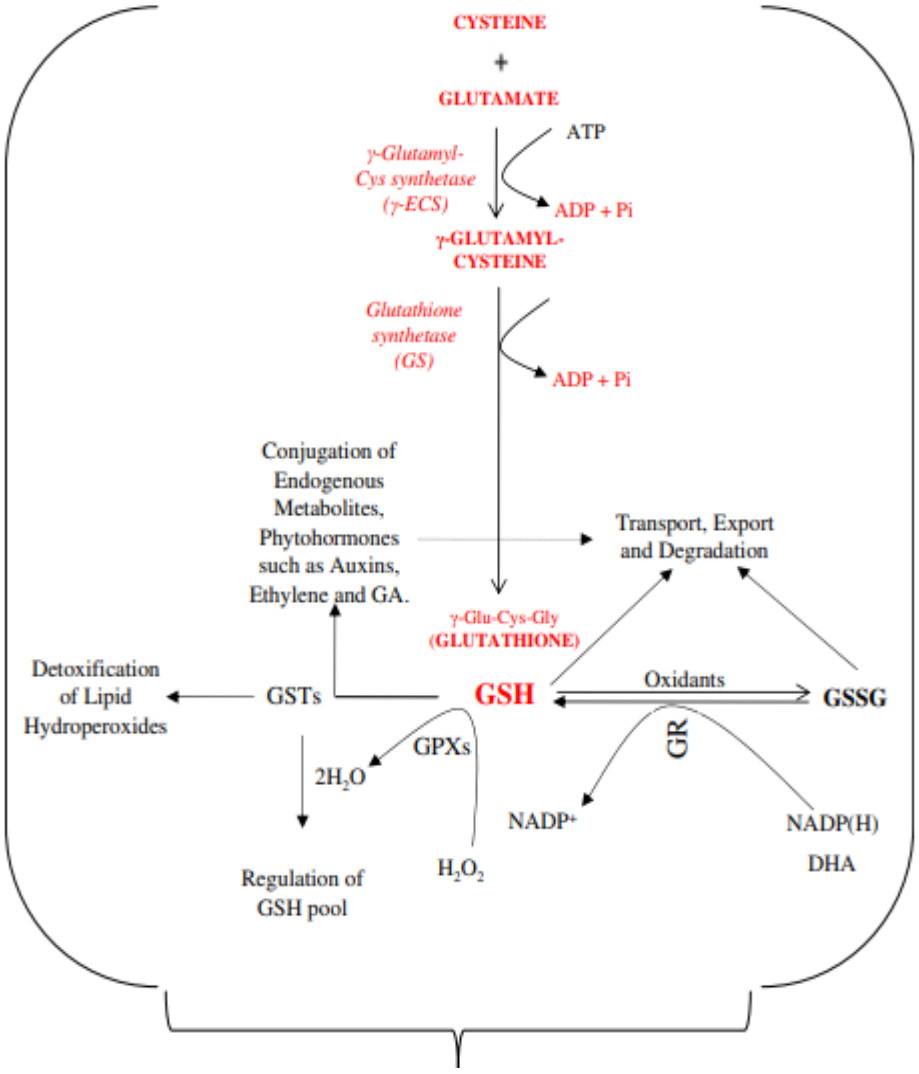


Figure 1.2. Glutathione metabolism [53].

1.9.2.1.2. Nicotinamide Adenine Dinucleotide Phosphate (NADPH)

When G6PD is broken down in the first stage of the phosphorylated pentose sugar production, NADPH is produced and produced in other ways. Its production is necessary to protect cells from oxidative damage by H_2O_2 and harmful superoxide radicals [52]. High oxidation reactions are generated from byproducts of drug metabolism, such as Primaquine, and metabolic action resulting from toxic products, such as divicine, one of the toxic components of fava beans. During natural poisoning, H_2O_2 is converted into water via GSH, the enzyme glutathione peroxidase, and GSSG. This transformation comes with the help of NADPH and the enzyme glutathione. The enzyme catalase also breaks down the resulting hydrogen peroxide reductase, which requires NADPH. NADPH production has a role in protecting and inhibiting hydrogen peroxide poisoning. Cellular damage occurs due to lipid lipoperoxidation, which leads to the breakdown of red blood cell membranes and the oxidation of genetic material proteins. Figures 1-3 show the role of NADPH and GSH in protecting cells from damage and destruction by free radicals (ROS) and the role of NADPH in determining GSH from its oxidized form, GSSG, which is produced by G6P-dehydrogenase enzyme [54].

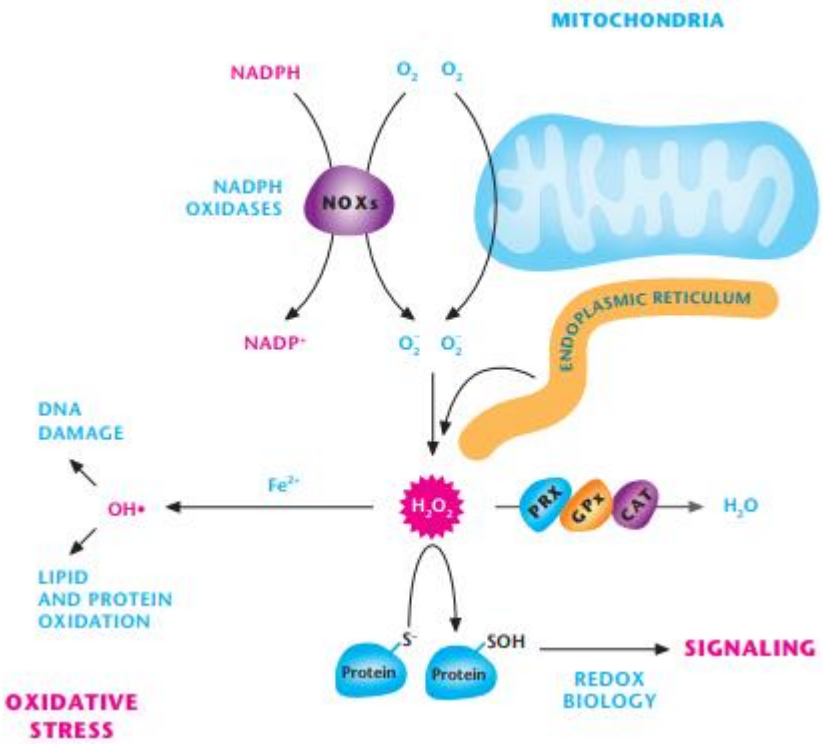


Figure 1.3. NADPH function [54].

1.9.2.1.3. Coenzyme q is Called (Ubiquinone)

Its lipophilic property characterizes it, and thus, it can hunt free radicals arising from the oxidation of fats in cellular membranes. It is found in the inner membrane of mitochondria. The third redox equivalent carrier in the respiratory chain is coenzyme Q (COAQ). It is found in all cells, and when it prevents the enzyme NADH dehydrogenase, which reduces electrons during the iron-sulfur conjugate to COAQ becomes, the latter is reduced to ubiquinol or QH2 with the oxidized form regenerated from NADH dehydrogenase [52]. There are also other non-enzymatic antioxidants in blood plasma, uric acid, proteins, and peptides such as carnosine and homocarnosine, which are highly efficient antioxidants in muscle tissue. There are many metal-binding proteins, as they bind to free metal ions such as Cu^{+} Fe^{+2}, "which plays a role in the generation of free radicals when they are in their free form" and their transfer from body fluids into the cell, including lactoferrin and transferrin, which are found in secretory fluids such as seminal plasma, oviduct fluids, and nasal secretions. Ferritin is Responsible for transporting the ferrous ion Fe^{+2}. At the same time, the ceruloplasmin protein binds the copper ion Cu^{+}, and both hypotaurine and taurine are final products of sulfur-containing amino acids that are present inside the cell and work to scavenge free radicals [55].

1.9.2.2. Nutrition of Antioxidants

Other non-enzymatic antioxidants come from food and are divided into industrial and natural antioxidants.

1.9.2.2.1. Synthetic Antioxidants

Synthetic antioxidants are important substances in the nutrition and food industries. These substances are used to delay the deterioration of food due to oxidation caused by oxygen. They are also used as antioxidants in chemical, pharmaceutical, and other industries [54]. Antioxidants work by removing oxidant molecules from the vital system. They thus can reduce the harmful effects of free radicals and limit the damage that oxidation can cause in the body. Thus, they contribute to maintaining a healthy organism [56]. The most famous are vitamin E and vitamin C, as vitamin E delays the oxidation process in fats, proteins, and carbohydrates. On the other hand, vitamin C is

widely used, as these vitamins work to remove the free radicals formed before they enter the reaction chain. In addition, some minerals, such as antioxidants, play an important role. When it interacts with some enzymes, such as selenium, magnesium, zinc, and copper, some amino acids, such as methionine, act as antioxidants to protect the liver from damage. However, excessive amounts of it may harm the liver and expose it to oxidative Stress [57]. In addition, there are other industrial antioxidants, such as butylated hydroxytoluene(BHT), butylated hydroxyl anisole(BHA), and propyl gallate (PG), which are used in the animal feed industry [18]. BHT is a phenol in which the phenolic ring contains di-tert-butyl groups, which are very effective antioxidants [58]. BHT and BHA are fat-soluble antioxidants that are stable at high temperatures, which makes them useful in feeding as antioxidants. They prevent the spread of peroxyl radicals and thus prevent self-perpetuating chain reactions [59]. The European Commission set the rate of adding BHA and BHT to the final feed at 150 grams per ton, as BHA and BHT work together to stop the chain reaction, especially in broiler feed, because it contains oils [39]. Propyl gallate (PG) and tertiary butyl hydroquinone (TBHQ)are phenolic compounds containing two or more hydroxyl groups that bind to free radicals to form peroxide and hydroperoxide. Propyl gallate (PG) Is used in the food and animal feed sector. The European Commission has set a maximum limit of 100 gm tons in the final feed. There are limited studies that show Some carcinogenic activity and potential liver damage at high doses [60]. PG is often used with BHT and HHA due to its synergistic action as an antioxidant [61].

1.9.2.2.2. Natural Antioxidants

Naturally occurring antioxidants may shield the organism from harm induced by free radicals arising from oxidative stress. Commonly, they are categorized as phenolic compounds, including flavonoids and phenolic acids, vitamins such as tocopherols, ascorbic acid, and carotenoids, and volatile compounds, which are present in herbs and spices [62]. The antioxidants with the most effective effect are those that contain two or more phenolic hydroxyl groups in their structure, as in herbs and spices, as antioxidants that suppress free radicals mainly based on these free hydroxyl groups in the formation of flavonoids [63]. One of the main phenolic compounds is flavonoids, considered among the most prominent natural antioxidants. They are polyphenolic secondary metabolites found in plant foods to a large extent, such as red and yellow onions, most

citrus fruits such as oranges, lemons, and grapefruit, and in apples, beans, grapes, pears, and soybeans [64]. The number of these phenolic compounds at present has reached 5000 compounds, and they differ among themselves in terms of the number of hydroxyl groups (OH) and their locations on the molecule. Flavonoids are glycosidic compounds, and the non-sugar part of the flavonoid glycoside consists mainly of the flavonoid compound and its derivatives, which is benzopyron, known as chromone (Chromon, which gives color to the plant, and most of the glycosides of this group dissolve in water. Therefore, they color the plant sap in the cell with their colors and contribute to giving the attractive color and taste to many fruits and vegetables; the general formula of flavonoids is (C6C3C6), which consists of two aromatic rings linked to carbon with three carbon units as in the figure (Figure 1-4) [65]. Flavonoids are known as vitamin P, and some flavonoids, such as rutin, possess properties similar to vitamins, as they affect the stability and permeability of capillary blood vessels, returning them to their normal state and reducing bleeding. Flavonoids, which are one of the main phenolic compounds, play an important role in protecting fats from oxidation by breaking down The oxidation reaction series, as it quickly reacts with the peroxide radical by giving it a hydrogen atom from the phenolic hydroxyl group, Although the alkoxyl radical is formed, it is inactive because it is unable to sustain the continuation of the reaction. In addition, it can be removed from the system through its reaction with another radical, which gives almost constant inactive radical products. Flavonoids, in addition to their ability to hydrogen atoms, can hold metal ions (chelate metal) to form complexes with metal elements such as iron and copper, which are among the elements that help in the occurrence of self-oxidation of fats. Flavonoids act as metal-absorbing substances (or chelating substances) found in oils and fats due to their contamination from tanks, pipes, and various manufacturing equipment. Thus, flavonoids work to get rid of these pollutants and thus prevent or delay the occurrence of the phenomenon of rancidity [66]. In addition to the above, some vitamins, including vitamins E and C, show effectiveness as antioxidants, and many herbs and spices, including *Petroselinum crispum*, contain compounds that are effective as natural antioxidants [67].

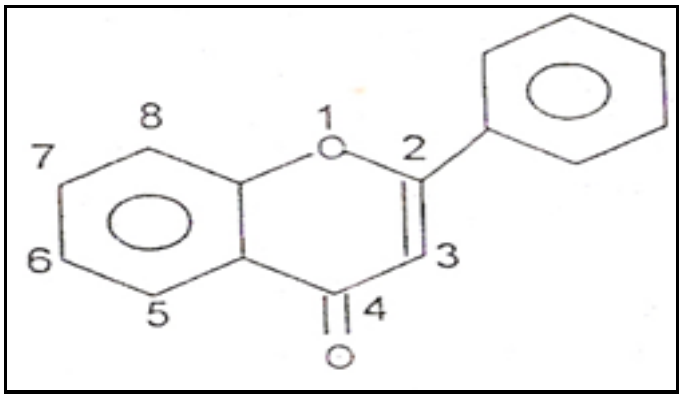


Figure 1.4. General chemical structure of flavonoids[65].

1.10. Parsley (*Petroselinum Crispum*)

Parsley *(Petroselinum crispum*) is a biennial plant with a height ranging from 25 to 80 cm every two years (cylindrical stem from 30 to 60 cm). It belongs to the Apiaceae family. The green leaves are divided into large or lobed segments, depending on the variety (Arabic Parsley, Chinese Parsley, coriander) [68]. Its small yellow flowers can be seen in September. Parsley requires partial shade and exposure to sunlight. It is easily cultivated in vegetable gardens, farms, and apartments [69]. Its original habitat is the Mediterranean region (Spain, Italy, Greece, Malta, Algeria, Tunisia, and Morocco), but it has been introduced for cultivation worldwide [70]. The concentration of essential oils in parsley leaves is much greater than in the roots. In addition, the volatile oils found in parsley leaves include a high concentration of mineral salts such as iron, calcium, phosphorus, and vitamins A and C. Recent scientific studies have emphasized parsley's therapeutic and medicinal properties and its nutritional significance. Recent studies have demonstrated that parsley is a potent cellular antioxidant, safeguarding cells against cancer. It enhances the immune system due to its high vitamin C content, which is four times more than that found in lemons. Furthermore, it boasts elevated levels of flavonoids and a specific compound called Apigenin, which curbs the division of cancerous cells, thereby contributing to disease treatment and mitigating its spread [71]. Three prevalent variations (*P. crispum var. crispum, var. neapolitanum, and var. Tuberosum*) serve diverse purposes. These encompass its role as a garnish and even as a root vegetable [70].

Parsley was discovered around 5000 years ago. It was recognized as a plant with stimulating and diuretic properties. Its cultivation spread to Western Europe and

subsequently to other temperate regions. Since the 15th century, the French appreciated parsley's culinary attributes.

Also, parsley alleviates nausea, stomach pains, and even high blood pressure. It is employed for soothing rheumatism, menstrual discomfort, and digestive disorders [69]. Furthermore, it is recognized as an aromatic, culinary, and medicinal plant. Its applications extend to the pharmaceutical, perfume, and cosmetic industries. It serves as a significant dietary reservoir of vitamins and essential nutrients; its volatile compounds, such as myristicin and apiole, are accountable for their medicinal applications [72]. In traditional medicine, parsley is acknowledged as possessing diuretic, uterine stimulant, sedative, emollient, and antiparasitic properties. It addresses various human ailments [73]. Apigenin is known as a flavonoid in parsley, with its antioxidative, antimutagenic, and anticancer effects.

Parsley contains a substantial amount of lutein, beta-carotene from the carotenoid family, and potent antioxidants [74]. Experimental studies conducted by a team of experts have shown that parsley antagonist, derived from plant oil, acts as an antioxidant and inhibits free radicals [12]. Numerous studies have attempted to uncover the secrets of parsley, revealing that parsley leaves contain an essential oil named myristicin, which is of utmost importance. One of the most significant compounds within this oil is apiole. Additionally, parsley leaves contain vitamins A, B_1, B_2, B_3, B_4, C, iron and calcium salts, and iodine, as documented by [13]. Extracts have demonstrated that parsley leaves are highly effective as antibacterial agents against harmful bacteria and cationic dyes such as gram-positive bacteria, as well as certain fungi, as noted by [75]. The significance of parsley goes beyond these points. It extends to treating other conditions, such as addressing anemia due to the plant's abundance of iron and folic acid. Additionally, it aids in fat dissolution and promotes bile secretion in the liver. Moreover, parsley is a diuretic [76].

1.11. Active Compounds in Parsley

Parsley contains volatile oils, constituting 0.004-0.4% in its leaves and 2-8% in its seeds. These oils contain various compounds, the most important ones being apiol and myristicin (15) and flavonoids, with a quantity of 100 mg/100 g of fresh parsley [77]. It includes both flavonols (kaempferol and quercetin) and flavones (apigenin, luteolin).

Additionally, parsley contains terpenes (α-pinene and β-pinene), myrcene, and coumarin[13]. As shown in Table (1-1), parsley contains active compounds rich in mineral elements (calcium, potassium, iron). It also contains vitamin C, which is found in a large percentage equivalent to 4 times its percentage in lemon, which helps the body increase resistance to colds and bronchitis, in addition to containing vitamin A, which is equivalent to 918 micrograms/100 grams, which is an amount that exceeds the basic need of an adult human. The World Health Organization recommends setting a minimum of 750 micrograms, a group of vitamins (B_1, B_2, B_6), and folic acid [78]. Parsley also contains the ring structure of some active compounds in its leaves, as in the figure(1-5) [79].

Table 1.1. Active compounds in all parts of parsley [80].

	Part of the plant	Leaf	Herb	Root	Fruit
Phenylpropanoids	apiol	+	+	+	+
	myristicin	+	+	+	+
	elemicin	+	-	+	+
	1-allyl-2,3,4,5-tetramethoxybenzene	-	+	-	+
	eugenol	-	-	-	+
Monoterpenes	β-phellandrene	+	+	+	+
	p-mentha-1,3,8-triene	+	+	-	-
	4-isopropenyl-1-methylbenzene	+	-	-	-
	myrcene	+	+	-	+
	α-pinene	+	+	+	+
	β-pinene	+	+	+	+
	α-phellandrene	+	+	-	-
	p-cymene	+	-	-	+
	terpinolene	+	+	+	-
	α-terpinene	+	-	-	-
	myrtenyl acetate	+	-	-	-
	limonene	+	+	+	+
	α, p - dimethylstyrene	-	+	-	-
	sabinene	+	-	-	+
	γ-terpinene	+	-	-	+
Sesquiterpenes	(*E*)-β-femesene	+			
	germacrene D	+			
	angelic acid esters	+			
	α-copaene	+			
	α and β-cubebene	+		-	
	γ-elemene	+	-		-
	α-humulene	+			
	γ-amorphene	+			
	α-, γ- and δ-cadinene	+			
	germacrene A	-		+	
	β- bisabolene	+		+	
	carotol	-		-	+

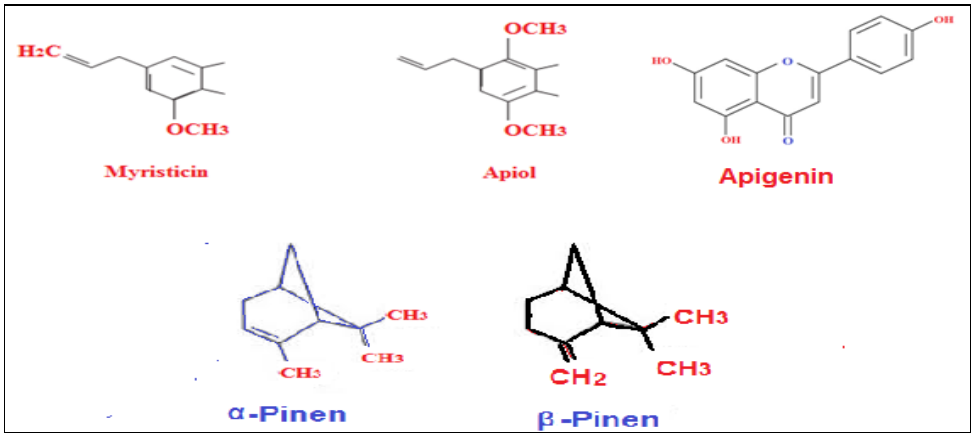


Figure 1.5. The ring structure of some active compounds in parsley leaves [79].

1.12. Medical Importance of the Parsley Plant

Scientific knowledge has currently expanded on the therapeutic and medical significance of parsley, in addition to its nutritional importance. Most experiments and research confirm that parsley is an antioxidant, protecting cells from cancer and enhancing the immune system [81]. This is due to its content of volatile essential oils, including myristicin, which has demonstrated effectiveness against cancer cells in the body. Furthermore, parsley contains high levels of flavonoids, especially Apigenin, which has shown powerful antioxidant, anti-inflammatory, and anti-tumor properties, inhibiting the proliferation of various human cancer cells, including breast, lung, liver, prostate, stomach, and blood cells [80]. Parsley is also considered a cell rejuvenator and aids the body in detoxification, helping to eliminate toxins [82]. Fresh parsley leaves contain various essential vitamins such as pantothenic acid (B_5), riboflavin (B_2), niacin, pyridoxine (B_6), and thiamine (B_1). These vitamins play a crucial role in carbohydrate metabolism and the nutritional breakdown of fats and proteins by acting as enzymatic cofactors within the human body[83].

It activates the digestive system by functioning as an antioxidant and inhibiting the growth and proliferation of harmful bacteria (Escherichia coli, Salmonella, Staphylococcus aureus, Vibrio cholera), as well as certain types of fungi [72]. Several studies have indicated that parsley is a potent diuretic that inhibits the potassium and sodium pump. This inhibition can reduce the absorption of these elements, resulting in the osmotic flow of water into the cavity and increased urine output [84]. It is also an

anti-hyperglycemic agent, exhibiting a protective effect against liver toxins caused by complications of diabetes[85]. And an anticoagulant [86].

1.13. Effect Extract Parsley on Broiler Productive Performance

A research study was conducted on broiler chickens, and the results revealed that supplementing the broiler feed with 3 g/kg of parsley seeds significantly improved ($p<0.05$) productive characteristics. No significant differences were observed in the qualitative traits of the meat [87]. In addition, adding 0, 5, 10, and 15 ml of parsley plant water extract per 1 liter of drinking water for broiler chickens led to a significant increase ($P<0.05$) in some productive performance indicators "body weight, weight gain, feed intake, feed conversion ratio." However, there was a significant decrease ($P<0.05$) in the overall mortality rate compared to the control group when treated with an aqueous extract of parsley leaves [10]. A study also indicated that adding (3, 6, and 9 grams of parsley/kg feed) led to a significant increase in the chemical composition of breast and thigh meat ($P<0.01$) at high rates. Also, adding parsley as a feed additive significantly enhances physical characteristics compared to Parsley-free control treatment [88]. A study also confirmed that adding (12 gm parsley/kg feed) significantly affected body weight and weight gain, and feed conversion efficiency and intake improved numerically compared to the control group throughout the study period. Where the highest weights of thigh and carcass were obtained [89]. The study, with the following treatments: (T1 - control diet without parsley oil addition, T2 - diet with the addition of 150 mg/kg parsley oil, T3 - diet with the addition of 300 mg/kg parsley oil, T4 - diet with the addition of 450 mg/kg parsley oil), revealed a statistically significant superiority ($p<0.01$) in live body weight for T3, the treatment with 300 mg/kg parsley oil, during weeks 3, 4, and 5. T3 also showed a significantly superior overall weight gain rate and significantly improved ($p<0.05$) compared to T1 and T2. Additionally, treatments T2 and T3 outperformed others in feed conversion ratio during weeks 4 and 5, with no significant differences observed in total feed conversion ratio, feed intake, dressing percentage, and the relative weight of primary and secondary carcass [90].

1.14. Effect of Extract Parsley on Broiler Physiological Performance

A study indicated that adding 3 g/kg of parsley seeds to the diet of broiler chickens recorded a significant decrease in cholesterol concentration and no significant differences in biochemical blood characteristics between the experimental treatments [87]. In another study, the parsley plant had a positive effect on the blood characteristics of Iraqi geese, as there was a significant improvement ($p<0.05$) in the blood characteristics, especially the percentage of lymphocytes responsible for immunity [91]. In a study on quails under different treatments, "0% (control), 0.5%, 1%, and 1.5% parsley seeds, respectively," the second treatment showed a significant decrease in albumin and cholesterol concentrations. However, the fourth treatment exhibited a significant superiority ($p<0.05$) in the AST enzyme, triglycerides, and total white blood cell count [92]. The results of a study indicated that dietary parsley leaves at 1000 and 1500 mg/kg feed led to a significant improvement ($P<0.05$) in the total protein, albumin, and globulin concentration. It was concluded from this experiment that adding parsley leaves at an amount of 1000 and 1500 mg/kg feed kg of feed to the ration can lead to improving the biochemical characteristics of the blood serum of broilers [93].

CHAPTER 2

MATERIAL AND METHOD

This study was conducted in the laboratories and fields of the College of Agriculture / University of Anbar, with the aim of the effects of parsley (*Petroselinum crispum*) extract by dıfferent ways ın drınkıng water and stockıng densıty on growth performance, some blood parameters and antıoxıdant status of broıler chıcks.The experiments were conducted as follows:

2.1. Laboratory Part of Experiment

The laboratory part of the experiment was conducted from November 13, 2022, to February 17, 2023, to obtain and analyze parsley plant material. Parsley plants were harvested, dried, and subjected to chemical composition analysis. Aqueous and alcoholic extractions were performed to identify active compounds within the plan.

The purpose of the laboratory part was to extract the aqueous and alcoholic extract of parsley and prepare it for the field experiment, which involved adding it to drinking water for broiler chickens.

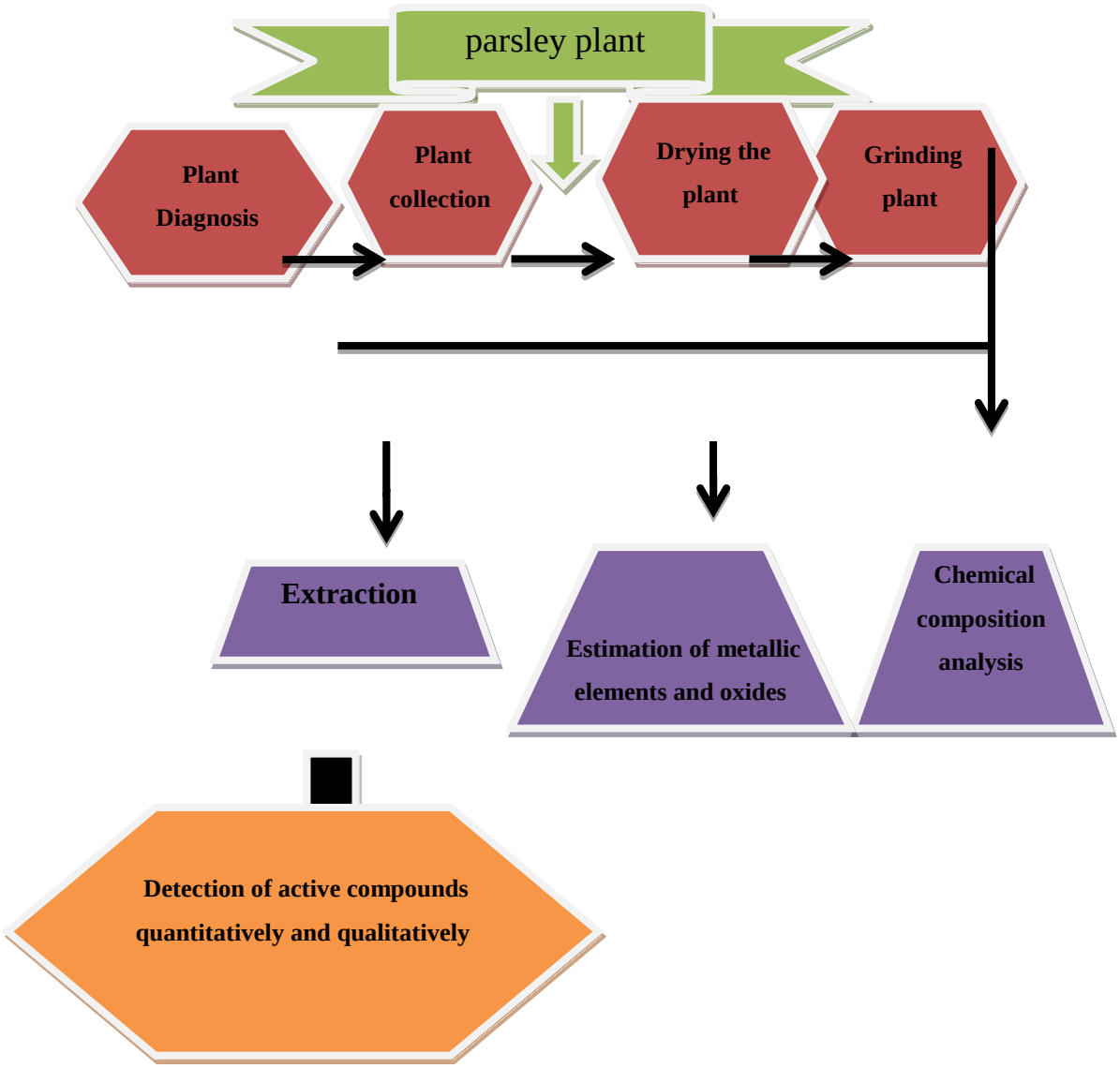


Figure 2.1. Scheme of the first experiment

2.1.1. Source of Parsley Plant (*Petroselinum crispum*)

The parsley plant was obtained from the farms of Anbar Governorate in Iraq, and the plant was identified in the herbarium of Anbar University, where the botanical classification was confirmed by the Department of Horticulture and Landscape Engineering / College of Agriculture / Anbar University. The parsley plant was collected in large quantities and then dried on aluminum foil away from light. There was an airflow, and it was stirred every three hours to speed up the drying process. This process continued until complete drying. After that, I stored the dried plants in clean, tightly sealed bags in a clean place at room temperature until used in Figures (2-2) and (2-3).



Figure 2.2. Collect, clean, dry, and crush of parsley plants (*Petroselinum crispum*)



Figure 2.3. Parsley plants (*Petroselinum crispum*)

2.1.2. Extraction

2.1.2.1. The Process of Aqueous Extraction of Parsley

10 grams of dried parsley powder was immersed in distilled water and cooked over low heat for 2 hours. The mixture was then filtered through eight layers of muslin and centrifuged at 5000 rpm for 10 minutes. The supernatant was collected. The operation was done twice. After 6 hours, the supernatant was collected at 2-hour intervals, pooled, and concentrated to provide a final amount of one-fourth the original volume. It was then autoclaved at 121°C under 15 lb pressure and kept at 4°C [94].

2.1.2.2. The Process of Alcoholic Extraction of Parsley

10 grams of dried parsley powder were dissolved in 100 ml of organic solvent (ethanol) in a conical flask, plugged with cotton, and shaken at 190-220 rpm for 24 hours. After 24 hours, it was filtered through eight layers of muslin fabric and centrifuged at 5000 rpm for 10 minutes. The supernatant was collected, and the solvent was evaporated to

reduce the final volume to one-fourth of the original volume, which was then kept in airtight bottles at 4 °C." [94].

2.1.3. Drying the Extract

Alcoholic extracts were desiccated by placing the samples onto glass Petri dishes and transferring them to a laboratory oven set at 40°C for 24 hours. Subsequently, the desiccated extracts were preserved within sterilized laboratory receptacles until they were utilized in the experimental procedures.

2.1.4. Chemical Estimation of Parsley Components

2.1.4.1. Moisture

The [95] methodology executed the determination of moisture content. A precise quantity of 30.05 grams of the specimen was meticulously measured and placed onto a covered ceramic dish. Subsequently, the dish was introduced into a convection oven set to operate at 105°C until a constant weight was attained. The percentage of moisture content was computed using the subsequent formula:

$$\textbf{Moisture\%} = \frac{\text{Weight prior to desiccation - Weight after desiccation}}{\text{Weight of pre-drying sample}} \times 100$$

2.1.4.2. Ash

The established procedure [95] was adopted to measure ash content by introducing 5 grams of the investigated herb onto a ceramic dish with a lid. Subsequently, the dish was incinerated at $550^{\circ C}$ until a greyish-white ash was obtained. The percentage of ash content was subsequently calculated using the following formula:

$$\text{Ash \%} = \frac{\text{Ash weight}}{\text{Sample weight before incineration}} \times 100$$

2.1.4.3. Oil

The crude oil percentage was determined following the procedure outlined in [95]. The Soxhlet apparatus was employed for this purpose. Approximately 10 g of the specimens under investigation were enclosed within filter paper and put in the apparatus. The extraction was conducted using hexane as a solvent for 5-6 hours. After the extraction, the solvent was excluded using a rotary evaporator, and the oil content was subsequently weighed, enabling the percentage calculation. This calculation was performed using the subsequent equation.

$$\text{Crude oil \%} = \frac{\text{Weight of the oil extract}}{\text{Sample weight}} \times 100$$

2.1.4.4. Protein

One gram of crushed parsley plant material was accurately weighed and transferred into a glass cylinder. Subsequently, 10 milliliters of concentrated sulfuric acid and 3 milliliters of concentrated perchloric acid were added. The mixture was allowed to stand for 10 minutes before being transferred to a heating apparatus to facilitate digestion. After digestion, the sample was diluted with distilled water to a final volume of 50 milliliters. The diluted sample was then analyzed using a Kjeldahl apparatus to determine the nitrogen content. The nitrogen value obtained from the Kjeldahl analysis was multiplied by a conversion factor of 6.25 to calculate the crude protein content using the following equation.

$$\text{Crude protein percentage} = \frac{\text{Kjeldahl apparatus value}}{\text{Sample weight (milligrams)}} \times 100 \times 6.25$$

2.1.5. Estimation and Detection of Oxides and Some Metallic Elements of the Plant

Estimation and detection of oxides and some metallic elements in the Petroselinum plant by SPECTRO X-epos. This device receives samples in the form of powder, and to obtain high accuracy for the analysis, the powder is compressed and converted into a pellet disc. This work uses a special piston with a pressure of five tons [95].

2.1.6. Detection of Some Active Compounds in Aqueous and Alcoholic Extracts

Diagnostic tests were conducted on the concentrated aqueous and alcoholic extracts to identify their specific compounds.

2.1.6.1. Steroids

This involved adding 2 ml of anhydrous acetic acid and 2 ml of concentrated sulfuric acid to 0.5 ml of the extract. A color change from violet to green or blue indicated the presence of steroidal compounds [96].

2.1.6.2. Tannins

One milliliter of the extract was combined with 10 ml of distilled water in a test tube and vigorously shaken for 20 minutes. The mixture was filtered, and 2 ml of the extract was transferred to a separate test tube. 3 ml of distilled water was added, and the mixture was vigorously shaken. Subsequently, two drops of the solution were introduced, followed by the addition of dilute ferric chloride. The formation of a notably dark precipitate was observed as an indication of the presence of tannins [96].

2.1.6.3. Saponins

Two milliliters of the concentrated extract were mixed with 6 ml of distilled water in a test tube and vigorously shaken. The foam formation on the mixture's surface indicated the presence of saponins [96].

2.1.6.4. Flavonoids

Two milliliters of the concentrated extract were put into a test tube, followed by a few drops of concentrated ammonia. The appearance of a yellow coloration indicated the presence of flavonoids [96].

2.1.6.5. Carbohydrates

The method for ascertaining the presence of carbohydrates within the samples involved the addition of 1 ml of iodine solution to 3 ml of the extract into a test tube. It is essential to observe that the development of a blue coloration subsequently transpires, serving as a conclusive indication of the presence of carbohydrates [96].

2.1.6.6. Terpenes

A solution of 2 ml chloroform and 3 ml of concentrated sulfuric acid was prepared. With the addition of 5 ml of the extract, the appearance of a reddish-brown layer indicates the presence of terpenes [96].

2.1.6.7. Phenols

Three milliliters of plant extract were added to 2 ml of 1% ferric chloride solution. The appearance of a bluish-green color indicates the presence of phenols [96].

2.1.6.8. Resins

Ten ml of plant extract was added to 20 ml of distilled water acidified with 4% hydrochloric acid (HCL). The presence of resins is indicated by the appearance of turbidity [96].

2.1.6.9. Alkaloids

Ten grams of the plant material were heated in 50 milliliters of distilled water acidified with 4% hydrochloric acid. The solution was chilled, clarified, and analyzed for alkaloids using Meyer's reagent. The presence of alkaloids was revealed by forming a white precipitate [96].

2.1.7. Determination of Minerals in Aqueous and Alcoholic Extract of Parsley

Minerals estimated included calcium, sodium, iron, copper, zinc, potassium, and manganese. The process was done by incinerating 3 grams of dried parsley ground from the samples at a temperature of 550° C until white ash was obtained. Then, the resulting ash was dissolved by adding 5 ml of 5% nitric acid and mixing it well. Then, the mixture was filtered, 1 ml of the filtrate was taken, and the volume was completed with distilled water to 10 ml. The metallic elements were analyzed using an atomic absorption spectrophotometer according to the standard method recommended by [97].

2.1.8. Determination of Some Compounds in the Extracts Using (GC-Mass) Analysis

Aqueous and alcoholic extracts of the plant material were analyzed, and the active Vehicles were separated using a gas chromatography device integrated with a mass spectrophotometer based on the method followed [98]. The conditions used in the separation were as follows: Capillary column dimensions: InertCap 1MS mm 0.25, m 30, µm 0.25), Injection volume: µl 5, Mobile phase carrier gas helium, Constant flow rate: (ml/min 1), Then active compounds were diagnosed by comparing these compounds that appeared in the extracts with the standard compounds using a computer program with the device type NIST spectra mass l search program for the NIST/EPA/NIH mass spectral library version 2.0 f / 2008 and NIST08.LIB.

2.2. The Field part of the Experiment (field)

This study investigated the effect of *Petroselinum crispum* extract in different ways in drinking water and stocking density on the broiler's productive and physiological performance and antioxidant status. 375 unsexed ROSS 308 broiler chicks were randomly allocated to 10 treatments, each with three replicates. Chicks were raised in cages within the broiler field of the Department of Animal Production, College of Agriculture, University of Anbar, from February 25, 2023, to April 7, 2023.

2.2.1. Experimental Design

The study included 375 one-day-old unsexed ROSS 308 chicks, randomly distributed in a factorial experiment of two factors (2×5). The first factor is stocking density, which consists of two treatments (10 and 15 birds per square meter). The second factor is additives, which include five treatments (0, 4a, 4c, 8a, 8c), each with three replicates (0 - control treatment without additives; 4a - addition of 4 milliliters of aqueous extract per liter of water; 4c - addition of 4 milliliters of alcoholic extract per liter of water; 8a - addition of 8 milliliters of aqueous extract per liter of water; 8c - addition of 8 milliliters of alcoholic extract per liter of water). Chicks were randomly assigned to 10 distinct treatment groups. Each treatment group was further divided into 3 replicates, resulting in a total of thirty experimental units. Five treatment groups comprised 10 chicks each, while the remaining five groups contained fifteen chicks, thereby ensuring equitable

exposure to all treatments. All these additives were supplemented into the drinking water of broilers. The chicks were given free access to food and water. Broilers were raised in a temperature-controlled environment, and the pen area was 1×1 m. To create a controlled experimental environment, temperature and humidity levels were carefully maintained throughout the 42-day experimental period. The initial temperature was set at 34°C and gradually reduced by 2°C each week until it reached 22°C. Relative humidity was consistently kept within a range of 45 to 55%.

Chicks were meticulously selected based on specific criteria. Only healthy individuals, free from pre-existing diseases or conditions that could compromise the study's integrity, were included. All chicks were of the same age, one day at the commencement of the experiment, to establish a uniform baseline for growth and development. Moreover, to eliminate genetic variability as a potential source of variation, chicks were sourced from a single commercial broiler strain, ROSS 308. The treatments were distributed within the field as follows (Figure 2-4).

Chicks were vaccinated against Newcastle and Gumboro diseases using vaccines diluted in dechlorinated water. The vaccines were administered via either spraying or drinking water. Water was withheld from the chicks for two hours before each vaccination to ensure accurate dosing. Vitamins A, D3, and E were provided after each vaccination.

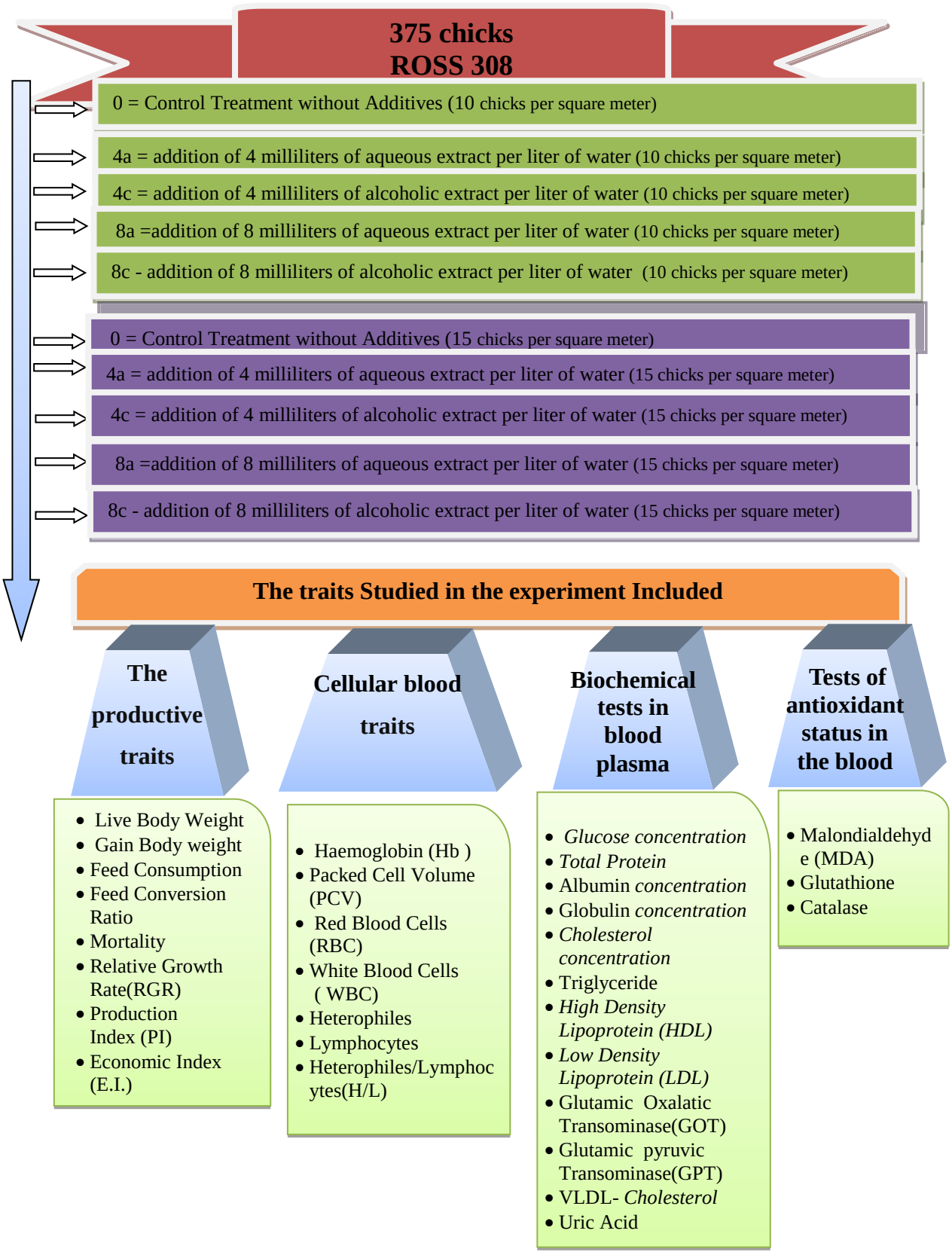


Figure 2.4. Scheme of the field part of the experiment

2.2.2. Poultry Management

The field designated for breeding was cleaned with water and detergents several times, and then the windows were left open to dry the field. It was then sterilized by burning with direct flame using a heat source (peeler) to eliminate pathogens. The breeding field was also sterilized with formalin and potassium permanganate, making sure to close all the field outlets and leave for three days; after that, air exhausts were operated for ventilation and to get rid of the odors of the materials used for sterilization. The field was equipped with 75-watt lamps to provide uniform lighting. Chicks received continuous lighting (24 hours per day) during the first week, followed by a gradual reduction to a 23-hour light cycle to acclimate them to a period of darkness. The chicks were distributed randomly within the cages (30 cages), each cage having an area of 1 square meter. One section of the cages contained 10 chicks in each cage, and the other contained 15 chicks in each cage. The chicks were raised on a sawdust mattress 4-5 cm thick. At a temperature of 30 to 36 °C and a relative humidity of 45 to 55%, they used gas incubators with a diameter of 120 cm. The incubators were distributed at equal distances inside the field to provide a suitable temperature for the chicks. The temperature was gradually reduced by two °C each week to reach 22 °C. At 42 days old, ventilation was used inside the field through windows and fans on both sides, which are used when needed.

2.2.3. Nutrition and Water

Feed was provided (*ad libitum*) to the chicks directly from the first day; for each replicate, a plastic dish with a diameter of 38 cm was used, which was replaced at 10 days of age with a circular plastic suspension feeder with a diameter of 45 cm, which was constantly raised to the top to be at the level of the bird is back. The diet was synthesized, and the chemical analysis of the diet was conducted as in (Table 2-1); according to the NRC (1994), water was provided through an inverted manual plastic siphon with a capacity of 4.5 liters. A siphon was placed inside each cage (pen), which was used in the experiment from the first day until three weeks of rearing; then, it was replaced with an inverted manual plastic siphon with a larger capacity; the aqueous and alcoholic extract of the parsley plant was added to drinking water.

Table 2.1. Components and chemical composition of the diets (starter and Finisher) used in the experiment 1-42 days.

Feed material %	Starter feed 1-21 days	Finisher feed 22-42 days
Yellow corn	50.74	50.74
Wheat	7	9.5
*Soybean meal 48%	32	28
**Animal protein Concentrate 40%	5	5
Corn oil	3	4.5
Limestone	0.5	0.5
Dicalcium phosphate	1.41	1.41
Salt	0.09	0.09
Methionine	0.13	0.13
Lysine	0.13	0.13
Total	100	100
Chemical composition calculated based on NRC(1994)		
Metabolizable Energy	3072	3184
Crude protein%	22.63	20.98
Crude fat%	2.67	2.69
Crude fiber%	2.68	2.60
Calcium	0.77	0.76
Total phosphorus%	0.75	0.74
Lysine%	1.34	1.24
Methionine%	0.63	0.61
Cysteine	0.37	0.35
Cysteine + methionine	1.01	0.97
Available phosphorus	0.50	0.49

*The soybean meal used is of Argentinian origin; the protein content is 48% and 2230 kilocalories kg-1. Metabolizable energy.

** The Dutch company Holland (imported) produces the animal protein concentrate. It contains 40% crude protein, 2107 kilocalories per kg-1 Metabolizable energy protein, 5% crude fat, 2.20% crude fiber, 4.20% calcium, 2.65% phosphorus, 3.85% Lysine, 3.70% methionine, 4.12% methionine + cysteine. It contains a mixture of rare vitamins and minerals that meet the bird's needs for these elements.

2.2.4. Vaccination Program

The chicks were vaccinated with the Newcastle and Gumboro vaccines following the vaccination program (Table 2.2). These vaccines were diluted with chlorine-free water, which was given by spraying and drinking water. The water was cut off from the chicks two hours before each vaccination to ensure that the chicks took the specified dose of the vaccine.

Table 2.2. Vaccination program used in the experiment

Age in days	Vaccines
1	Newcastle + Infectious Bronchitis (IB) mixed vaccine (Lasota strain) via spraying
1,2,3	An anti-inflammatory agent (Anrosol) was administered in drinking water at 2 ml/5 liters
7	Gumboro 78 light strain Lasota vaccine was administered through drinking water
10	Newcastle + IB mixed vaccine (Lasota strain) by spraying
14	Gumboro 78 light strain Lasota vaccine was administered through drinking water
21	Newcastle + IB mixed vaccine (Lasota strain) by spraying
31	Newcastle (Lasota strain) by spraying

*Vitamins A, D_3, and E were given after each vaccination

2.2.5. Parsley Plant (*Petroselinum Crispum*)

The parsley plant was dried and ground with an electric grinder. It was extracted in two ways: aqueous and alcoholic. Then, the extracts are added to drinking water in different concentrations (Without addition, 4 ml aqueous extract/liter of water, 8 ml alcoholic extract/liter of water, 4 ml aqueous extract/liter of water, 8 ml alcoholic extract/liter of water).

2.2.6. The Studied Traits

2.2.6.1. Characteristics of Productive Performance

2.2.6.1.1. Live Body Weight

All chicks were weighed weekly using a sensitive balance for all replicates of the experiment after starving the birds for 2-3 hours [99], which is as follows:

$$\text{Live Body weight (GM)} = \frac{\text{The total live weight at the end of the week}}{\text{. The number of birds at the end of the week}}$$

2.2.6.1.2. Gain Body Weight

The weight gain of one repetition per week was calculated according to the equation mentioned by [99], which is as follows:

Gain Body weight = Average body weight at the end of the week - average body weight at the beginning of the week

2.2.6.1.3. Feed Consumption

The amount of feed consumed weekly was calculated according to the equation provided by [99], which is as follows:

Feed consumption = feed added at the beginning of the period - feed remaining at the end/number of birds in one replicate.

2.2.6.1.4. Feed Conversion Ratio

calculated the feed conversion ratio for each replicate every week using the equation presented by [99], as follows:

FCR = Total feed consumed (g) / Total live weight gain (g)

2.2.6.1.5. Mortality Ratio

The Mortality was recorded, weighed as they occurred, and calculated as a percentage weekly according to the equation provided by [99], which is as follows:

MR = (Number of dead chicks / Total number of chicks) * 100

2.2.6.1.6. Relative Growth Rate (RGR)

The relative growth rate was calculated for one replicate per week and the period from 1-42 days, as mentioned by [100], according to the following equation:

RGR = (ln(W2) - ln(W1)) / (t2 - t1)

Where:

- **W1:** Initial weight of the broiler chickens
- **W2:** Final weight of the broiler chickens
- **t1:** Initial time
- **t2:** Final time

2.2.6.1.7. Production Index (PI)

The production index was calculated by applying the equation indicated by [99], which is as follows:

$$\mathbf{PI}= \frac{\text{Average body weight (g)} \times \text{vitality percentage}}{\text{Number of days of raising} \times \text{Feed Conversion ratio} \times 10}$$

2.2.6.1.8. Economic index (E I)

The economic index was computed using the equation specified by [99], which is as follows:

$$\mathbf{EI}= \frac{\text{Total weight of marketed birds (kg)}}{\text{Number of marketed chickens x length of raising period (day) x feed conversion ratio}} \mathbf{x100}$$

2.2.6.2. Physiological Traits

Blood samples were collected from one bird per replicate on day 42 of the experimental period using the brachial vein of the wing. Samples were anticoagulated with Ethylene Diamine Tetraacetic Acid (EDTA) and centrifuged to separate plasma and cellular components. Cellular blood parameters (hemoglobin, packed cell volume, red blood cells, white blood cells, heterophiles, lymphocytes, and heterophiles/lymphocytes) were assessed. Then, blood samples were centrifuged to separate plasma and cellular components. Biochemical parameters (glucose, total Protein, albumin, globulin, cholesterol, triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL), very-low-density lipoprotein (VLDL), glutamic oxaloacetic transaminase (GOT), glutamic pyruvic transaminase (GPT), and uric acid) were assessed. Antioxidant status was evaluated by measuring malondialdehyde, glutathione, and catalase levels.

2.2.6.2.1. Cellular Blood Tests

Blood samples from one bird for each replicate were drawn randomly from the brachial vein of the wing. Then, the blood samples were placed in a tube containing the anticoagulant ethylene diamine tetraacetic acid (EDTA) to perform cellular blood tests.

2.2.6.2.1.1. Haemoglobin (Hb g /dl)

20 microliters of blood samples were used with 5 ml of Drabkin's reagent and incubated for 5 minutes. The solution was centrifuged, and the absorbance was measured at 540 nm using a spectrophotometer. The hemoglobin concentration was determined by comparing the absorbance to a standard hemoglobin curve. The reading was done according to the method indicated by [101].

2.2.6.2.1.2. Packed Cell Volume (PCV)

The capillary tubes open at both ends, containing EDTA anticoagulant, were filled with blood from one of their openings up to two-thirds for each sample. This was achieved by placing them horizontally in a blood tube, allowing blood to flow through the capillary property. Subsequently, they were placed in a Micro Centrifuge device and centrifuged at a speed of 5000 revolutions per minute for 5 minutes to separate serum from the cellular component of the blood. The percentage of the cellular component to the whole blood was determined using a special ruler, where the cellular component represents the volume of compressed cells (Packed Cell Volume), including red and white blood cells and platelets [101].

2.2.6.2.1.3. Red Blood Cells (RBC)

A cell counting process for red blood cells was conducted using a specialized pipette containing a chamber with a red ball. Blood was drawn into the chamber up to the 0.5 mark and then diluted solution until reaching the 101 mark. This indicates a 200-fold dilution of the blood. Gentle pipette agitation was then performed for two minutes to mix the blood with the solution inside the chamber. The first three drops were discarded as they represented only the solution. One drop of the mixture was then placed in the well under the cover glass of the Hemocytometer. The spread of the solution under the cover glass was observed, and after the cells settled, the cell count was determined using a light microscope with a magnification power of X100. Their blue-stained cytoplasm and pink-stained nuclei identified red blood cells. Cell counting was performed within 5 out of 25 squares on the counting chamber. The center square and the remaining four squares at each corner represented the sample. The following equation was then applied:

$$\text{The number of red blood cells in (1) mm}^3\text{ of blood} = \frac{N}{5} \times 25 \times 200 \times 10$$

Whereas the:

N = total number of red blood cells in five squares.

5 = the number of squares in which the cells were counted.

25=total number of squares.

200 = number of dilutions.

10= To convert the calculated volume of red blood cells from 0.1 mm^3 to 1 ml^3.

Prepare the Natt and Harrick solution shown in Table 2.3 by dissolving the below materials in 1 liter of distilled water in the following proportions. Shake the solution well and leave it for the next day, then filter it using filter paper. Thus, the solution is ready for use.

Table 2.3. Components of Natt and Harrick's solution were used to count red and white blood cells [102].

Materials	**Concentration**
NaCl	3.88 gm
Na_2SO_4	2.5 gm
$Na_2HPO_4.12H_2O$	2.9 gm
KH_2PO_4	0.25 gm
Formalin (37%)	7.5 gm
Methyl violet 2B	0.1 gm

2.2.6.2.1.4. White Blood Cells (WBC)

The same method was used to calculate the number of red blood cells, except for the dilution, which was 20 times, by adding one part of the blood to 20 parts of the Natt and Herick solution. The numbers of blue-colored white blood cells stained with the color of the methyl violet dye present in the solution were counted in the four squares. "White blood cells were counted in all four squares of the Neubauer counting chamber, as they appeared dark blue and granular. The total white blood cell count was calculated using the equation" [102].

WBC count (cells/µL) of blood = (N/4) x 20 x 10

The: N = total number of white blood cells calculated from the four squares.

4 = the number of large squares in which the count was made.

20 = number of dilutions.

10 = to convert the calculated volume of white blood cells from 0.1 mm^3 to 1 ml^3.

2.2.6.2.1.5. Heterophiles

A drop of blood from the test tube containing EDTA was placed on the glass slide using a capillary tube, and the drop of blood was distributed on the slide using a second slide. It was placed directly on the drop and pulled over the first slide at an angle of 45 degrees without putting pressure on it. Then, the slide was stained with Wright-Giemsa stain as indicated by Shen and Patterson (1983), and the slide was left for ten minutes to dry. Then, the slide was read using an optical microscope with magnification power (100x) by placing a drop of oil on the slide according to what was reported by Burton and Guion 1968; the number of heterogeneous cells was then counted [103].

2.2.6.2.1.6. Lymphocytes

A drop of blood from the test tube containing EDTA was placed on the glass slide using a capillary tube, and the drop of blood was distributed on the slide using a second slide. It was placed directly on the drop and pulled over the first slide at an angle of 45 degrees without putting pressure on it. Then, the slide was stained with Wright-Giemsa stain as indicated by Shen and Patterson (1983), and the slide was left for ten minutes to dry. Then, the slide was read using an optical microscope with magnification power (100x) by placing a drop of oil on the slide; the number of lymphocyte cells was then counted according to what was reported by [103].

2.2.6.2.1.7. Heterophiles/Lymphocytes (H/L)

A drop of blood from the test tube containing EDTA was placed on the glass slide using a capillary tube, and the drop of blood was distributed on the slide using a second slide. It was placed directly on the drop and pulled over the first slide at an angle of 45

degrees without putting pressure on it. Then, the slide was stained with wright-giemsa stain as indicated by Shen and Patterson (1983), and the slide was left for ten minutes to dry. Then, the slide was read using an optical microscope with magnification power (100x) by placing a drop of oil on the slide. The ratio of heterophil cells to lymphocytes H/L using the following equation and according to [103].

$$\text{The ratio of heterophil cells to H/L lymphocytes} = \frac{\text{Number of neutrophil cells}}{\text{Number of lymphocytes}}$$

2.2.6.2.2. Biochemical Tests in Blood Plasma

Blood samples were centrifuged at a speed of 3000 rpm for 15 minutes to separate the plasma from the cellular part of the blood to conduct some biochemical tests, which include Glucose concentration (glucose, total Protein, albumin, globulin, cholesterol, triglycerides, high-density lipoprotein (HDL), low-density lipoprotein(LDL),very-low-density lipoprotein(VLDL), glutamic oxaloacetic transaminase(GOT), glutamic pyruvic transaminase (GPT), and uric acid).

2.2.6.2.2.1. Glucose Concentration

The concentration of glucose in blood plasma was estimated according to the method mentioned by[104], where the steps listed with the kit manufactured by Biosystems-Spain were carried out using a spectrophotometer device at a wavelength of 505 nm, and the glucose concentration was calculated according to the following equation.

$$\text{Glucose concentration (mg dl)} = \frac{\text{Sample absorbance}}{\text{Absorbance of standard sample}} \times 5 \text{ (standard solution)}$$

2.2.6.2.2.2. Total Protein

The total Protein in blood plasma was estimated using ready-made analysis materials (Kit) manufactured by Biosystems-Spain and a spectrophotometer. At a wavelength of 546 nm, as the method adopted for this process is the same as that stated [105], by reacting the carbonyl group directly with an alkaline copper solution to form a compound that has a purple color, this measurement was made by applying the following equation.

$$\text{Total protein concentration } \left(\frac{g}{dl}\right) = \frac{\text{Optical absorption of the sample}}{\text{optical absorption of standard solution}} \text{ x 6 (standard solution)}$$

2.2.6.2.2.3. Albumin *Concentration*

The process of estimating the concentration of albumin in blood plasma using the analysis kit (Kit) manufactured by Biosystems-Spain, which is an enzymatic method. The reading has been done using a spectrophotometer set at a wavelength of 628 nm. The albumin has been calculated using the following law [105].

$$\text{Albumin concentration}\left(\frac{g}{dl}\right) = \frac{\text{Optical absorption of the sample}}{\text{optical absorption of standard solution}} \text{x5(standard solution)}$$

2.2.6.2.2.4. Globulin Concentration

Globulin concentration in blood plasma was calculated using the following equation and according to [105].

Globulin concentration (g/100 ml) = total protein concentration – albumin concentration

2.2.6.2.2.5. Total Cholesterol Concentration

The method of enzymatic cholesterol degradation was followed according to the method [105], using the analysis kit (Kit) manufactured by Biosystems-Spain an enzymatic method. The reading was done using a spectrophotometer at a wavelength of 500 nm, and the cholesterol concentration was calculated according to the following equation.

$$\text{Total Cholesterol concentration}\left(\frac{mg}{100}\text{ml plasma} = \frac{\text{the optical absorbance of plasma sample}}{\text{optical absorption of standard cholesterol solution}} \times 100\text{(concentration of standard solution)}\right.$$

2.2.6.2.2.6. Triglyceride

According to the enzymatic method proposed by [105], to estimate the concentration of triglycerides in blood serum, the analysis kit (Kit) manufactured by Biosystems-Spain

was used. The reading was done using a spectrophotometer at a wavelength of 546 nm, and according to the concentration of triglycerides, the following equation was applied.

$$\text{Triglyceride (mg/100 ml plasma)} = \frac{\text{optical absorbance of plasma sample}}{\text{optical absorption of cholesterol solution}} \times 200(\text{ standard solution})$$

2.2.6.2.2.7. High-density Lipoprotein (HDL)

The enzymatic analysis method was followed to measure the concentration of high-density lipoprotein (HDL) in blood plasma according to the method [106]; this was done using various analysis kits manufactured by Biosystems-Spain. The enzymatic method readings were taken using a spectrophotometer at a wavelength of 500 nanometers, and HDL was calculated based on the following equation.

$$\text{HDL concentrati(ng 100 ml)} = \frac{\text{optical absorbance of plasma sample}}{\text{optical absorption of standard cholesterol solution}} 50\times101$$

2.2.6.2.2.8. Low Density Lipoprotein (LDL)

The method proposed by [107] was employed in measuring the concentration of low-density lipoprotein (LDL) according to the following equation:

The LDL (mg/100 ml) concentration =Total Cholesterol Concentration − (VLDL Concentration + HDL Concentration) Where VLDL=TG/5.

2.2.6.2.2.9. Glutamic Oxalatic Transominase (GOT)

The GOT enzyme was estimated using the method [108], which used pre-packaged analysis kits manufactured by BioSystems -Spain. This method relies on the enzyme's ability to convert aspartic acid into oxaloacetic acid, which spontaneously converts to pyruvic acid. The latter then reacts with the compound 2,4-dinitrophenyl hydrazine (DNPH) to form a reddish-brown collared complex. The absorbance was measured at a wavelength of 546 nanometres and expressed in international units per litter (IU/L).

2.2.6.2.2.10. Glutamic Pyruvic Transaminase (GPT)

The method involved using pre-packaged analysis kits manufactured by Bio Systems-Spain. This approach relies on colorimetric measurement to assess the enzyme's activity

by measuring pyruvic acid levels derived from alanine; the pyruvic acid reacts with the compound DNPH, forming a reddish-brown collared complex. This complex is measured at a wavelength of 546 nanometres and quantified in international units per litter (IU/L), following the established method [108].

2.2.6.2.2.11. VLDL- *Cholesterol*

To measure the concentration of very low-density lipoprotein, I used the ready-made standard kit produced by the Spanish company Bio-System, according to the method indicated [107]. The following equation was applied to calculate the vLDL concentration.

VLDL = (LDL+HDL)_CHOLESTEROL.

2.2.6.2.2.12. Uric Acid

The enzymatic analysis method for uric acid was followed using pre-packaged analysis kits (Kit) manufactured by Bio Systems-Spain. The enzymatic method employed a spectrophotometer at a wavelength of 520 nanometres for the readings. The concentration of uric acid was calculated using the following equation.

$$\textbf{Uric acid (mg/dl)} = \frac{\text{optical absorbance of plasma sample}}{\text{optical absorption of cholesterol solution}} \times \text{Standard solution}$$

2.2.6.2.3. Tests of Antioxidant Status in the Blood

Following the experiment's conclusion, three birds were randomly chosen from each treatment group. After a 12-hour fasting period, 5.0 mL of blood was extracted from a wing vein and placed into tubes containing EDTA. The blood samples underwent centrifugation at 1,500 × g for 10 minutes, and the resulting plasma samples were preserved in 1.5 mL microtubes at -20°C until further analysis.

2.2.6.2.3.1. Malondialdehyde (MDA)

The MDA concentration in the TBARS assay was determined using the TBA method, following the procedure outlined by [109]. Cayman's assay kit facilitated the process, involving the mixing of 0.5 mL of plasma with 2.5 mL of 20% trichloroacetic acid and 1

mL of 67% TBA. The mixture was then subjected to a hot water bath at 95 ˚C for 30 minutes. After cooling, 4 mL of butanol was added, mixed, and centrifuged at 2000 × g for 10 minutes. Following the supernatant collection, optical densities were measured spectrophotometrically at 532 nm.

2.2.6.2.3.2. Glutathione

The glutathione (GSH) concentrations in blood plasma were assessed using the HPLC method developed by[110]. In summary, protein precipitation was achieved through perchloric acid, followed by a reaction of thiols with iodoacetic acid to produce S-carboxymethyl derivatives. The supernatant underwent derivatization of amino groups using 1-fluoro-2,4-dinitrobenzene, determining glutathione and oxidized glutathione (GSSG) was based on the retention. Times of authentic standards and concentrations were calculated from the integrated peak areas.

2.2.6.2.3.3. Catalase

Blood samples were collected from broiler chickens and put into heparinized tubes to prevent clotting. The blood was centrifuged at a low speed (1500 × g) to separate the plasma from cellular components. The plasma was carefully transferred to clean tubes, ensuring no contamination with blood cells occurred. The reaction mixture was prepared by creating a phosphate buffer solution (pH 7.0) and diluting the hydrogen peroxide solution to an appropriate concentration (e.g., 30 mM).In the assay procedure, a cuvette was used to mix 0.9 mL of phosphate buffer with 0.1 mL of the blood plasma sample. The reaction was initiated by adding 10 µL of the diluted hydrogen peroxide solution to the cuvette. The contents were then mixed quickly and thoroughly. The absorbance was measured by assessing the decrease at a specific wavelength (e.g., 240 nm) over a suitable period (e.g., 1-3 minutes). Both the initial and final absorbance values were recorded. The formula was applied to calculate catalase activity [111].

$$\text{Catalase Activity} = \frac{\text{Change in absorbance per minute}}{\text{Catalase standard slope solution}} \times \text{Dilution Factor}$$

2.2.6.3. Statistical Analysis

A Two-Way Analysis was conducted, the first addressing the impact of two storage treatments on the measured traits and the second examining the influence of four

additive factors on the studied traits. This was achieved using the General Linear Model and the statistical software SAS, version 9. Significant differences between means were tested using Duncan's multiple range test [112] at a significance level of ($P \leq 0.05$), following the mathematical model.

$Yijk = \mu + Ai + Bj + ABij + Eijk$

Yijk: Observation value k for the studied trait corresponding to the effect of treatment i from storage factor A and treatment j from additive factor B.

μ: Overall mean of the trait.

Ai: Effect of treatment i from storage factor A.

Bj: Effect of treatment j from additive factor B.

ABij: Interaction effect between treatment I from storage factor A and treatment j from additive factor B.

CHAPTER 3

RESULTS

3.1. Chemical Evaluation of Parsley

3.1.1. Chemical Estimates of the Parsley Plant Components

The parsley plant's chemical analyses revealed its moisture, ash, oil, and protein content, as indicated in Figure 3.1. The percentages were as follows: moisture 81%, Ash 8%, oil 2%, and Protein 9%.

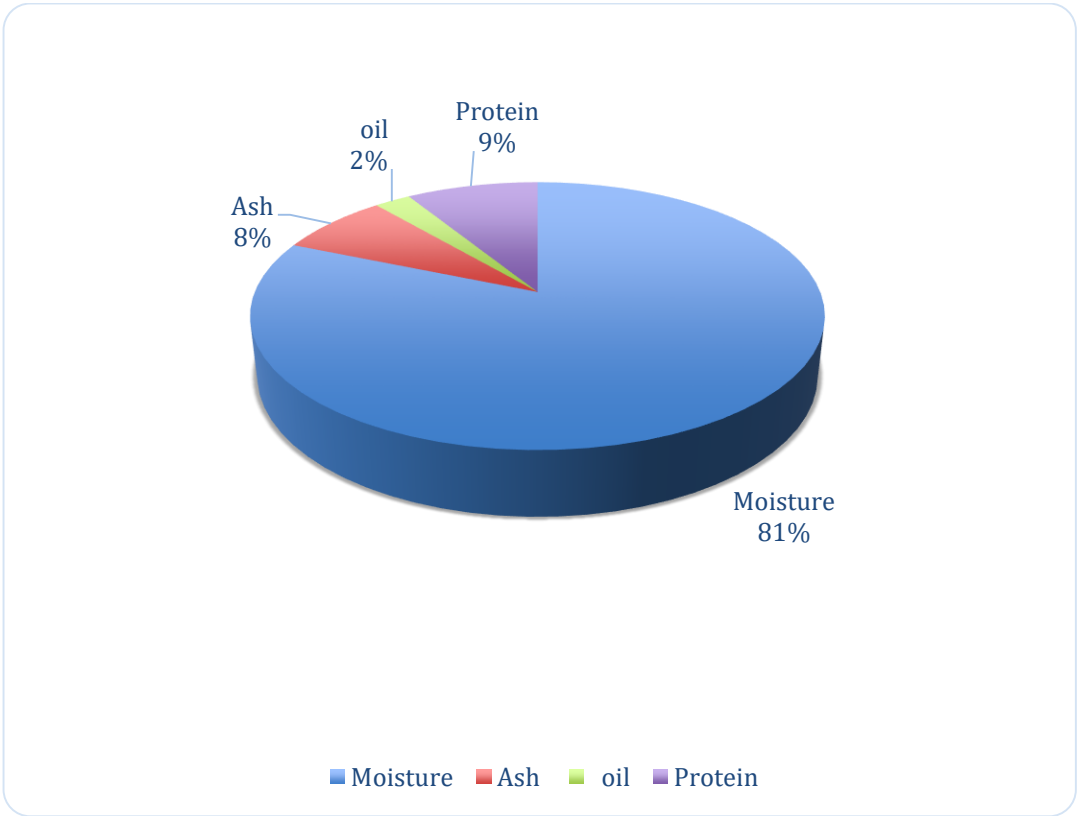


Figure 3.1. Results of chemical estimation analyses for parsley plant

3.1.2. Estimation and detection of oxides and some metallic elements of parsley

As shown in Table 3.1. the estimation of the oxides of certain mineral elements in parsley plants is Magnesium (2.158%), Aluminium (0.0673%), Silicon (1.345%), Phosphorus (1.521%), Sulphur (2.148%), Chlorine (2.650%), Potassium (7.922%), Calcium (4.605%), Titanium (0.0303%), Vanadium (0.0020%), Chromium (0.00070%), Manganese (0.01116%), Iron (0.1843%), Cobalt (0.00039%), Nickel (0.00212%), Copper(0.00216%), Zinc(0.00530%), Selenium(0.00005%), Bromine (0.00842%) and Iodine (0.00052%).

Table 3.1. The percentages of some mineral elements in the whole parsley plant

N	Element	Concentration %
1	Magnesium	2.158
2	Aluminum	0.0673
3	Silicon	1.345
4	Phosphorus	1.521
5	Sulfur	2.148
6	Chlorine	2.650
7	Potassium	7.922
8	Calcium	4.605
9	Titanium	0.0303
10	Vanadium	0.0020
11	Chromium	0.00070
12	Manganese	0.01116
13	Iron	0.1843
14	Cobalt	0.00039
15	Nickel	0.00212
16	Copper	0.00216
17	Zinc	0.00530
18	Selenium	0.00005
19	Bromine	0.00842
20	Iodine	0.00052

3.1.3. Detection of Some Active Compounds in Aqueous and Alcoholic Extracts of Parsley

The results are in Table 3.2. The aqueous parsley extract contains many compounds, such as saponins, flavonoids, carbohydrates, terpenoids, phenols, resins, and alkaloids. However, steroids were not present in parsley's aqueous extract. The results are in Table 3.2. Also, the alcoholic parsley extract contains many compounds, such as steroids,

saponins, flavonoids, carbohydrates, terpenoids, phenols, resins, and alkaloids. However, saponins were not present in parsley's alcoholic extract.

Table 3.2. Qualitative detection of some active compounds in the aqueous and alcoholic extracts of parsley

n	Active compounds	Aqueous extract	Alcoholic extract
1	Steroids	-	+
2	Tannins	+	-
3	Saponins	+	
4	Flavonoids	+	+
5	carbohydrates	+	+
6	Turbines	+	+
7	Phenols	+	+
8	Resins	+	+
9	Alkaloids	+	+

*The symbol (+) indicates the presence of the exposed compound in the sample.
*The symbol (−) indicates the sample's absence of the exposed compound.

3.1.4. Determining of Som Minerals and Heavy Metals in Parsley Extract

The results of the parsley content of some minerals and heavy metals present in aqueous and alcoholic extracts are shown in Table 3.3. Parsley plants contain good amounts of the essential elements. The aqueous extract contains higher Na, Ca, Fe, and Cu concentrations, but K, Mg, and Zn concentrations were comparable.

Table 3.3. Some minerals and heavy metals in aqueous and alcoholic extracts of parsley

n	Element	Aqueous extract mg/L	Alcoholic extract mg/L
1	Sodium	151	39.7
2	Potassium	283	285
3	Calcium	138	100
4	Iron	12.63	8.166
5	Manganese	1.36	1.40
6	Copper	0.323	0,109
7	Zinc	0.814	0.880

3.1.5. Determination of Some Compounds in Aqueous Extracts of Parsley

Table 3.4 shows the results of (the GC-MS) analysis of the aqueous extract of the parsley plant. This extract contained various active compounds like acids, esters, and other organic compounds. Alcohols, especially those with low molecular weights, were

also present. The area percentages of the major components of the aqueous extract were 7.7% for butoxy hydroxy-, butyl ester, 1-propanol, 2,2-dimethyl acetic acid, butyl 14-methylhexadecanoate, o-n-butyl hydroxylamine, and 2-heptafluorobutyroxydodecane; 17.52% for methyl esters of 9-octadecenoic acid and some of its isomers; 11.32% for butyl 14-methylhexadecanoate, o-n-butylhydroxylamine, 2-heptafluorobutyroxydodecane; 9.52 for 2-trifluoroacetoxytetradecane, o-n-butylhydroxylamine, cyclohexane, 1R-acetamido-2,3-cis-epoxy-4-cis-formyloxy-, and other compounds with fewer area percentages.

Table 3.4. Results of GC-MS analysis of aqueous extract of parsley

n	% Area	Compounds
1	2.48	Ethyl formate,Oxirane,(ethoxymethyl)- Methyl Alcohol
2	2.71	Ethyl formate, Methyl Alcohol, Oxirane (ethoxymethyl)
3	2.17	Ethyl formate, Methyl Alcohol, 1-ethoxy-2,2,2-trifluoro Ethanol -
4	3.69	(ethoxymethyl) - Oxirane, Ethyl formate Hydrazinecarboxylic acid, ethyl ester
5	1.94	2- methyl,(S)-1-Butanol , 1-hydroxy-2-butanone , Azetidine
6	1.95	Acetic acid, butoxy hydroxy-, butyl ester , n-Hexane , 1-Butanol, 2-methyl-, (S)-
7	7.70	Acetic acid, butoxy hydroxy-, butyl ester , 1-Propanol, 2,2-dimethyl , n-Hexane-
8	2.06	butoxyethanol - (2,4,5-Trichlorophenoxy)acetic acid ester, n-Hexane, Acetic acid, butoxy hydroxy- butyl ester
9	3.06	n-Hexane, 1-Propanol, 2,2-dimethyl-
10	2.28	(2,4,5-Trichlorophenoxy)acetic acid butoxyethanol ester, n-Hexane, 1-Propanol, 2,2-dimethyl-
11	2.80	n-Hexane, 1-Propanol, 2,2-dimethyl-
12	17.52	9-Octadecenoic acid, methyl ester, 11-Octadecenoic acid, methyl ester, cis-13-Octadecenoic acid, methyl ester
13	2.02	n-Hexane , Acetic acid, butoxy hydroxy-, butyl ester , 1-Butanol, 2-methyl-, (S)-
14	2.16	1-Butanol, 2-methyl-, (S)- , n-Hexane
15	2.57	1-Hydroxy-2-butanone , n- Hexane
16	1.87	Benzene, (3-nitropropyl)- , Azetidine, 1-benzyl-3,3-dimethyl-2 – phenyl , 1,2-Propanediol, 3-benzyloxy-1,2- diacetyl
17	2.42	Acetic acid, butoxy hydroxy-, butyl ester , 1-Butanol, 2-methyl-, (S)- , Oxirane, (butoxymethyl)-
18	3.03	Butyl isocyanate acetate, n-hexane
19	4.01	Acetic acid, butoxy hydroxy-, butyl ester , 1-Butanol, 2-methyl-, (S)- , Oxirane, (butoxymethyl)-
20	3.20	Acetic acid, butoxy hydroxy-, butyl ester , 1-Butanol, 2-methyl-, (S)-
21	11.32	Butyl 14-methylhexadecanoate, o-n-Butylhydroxylamine, 2-Heptafluorobutyroxydodecane
22	1.92	Acetic acid, butoxy hydroxy-, butyl ester , 1-Butanol, 2-methyl-, (S)-
23	9.52	2-Trifluoroacetoxytetradecane , o-n-Butylhydroxylamine , Cyclohexane, 1R-acetamido-2,3-cis- epoxy-4-cis-formyl oxy-
24	3.60	Thiocyanic acid, butyl ester , o-n-Butylhydroxylamine , Acetic acid, cyano-, 2-ethylhexyl ester
25	2.02	Acetic acid, butoxy hydroxy-, butyl ester , 2-Butyne-1,4-diol , 1-Butanol, 2-methyl-, (S)-

3.1.6. Determination of Some Compounds in Alcoholic Extracts Of Parsley

Table 3.5. Shows some of the major components in the alcoholic extract of the parsley plant. The major compounds in this extract were ethanol, 2-(9,12-octadecadienyloxy)-, (Z, Z)-, 9,12,15-octadecatrienoic acid, (Z, Z)- (7.92%), ergost-5-en-3-ol, (3.beta.)-, campesterol (21.58%), stigmasterol (17.54%), and gamma. -Sitosterol, beta-Sitosterol (33.76%).

Table 3.5. Results of GC-MS analysis of alcoholic extract of parsley

n	% Area	Compounds
1	1.68	Diethyl Phthalate
2	1.07	4(1H)-Pyrimidinone, 2-(ethylthio)- , 3,8-Dioxatricyclo [5.1.0.0(2,4)]octane,4-ethyl , Spirohexan-4-one, 5-chloro-6,6-dimethyl-
3	0.32	Pyrimidine, 4,6-dimethoxy-5-nitro- , cis-Aconitic anhydride , 2-Propenamide
4	0.40	4(1H)-Pyrimidinone, 2-(ethylthio)- , Spirohexan-4-one, 5-chloro-6,6-dimethyl , Spirohexan-4-one, 5,5-dimethyl-
5	0.39	Urea
6	3.62	n-Hexadecanoic acid , Pentadecanoic acid
7	1.71	Phytol, Cyclohexanol, 5-methyl-2-(1-methyl ethyl)-, (1.alpha. 2. beta.,5.beta.
8	7.92	Ethanol, 2-(9,12-octadecadienyloxy)-, (Z,Z)- , 9,12,15-Octadecatrienoic acid, (Z, Z,Z)-
9	0.54	Heptane, 1-(ethenylthio)- , 4(1H)-Pyrimidinone, 2-(propylthio)
10	0.30	cis-Aconitic anhydride , 2-Propenamide , 2,2'-(1,4-Piperazinediyl)bis[N-(4-methoxyphenyl)succinimide]
11	0.39	cis-Aconitic anhydride , 2,2'-(1,4-Piperazinediyl)bis[N-(4-methoxyphenyl)succinimide]
12	2.60	cis-Aconitic anhydride , 2,2'-(1,4-Piperazinediyl)bis[N-(4-methoxyphenyl)succinimide] , 1,2-Cyclobutanedicarboxylic acid, 3-methyl-, dimethyl ester
13	0.56	1,2-Propanediol, 3-benzyloxy-1,2-diacetyl- , Isoxazole, 5-chloro-4-(2-phenylethyl)- , 2-Propenoic acid, 3-[(phenylmethyl)thio]-, (E)-
14	0.92	cis-Aconitic anhydride , 2H-Pyran, 2-(3-butynyloxy)tetrahydro-
15	0.36	cis-Aconitic anhydride , 2,2'-(1,4-Piperazinediyl)bis[N-(4-methoxyphenyl)succinimide]
16	0.62	cis-Aconitic anhydride , 2,2'-(1,4-Piperazinediyl)bis[N-(4-methoxyphenyl)succinimide] , Pyrimidine, 4,6-dimethoxy-5-nitro-
17	0.87	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans- , 1H-Indole, 5-methyl-2-phenyl- , 1H-Indole, 2-methyl-3-phenyl-
18	0.32	cis-Aconitic anhydride , 2,2'-(1,4-Piperazinediyl)bis[N-(4-methoxyphenyl)succinimide]
19	21.58	Ergost-5-en-3-ol, (3.beta.)- , Campesterol
20	17.54	Stigmasterol
21	0.48	cis-Aconitic anhydride , 3-Butyn-1-ol , 3-(2,4-Dichlorophenyl)-2-(4-nitros tyryl)-4(3H)-quinazolinone
22	0.71	cis-Aconitic anhydride , 3-Butyn-1-ol , Pyrimidine, 4,6-dimethoxy-5-nitro-
23	33.76	gamma.-Sitosterol , beta.-Sitosterol
24	0.45	cis-Aconitic anhydride , 2,2'-(1,4-Piperazinediyl)bis[N-(4-methoxyphenyl)succinimide]
25	0.90	1,1,1,2,3,3,3-Heptafluoro-2-methox ypropane , cis-Aconitic anhydride , 2,2'-(1,4-Piperazinediyl)bis[N-(4- methoxyphenyl)succinimide]

3.2. Productive Performance

3.2.1. Body Weight (g)

Effect of stocking density treatments on the body weight of broilers are provided Table 3.6 and Figure 3.2. No notable distinction was seen in the first, second, and third weeks. However, during the fourth, fifth, and sixth weeks, the stocking density of 10 chickens per square meter exhibited significant superiority compared to the stocking density of 15 chickens per square meter ($P \leq 0.05$).

Effects of the additive treatments on the body weight of broilers are provided in Table 3.6. and Figure 3.3. 8c treatment showed a significant superiority compared to the control (0) treatment during all weeks ($P \leq 0.05$). Furthermore, during the third, fourth, and fifth weeks, the 4c treatment exhibited a significant superiority compared to the control (0) treatment ($P \leq 0.05$).

Effects of interactions between stocking density and additive treatments on the body weight of broilers are provided in Table 3.6 and Figure 3.4. In the first and third weeks, there were no significant differences among the treatments; however, in the second week, 4c and 8c treatments with a density of 10 chickens showed significant superiority as compared to the control (0) treatment with a density of 10 and 15 chicks ($P \leq 0.05$). As for the fourth, fifth and sixth weeks, 4c and 8c treatments with a density of 10 and 15 chickens showed significant superiority as compared to the control treatment (0) with a density of 10 and 15 chickens ($P \leq 0.05$).

Table 3.6. Effect of aqueous and alcoholic extract of parsley (*Petroselinum crispum*) supplemented into drinking water and stocking density on body weight of broilers

Treatment			First week	Second Week	Third week	Fourth Week	Fifth week	Sixth week
Density		10	194	527	1118	1847^{a}	2624^{a}	3352^{a}
		15	195	520	1096	1760^{b}	2487^{b}	3152^{b}
Additives		0	189^{b}	504^{c}	1062^{b}	1656^{c}	2396^{b}	2979^{c}
		4a	194^{ab}	520^{c}	1108^{ab}	1745^{b}	2485^{b}	3185^{b}
		4c	195^{ab}	531^{ab}	1121^{a}	1911^{a}	2661^{a}	3428^{a}
		8a	181^{b}	522^{abc}	1105^{ab}	1754^{b}	2479^{b}	3139^{bc}
		8c	211^{a}	540^{a}	1138^{a}	1953^{a}	2756^{a}	3529^{a}
Interaction	Density	Additives						
	10	0	189	505^{cd}	1080	1635^{f}	2299^{e}	2937^{e}
		4a	190	513^{cd}	1107	1775^{cde}	2596^{bcd}	3343^{bc}
		4c	199	541^{ab}	1150	1983^{ab}	2776^{ab}	3551^{ab}
		8a	188	526^{abcd}	1122	1812^{cd}	2581^{bcd}	3232^{cd}
		8c	202	549^{a}	1128	2031^{a}	2866^{a}	3694^{a}
	15	0	190	503^{d}	1043	1677^{ef}	2493de	3020de
		4a	198	528^{abcd}	1109	1714^{edf}	2375de	3020de
		4c	192	521^{abcd}	1092	1838^{c}	2546^{cd}	3305^{bcd}
		8a	175	518^{bcd}	1088	1696^{edf}	2376de	3046de
		8c	219	531^{abc}	1147	1874^{bc}	2645^{bc}	3363^{bc}
P-value	Density		NS	NS	NS	0.001	0.004	0.002
	Additives		0.021	0.005	0.030	0001	0.0002	0.0001
	Interaction		NS	0.017	NS	0001	0.0001	0.0001
SEM			2.93	3.37	8.13	25.2	36.2	49.5

SEM = Standard Error of Means; NS= Non-significant; 10 or 15 = number of chickens per square meter; $^{a-f}$ = means in the same column with different superscripts are different ($P < 0.05$); 0 = control without additives; 4a or 8a= means 4 or 8 millilitres of aqueous extract per litre of water; 4c or 8c= means 4 or 8 millilitres of alcoholic extract per litre of water.

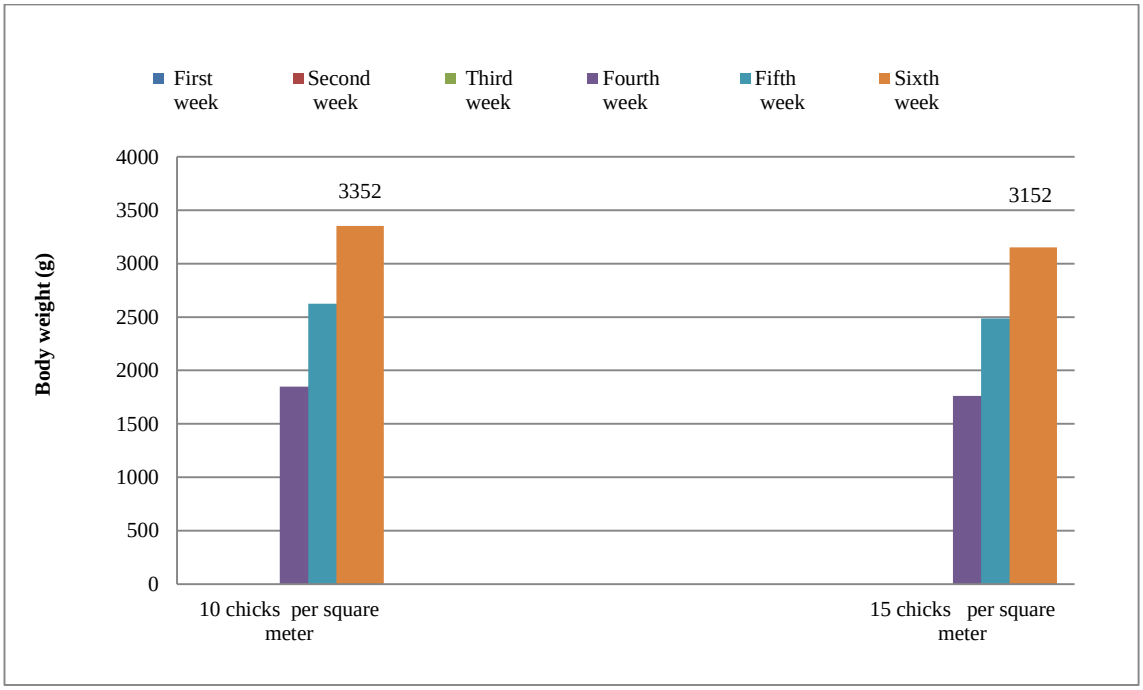


Figure 3.2. Effect of stocking density treatments on the body weight of broilers

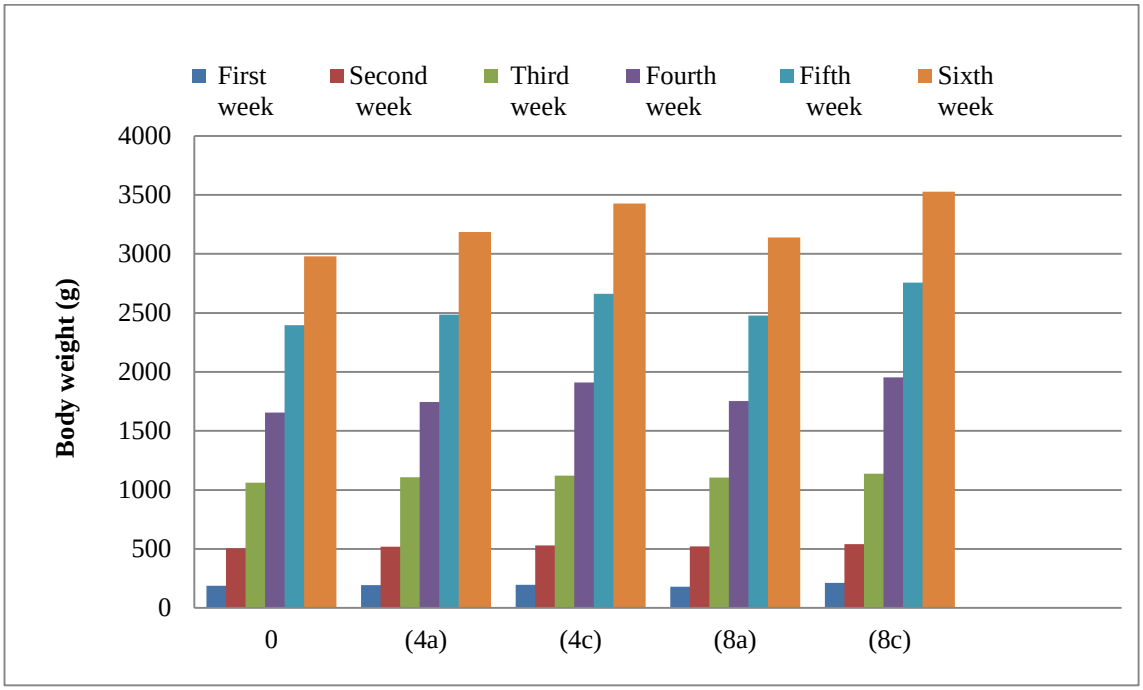


Figure 3.3. Effect of additives treatments on the body weight of broilers

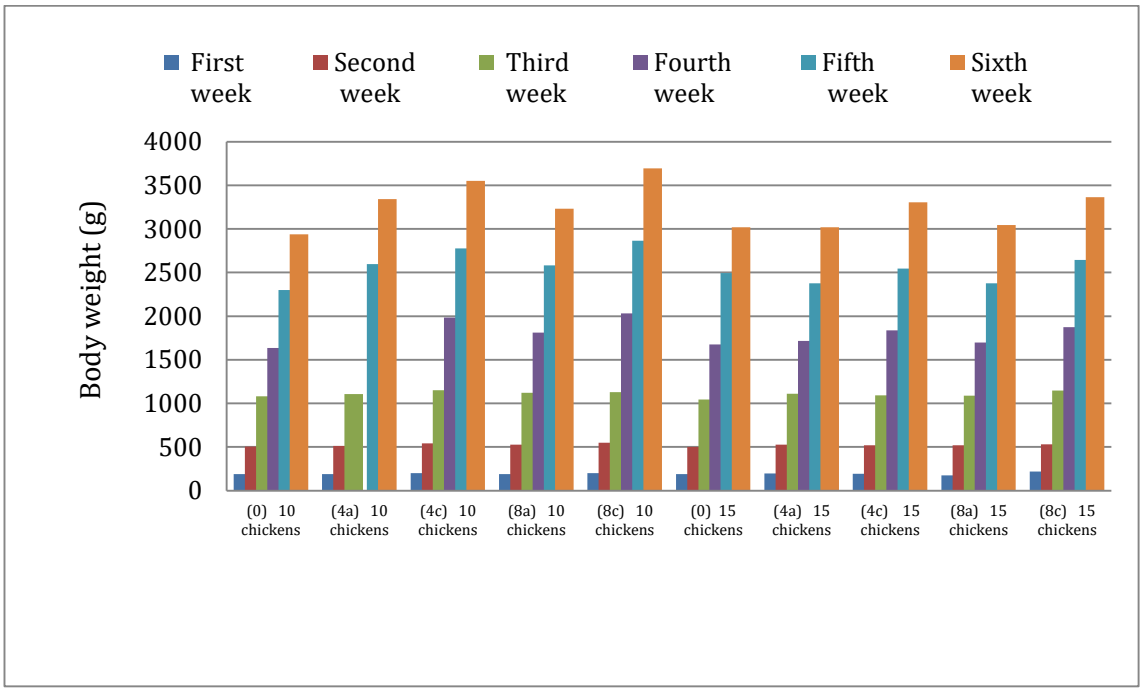


Figure 3.4. Effect of ınteraction between density and additives treatments on the body weight of broilers

3.2.2. Body Weight Gain (g)

The effects of stocking density treatments on broilers' body weight gain are shown in Table 3.7 and Figure 3.5. No significant differencesbetween stocking densities of 10 and 15 chickens per square meter during the first, second, third, fifth, and sixth weeks. However, significantly superior performance was noted for the 10-chick density compared to the 15-chick density during the fourth week and total period ($P \leq 0.05$).

Effects of the additive treatments on broilers' body weight gain are given in Table 3.7 and Figure 3.6. In the first week, the 8c treatment showed significant superiority as compared to the control (0) treatment and the 8a treatment ($P \leq 0.05$). However, all treatments had no significant differences in the second, third, and fifth weeks. As for the fourth and sixth weeks and the Total period, 4c and 8c treatments showed significant superiority compared to all treatments($P \leq 0.05$).

Table 3.7. Effect of aqueous and alcoholic extract of parsley (*Petroselinum crispum*) supplemented into drinking water and stocking density on body weight gain of broiler

Treatment			First week	Second Week	Third week	Fourth Week	Fifth week	Sixth week	Total Period
Density		**10**	151	333	590	729^{a}	776	727	3309^{a}
		15	152	325	575	663^{b}	727	664	3109^{b}
Additives		0	146^{b}	315	557	594^{b}	740.5	582^{b}	2936^{c}
		4a	151^{ab}	326	587	636^{b}	8740	699^{ab}	3142^{b}
		4c	152^{ab}	335	590	789^{a}	750	766^{a}	3385^{a}
		8a	139^{b}	340	583	648^{b}	724	660^{ab}	3096^{bc}
		8c	168^{a}	329	597	814^{a}	803	773^{a}	3486^{a}
Interaction	Density	Additives							
	10	0	146	316	574	555^{f}	664	638	2895^{e}
		4a	147	322	594	667^{cde}	820	747	3300^{bc}
		4c	156	341	609	832^{ab}	792	774	3508^{ab}
		8a	145	338	596	689^{cde}	769	651	3189^{cd}
		8c	159	346	579	903^{a}	834	828	3651^{a}
	15	0	146	313	540	633^{ef}	816	526	2977de
		4a	155	329	581	604^{ef}	660	651	2984de
		4c	148	329	571	746^{ac}	707	758	3262^{bd}
		8a	132	343	570	608^{ef}	679	669	3003de
		8c	176	311	615	726^{cd}	771	718	3320^{bc}
P-value	Density		NS	NS	NS	NS	NS	NS	0.002
	Additives		0.025	NS	NS	0001	NS	0.124	0.0001
	Interaction		NS	NS	NS	0001	NS	NS	0.0001
SEM			2.94	3.75	6.23	20.7	17.2	25.5	49.5

SEM = Standard Error of Means; NS= Non-significant; 10 or 15 = number of chickens per square meter; $^{a-f}$ = means in the same column with different superscripts are different ($P < 0.05$); 0 = control without additives; 4a or 8a= means 4 or 8 millilitres of aqueous extract per litre of water; 4c or 8c= means 4 or 8 millilitres of alcoholic extract per litre of water.

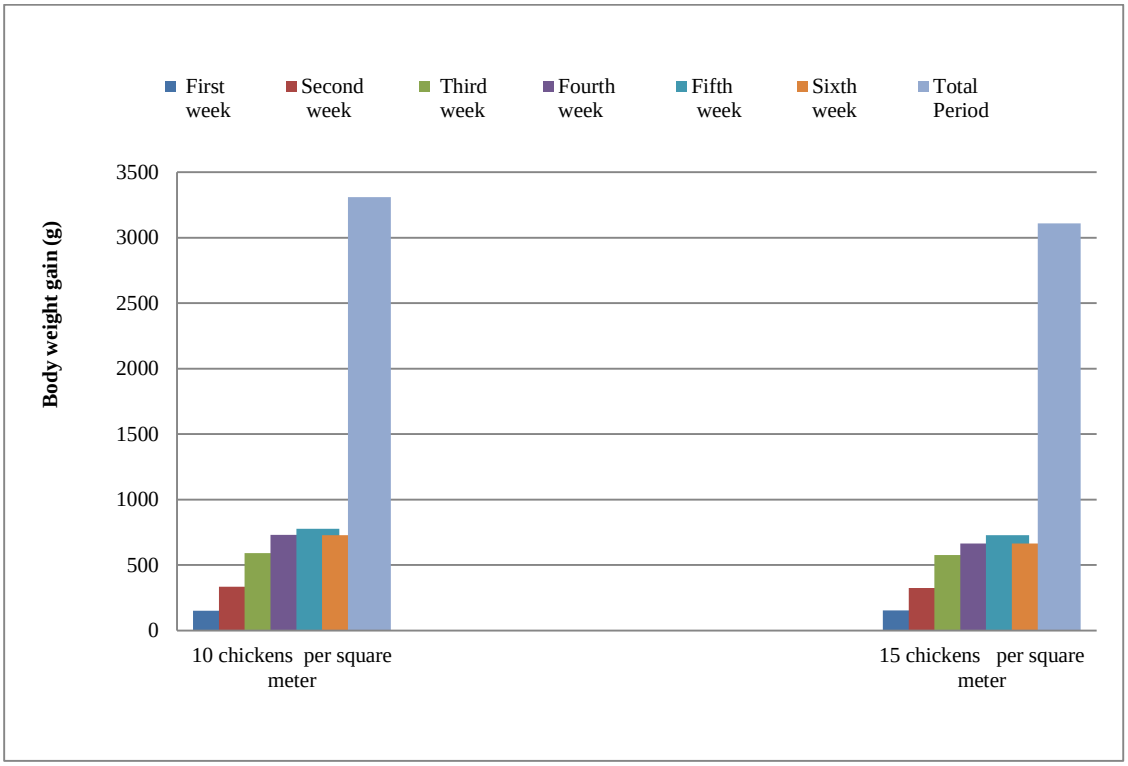


Figure 3.5. Effect of stocking density treatments on the body weight gain of broilers

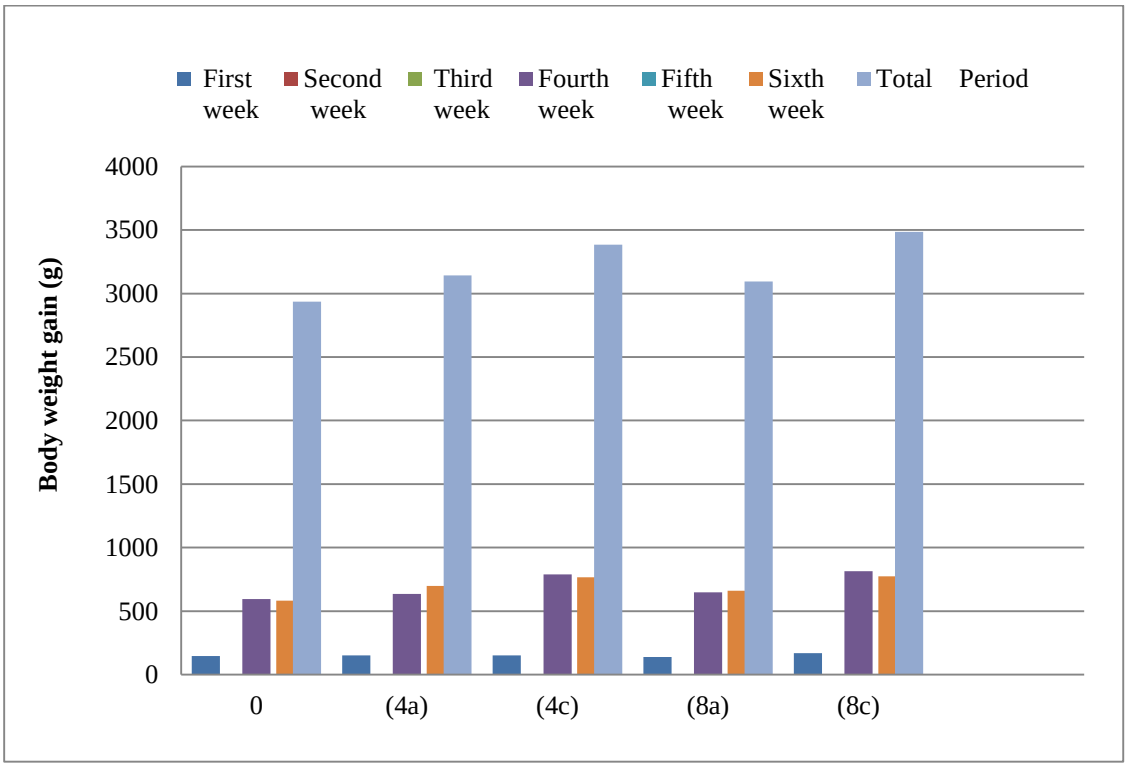


Figure 3.6. Effect of additives treatments on the body weight gain of broilers

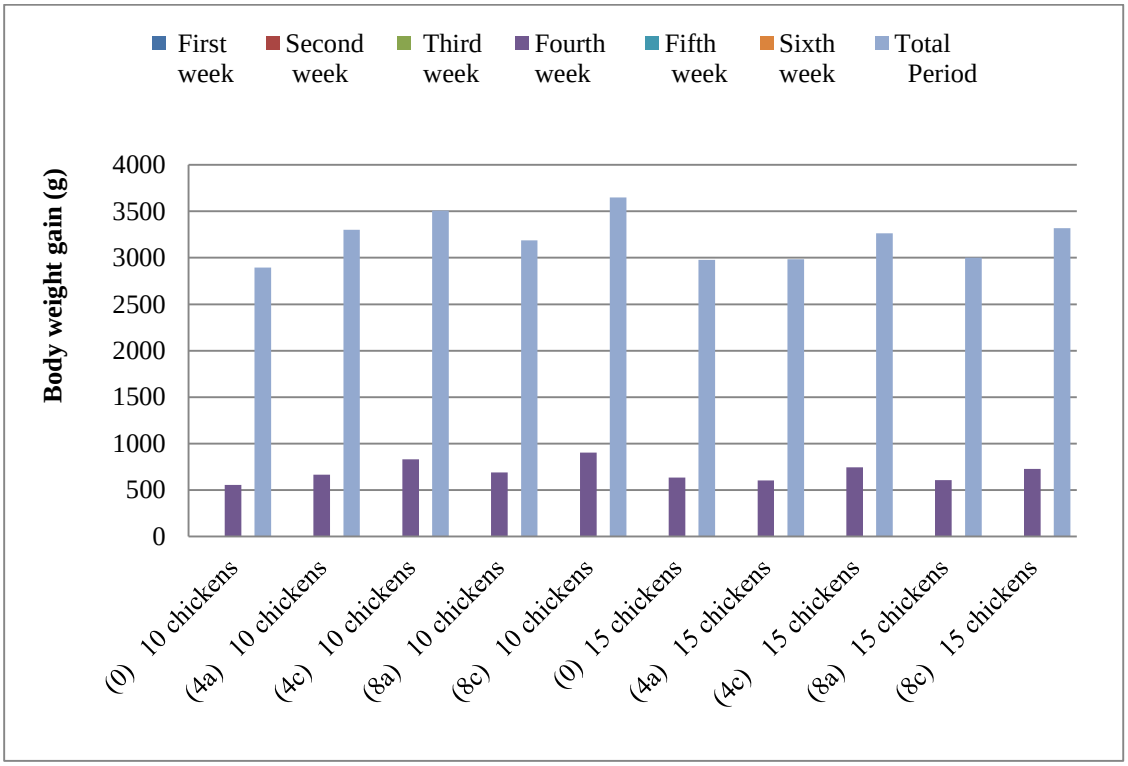


Figure 3.7. Effect of interaction between density and additives treatments on the body weight gain of broilers

3.2.3. Feed Consumption (g)

The effects of stocking density treatments on feed consumption broilers are given in Table 3.8. and Figure 3.8. The results indicate that the stocking density treatment with a density of 10 chickens per square meter was significantly superior compared to the treatment with a density of 15 chickens throughout the first, third, fourth, fifth, and sixth weeks, as well as the Total period($P \leq 0.05$). During the second week, there was no significant difference between the treatments with a density of 10 and 15 chickens per square meter.

The effects of additive treatments on feed consumption broilers are given in Table 3.8 and Figure 3.9. During the first week, the 8c treatment had significantly superior($P \leq 0.05$) to all treatments except the 4a treatment. In the second week, the 8c treatment was significantly superior to the control (0) treatment ($P \leq 0.05$). 8c treatment had significantly superior($P \leq 0.05$) then to all treatments except 4c treatment during the fourth week. In the Total period, the 8c treatment was significantly superior to the control (0) treatment and 8a treatment ($P \leq 0.05$); however, there were significant differences among the additive treatments in the third, fifth, and sixth weeks.

Effects of interactions between stocking density and additive treatments on feed consumption broilers are given in Table 3.8 and Figure 3.10. During the first week, the 4c treatment with a density of 10 chickens was significantly superior compared to 0, 4a, 4c, and 8a treatments with a density of 15 chickens (P≤0.05). In the fourth week, the 8c treatment with a density of 10 chickens was significantly superior compared to all treatments with a density of 10 and 15 chickens, and the 4c treatment with a density of 10 chickens was significantly superior compared to 8a and 8c treatments with a density of 15 chickens (P≤0.05). During the total period, the 8c treatment with a density of 10 chickens had significantly superior (P≤0.05) compared to all treatments with a density of 15 chickens. The 4a and 4c treatments with a density of 10 chickens were significantly superior compared to all treatments with a density of 15 chickens (P≤0.05)—non-significant differences among the treatments during the second, third, fifth and sixth weeks.

Table 3.8. Effect of aqueous and alcoholic extract of parsley (*Petroselinum crispum*) supplemented into drinking water and stocking density on feed consumption of broiler

Treatment			First week	Second Week	Third week	Fourth Week	Fifth week	Sixth week	Total Period
Density		**10**	212^{a}	508	805^{a}	976^{a}	1206^{a}	1179 a	4888^{a}
		15	194^{b}	486	758^{b}	899^{b}	1137^{b}	1029^{b}	4508^{b}
Additives		0	200^{b}	475b	766	910^{b}	1193	1004	4552^{b}
		4a	204^{ab}	491ab	797	924^{b}	1171	1122	4710^{ab}
		4c	198^{b}	497ab	801	957^{ab}	1178	1151	4785^{ab}
		8a	198^{b}	497ab	764	904^{b}	1169	1026	4562^{b}
		8c	216^{a}	525a	779	994^{a}	1148	1218	4883^{a}
Interaction	Density	Additives							
	10	0	210^{abc}	509	796	934^{bc}	1209	1068	4729^{abc}
		4a	213^{ab}	493	821	940^{bc}	1198	1297	4953^{ab}
		4c	215^{ab}	511	831	1000^{b}	1213	1193	4965^{ab}
		8a	206^{abc}	501	781	918^{bc}	1218	1032	4662^{bc}
		8c	217^{a}	528	795	1088^{a}	1195	1308	5133^{a}
	15	0	190^{cd}	441	737	886^{c}	1177	941	4375^{c}
		4a	194^{bcd}	489	773	908^{bc}	1144.2	947	4467^{c}
		4c	181^{d}	482	772	914^{bc}	1144.5	1109	4605^{c}
		8a	190^{cd}	494	747	889^{c}	1120	1019	4462^{c}
		8c	214^{ab}	523	762	900^{c}	1101	1129	4633^{bc}
P-value	Density		0.0004	NS	0.001	0.0003	0.018	0.023	0.0004
	Additives		NS	0.171	NS	0.021	NS	NS	0.125
	Interaction		0.008	NS	NS	0.001	NS	NS	0.016
SEM			2.89	6.65	7.55	13.1	13.4	34.3	57.3

SEM = Standard Error of Means; NS= Non-significant; 10 or 15 = number of chickens per square meter; $^{a-f}$ = means in the same column with different superscripts are different (P < 0.05); 0 = control without additives; 4a or 8a= means 4 or 8 millilitres of aqueous extract per litre of water; 4c or 8c= means 4 or 8 millilitres of alcoholic extract per litre of water.

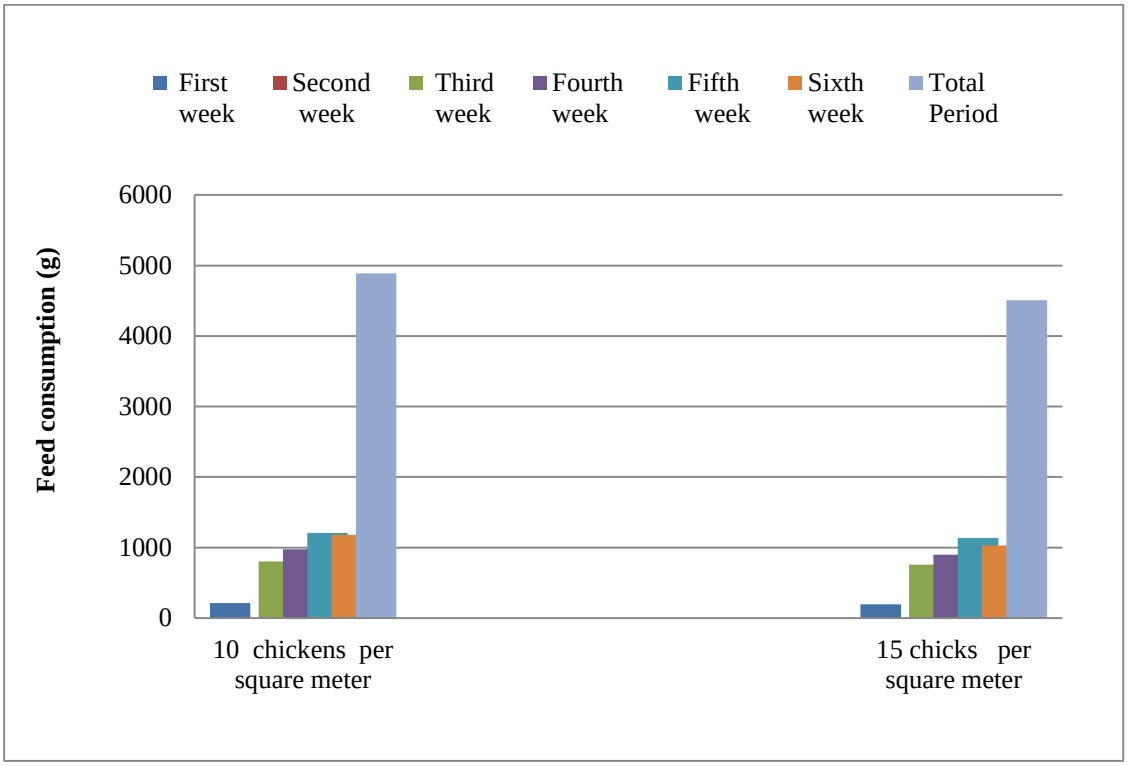


Figure 3.8. Effect of stocking density treatments on feed consumption of broiler

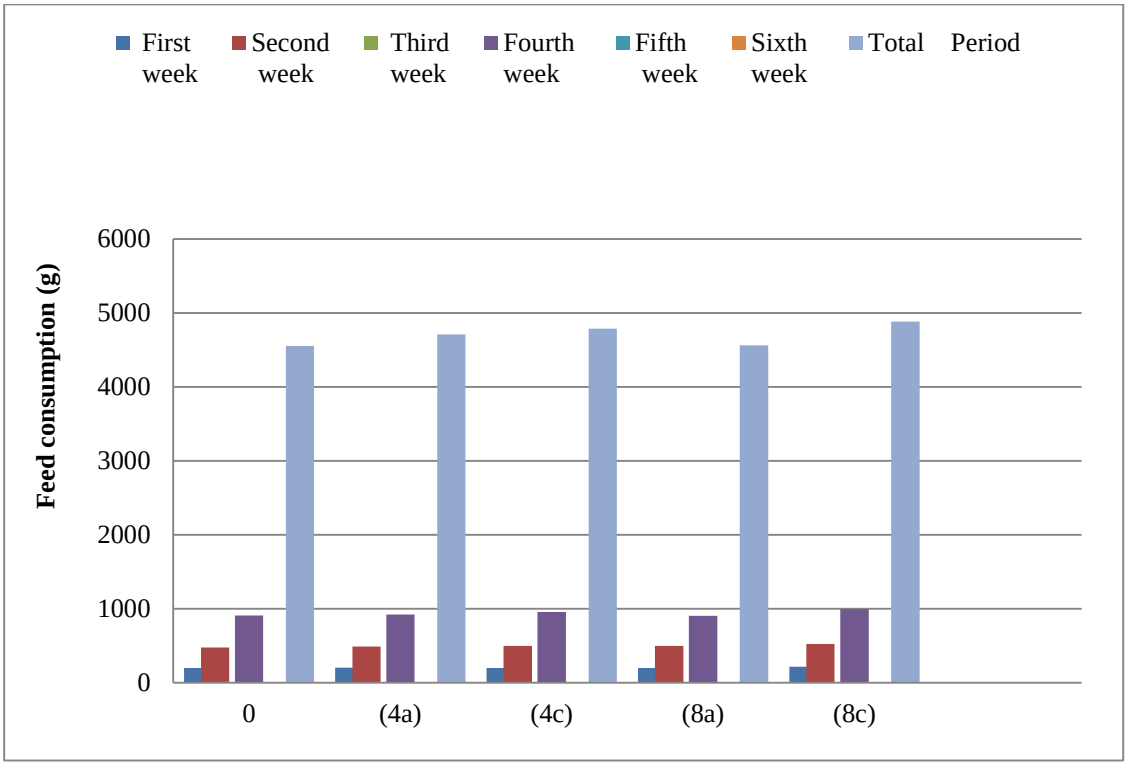


Figure 3.9. Effect of additives treatments on feed consumption of broiler

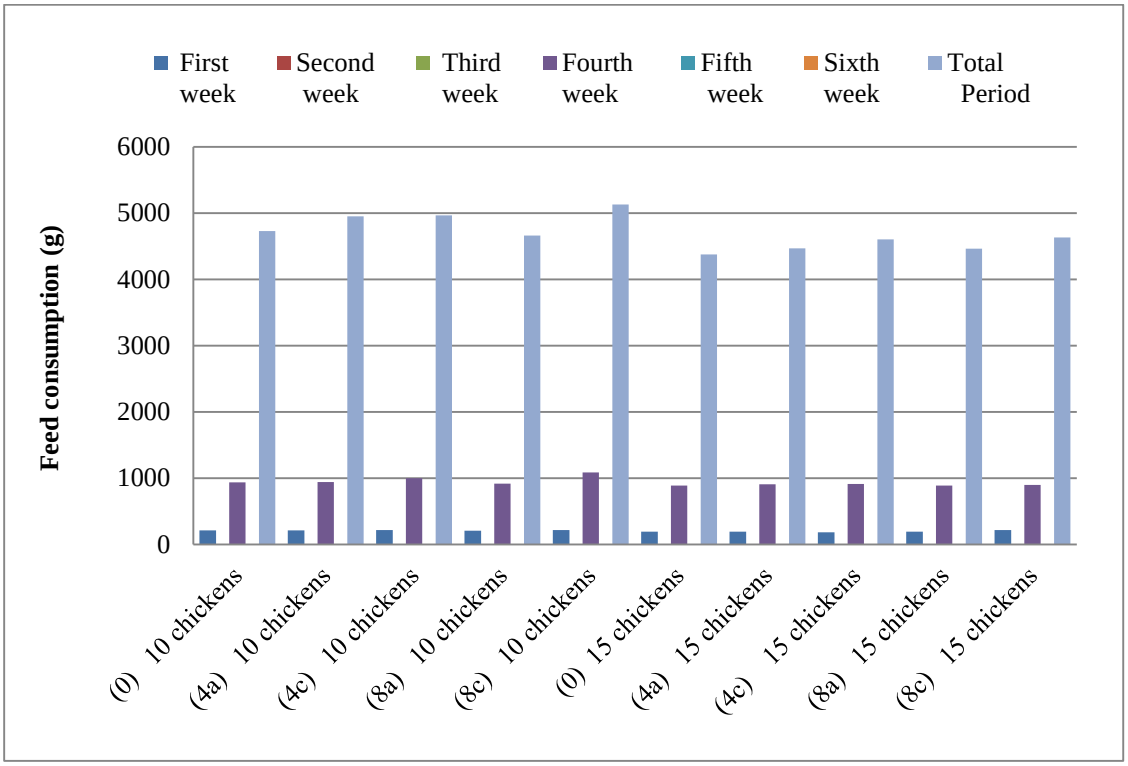


Figure 3.10. Effect of ınteraction between density and additives treatments on feed consumption of broiler

3.2.4. Feed Conversion Ratio (%)

The effects of stocking density treatments on the feed conversion ratio of broilers are given in Table 3.9 and Figure 3.11. The results indicate no significant differences among the stocking density treatments of 10 and 15 chicks per square meter during the second, third, fourth, fifth, and sixth weeks and total periods except the first week. There was a significant improvement ($P \leq 0.05$) in the treatment of 15 chicks compared to 10 chicks per square meter.

The effects of additive treatments on the feed conversion ratio of broilers are given in Table 3.9 and Figure 3.12. During the fourth and total period, 4c, 8a and 8c treatments had significant improvement compared to the control (0) treatment ($P \leq 0.05$)—non-significant difference among treatments during the first, second, third, fifth, and sixth weeks.

The effects of interactions between stocking density and additive treatments on the feed conversion ratio of broilers are given in Table 3.9. and Figure 3.13. There was no significant difference among the treatments through the first, second, third, and sixth

weeks. However, in the fourth week, all the treatments had significant improvement (P≤0.05) compared to the control (0) treatment with a density of 10 chickens. Also, 4c and 8c treatments with a density of 10 chickens had significant improvement (P≤0.05) compared to the control (0) treatment with a density of 15 chickens. During the fifth week, all treatments showed a significant improvement (P≤0.05) compared to the control treatment (0) with a density of 10 chickens, except for 4a and 8a treatments with a density of 15 chickens. All the treatments significantly improved (P≤0.05) compared to the control treatment (0), with a density of 10 chickens during the total period.

Table 3.9. Effect of parsley (*Petroselinum crispum*) extract by dıfferent ways ın drınkıng water and stockıng densıty on feed conversion ratio of broiler

Treatment			First week	Second Week	Third week	Fourth Week	Fifth week	Sixth week	Total Period
Density		**10**	1.40[a]	1.52	1.36	1.37	1.56	1.65	1.48
		15	1.29b	1.50	1.31	1.36	1.57	1.58	1.45
Additives		0	1.36	1.51	1.37	1.55 [a]	1.64	1.74	1.55[a]
		4a	1.34	1.50	1.35	1.46[ab]	1.59	1.64	1.50[ab]
		4c	1.29	1.48	1.35	1.21[c]	1.57	1.50	1.41[c]
		8a	1.46	1.46	1.31	1.39[b]	1.62	1.60	1.47[bc]
		8c	1.29	1.61	1.30	1.22[c]	1.43	1.59	1.40[c]
Interaction	Density	Additives							
	10	0	1.44	1.61	1.39	1.70[a]	1.82[a]	1.70	1.63[a]
		4a	1.44	1.52	1.38	1.41[bc]	1.46[cd]	1.71	1.50[b]
		4c	1.37	1.49	1.36	1.20[d]	1.53[bcd]	1.54	1.41[b]
		8a	1.42	1.48	1.31	1.33[cd]	1.59[bcd]	1.67	1.46[b]
		8c	1.36	1.52	1.37	1.20[d]	1.43[d]	1.60	1.40[b]
	15	0	1.29	1.40	1.36	1.39[bc]	1.47[cd]	1.78	1.47[b]
		4a	1.25	1.48	1.33	1.50[b]	1.73[ab]	1.56	1.50[b]
		4c	1.22	1.46	1.35	1.22d	1.61[bcd]	1.46	1.41[b]
		8a	1.50	1.45	1.31	1.46[bc]	1.65[abc]	1.52	1.48[b]
		8c	1.22	1.69	1.24	1.24[d]	1.42[d]	1.58	1.39[b]
P-value	Density		0.028	NS	NS	NS	NS	NS	NS
	Additives		NS	NS	NS	0.001	NS	NS	0.001
	Interaction		NS	NS	NS	0001	0.002	NS	0.003
SEM			0.026	0.025	0.013	0.031	0.028	0.045	0.015

SEM = Standard Error of Means; NS= Non-significant; 10 or 15 = number of chickens per square meter; [a-f] = means in the same column with different superscripts are different (P < 0.05); 0 = control without additives; 4a or 8a= means 4 or 8 millilitres of aqueous extract per litre of water; 4c or 8c= means 4 or 8 millilitres of alcoholic extract per litre of water.

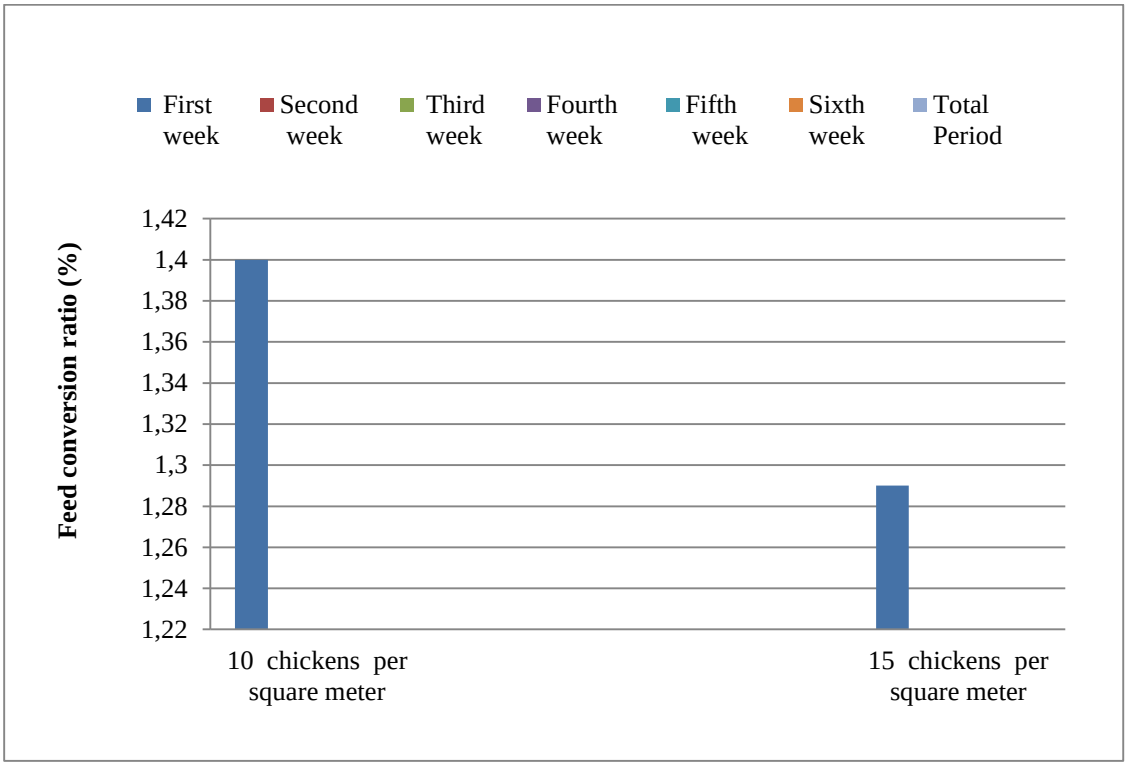


Figure 3.11. Effect of density treatments on the feed conversion ratio of broiler

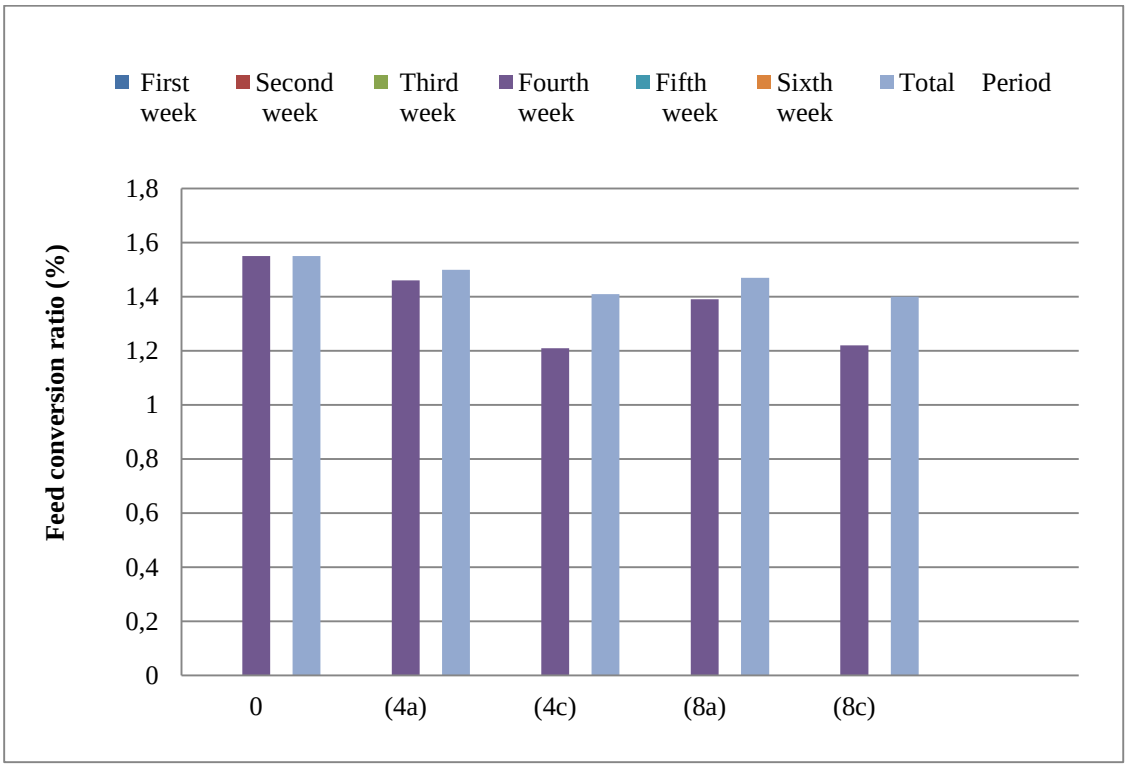


Figure 3.12. Effect of additives treatments on the feed conversion ratio of broiler

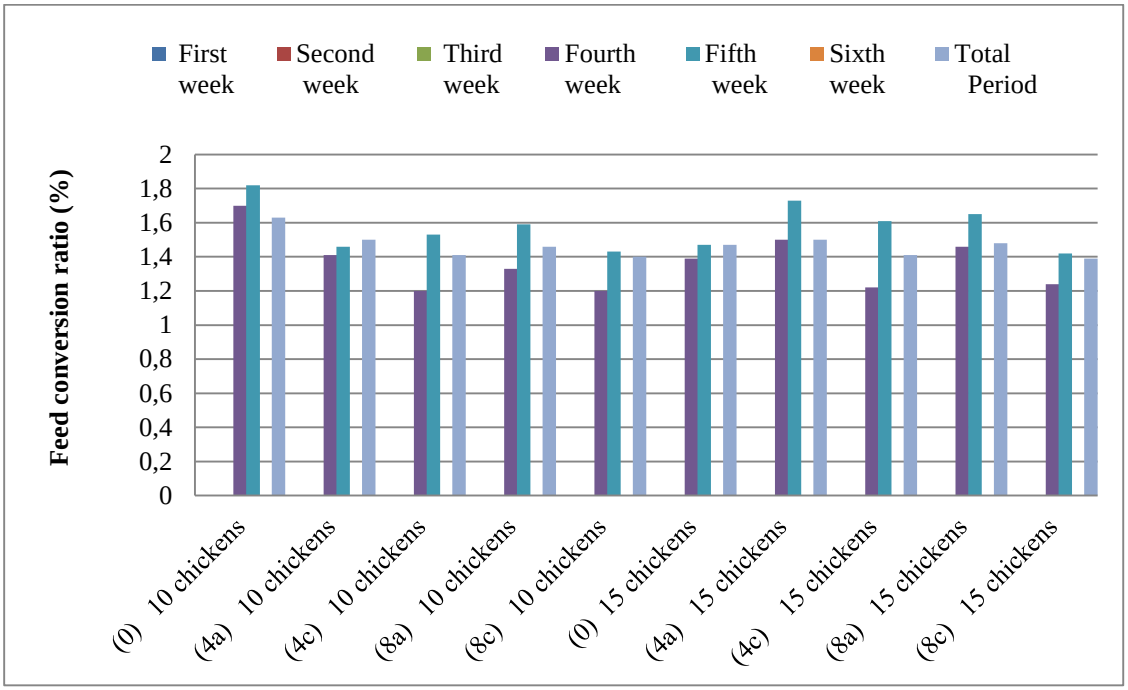


Figure 3.13. Effect of interaction between density and additives treatments on feed consumption of broiler

3.2.5. Mortality Ratio (%)

Mortality, defined as the percentage of deaths within a poultry flock, is a critical indicator of broiler health and economic viability. A sudden increase in mortality is a significant cause for concern, as it can adversely impact flock performance and profitability.

The effects of stocking density treatments on the mortality ratio of broilers are given in Table 3.10. The results indicate no significant differences between the stocking density treatment of 10 and 15 chickens per square meter during all the weeks and the Total period.

The effects of additive treatments on the mortality ratio of broilers are given in Table 3.10. The results indicate no significant differences between the treatments during all the weeks and the total period.

Effects of interactions between stocking density and additive treatments on mortality ratio of broilers are given in Table 3.10. There were no significant differences among the treatments during all the weeks and the total period.

Table 3.10. Effect of parsley (*Petroselinum crispum*) extract by dıfferent ways ın drınkıng water and stockıng densıty on mortality ratio of broiler

Treatment			First week	Second Week	Third week	Fourth Week	Fifth week	Sixth week	Total Period
Density		**10**	0	0	0	0	0.667	0.666	1.33
		15	0	0	0	0	1.33	0.888	2.22
Additives		0	0	0	0	0	3.33	0	3.33
		4a	0	0	0	0	1.66	2.22	3.88
		4c	0	0	0	0	0.000	0	0
		8a	0	0	0	0	0.000	1.66	1.66
		8c	0	0	0	0	0.000	0	0
Interaction	Density	Additives							
	10	0	0	0	0	0	0.000	0	0
		4a	0	0	0	0	3.33	0	3.33
		4c	0	0	0	0	0.000	0	0
		8a	0	0	0	0	0.000	3.33	3.33
		8c	0	0	0	0	0.000	0	0
	15	0	0	0	0	0	6.66	0	6.66
		4a	0	0	0	0	0.000	4.44	4.44
		4c	0	0	0	0	0.000	0	0
		8a	0	0	0	0	0.000	0	0
		8c	0	0	0	0	0.000	0	0
P-value	Density		NS	NS	NS	NS	NS	NS	NS
	Additives		NS	NS	NS	NS	NS	NS	NS
	Interaction		NS	NS	NS	NS	NS	NS	NS
SEM			0	0	0	0	0.735	0.546	0.886

SEM = Standard Error of Means; NS= Non-significant; 10 or 15 = number of chickens per square meter; $^{a-f}$ = means in the same column with different superscripts are different ($P < 0.05$); 0 = control without additives; 4a or 8a= means 4 or 8 millilitres of aqueous extract per litre of water; 4c or 8c= means 4 or 8 millilitres of alcoholic extract per litre of water.

3.2.6. Relative Growth Rate (%)

The effects of stocking density treatments on the relative growth rate of broilers are given in Table 3.11. and Figure 3.14. During the fourth week and total period, the treatment of 10 chicks had a significant superiority ($P \leq 0.05$) Compared to the treatment of 15 chickens per square meter. However, there was no significant difference between 10 and 15 chickens per square meter treatments during the first, second, third, fifth, and sixth weeks.

The effects of additive treatments on the relative growth rate of broilers are given in Table 3.11. and Figure 3.15. During the fourth week, The 4c and 8c treatments had a significant superiority ($P \leq 0.05$) compared to the control (0), 4c, and 8a treatments. In the total period, 4c and 8c treatments had a significant superiority ($P \leq 0.05$)compared to the control (0), 4a, and 8a treatments. Also, 4a had a significantly superior ($P \leq 0.05$) to

the control (0) treatment; however, there was no significant difference among the treatments through the first, second, third, fifth, and Sixth weeks.

Effects of interactions between stocking density and additive treatments on the relative growth rate of broilers are given in 4.11. and Figure 3.16. The 4c and 8c treatments with a density of 10 chickens and 4c with a density of 15 chickens showed significant superiority as compared to the control treatment (0) with a density of 10 and 15 chickens ($P \leq 0.05$). Moreover, 8a treatments with a density of 10 chickens and 4a and 8c treatments with a density of 15 chickens showed significant superiority as compared to the control treatment (0) with a density of 10 chickens ($P \leq 0.05$). In the Total period, 4a, 4c, and 8c treatments with a density of 10 chickens and 4c and 8c treatments with a density of 15 chickens showed significant superiority as compared to the control treatment (0) with a density of 10 and 15 chickens ($P \leq 0.05$). However, there was a non-significant difference among the treatments through the first, second, third, fifth and sixth weeks.

Table 3.11. Effect of parsley (*Petroselinum crispum*) extract by dıfferent ways ın drınkıng water and stockıng densıty on relative growth rate of broiler

Treatment			First week	Second Week	Third week	Fourth Week	Fifth week	Sixth week	Total Period
Density		**10**	127	92.3	71.7	48.8^{a}	34.7	24.3	194.90^{a}
		15	127	91.2	71.1	46.4^{b}	34.1	23.5	194.60^{b}
Additives		0	126	90.7	71.09	43.6^{b}	36.3	21.7	194.30^{c}
		4a	127	91.2	72.1	44.5^{b}	34.9	24.4	194.65^{b}
		4c	127	92.2	71.3	52.01^{a}	32.7	25.1	195.03^{a}
		8a	122	96.9	71.5	45.3^{b}	34.15	23.5	194.60^{bc}
		8c	132	87.6	71.1	52.6^{a}	34.10	24.5	195.16^{a}
Interaction	Density	Additives	126	91.05	72.3	40.7^{e}	33.8	24.46	194.26^{e}
	10	0	126	91.6	73.2	46.2^{cde}	37.5	25.04	194.91^{abc}
		4a	129	92.2	72.02	53.1^{ab}	33.3	24.45	195.22^{ab}
		4c	125	94.6	72.2	46.9^{cd}	34.9	22.46	194.75^{cde}
		8a	129	92.1	69.01	57.1^{a}	34.0	25.25	195.36^{a}
		8c	125	90.3	69.8	46.5^{cde}	38.8	19.09	194.34^{de}
	15	0	128	90.7	71.03	42.8^{de}	32.3	23.90	194.39^{de}
		4a	126	92.3	70.7	50.8^{bc}	32.2	25.93	194.83^{cd}
		4c	120	99.3	70.9	43.6^{de}	33.3	24.72	194.46^{cde}
		8a	134	83.1	73.3	48.1^{bcd}	34.1	23.89	194.96^{ab}
		8c	126	91.05	72.3	40.7^{e}	33.8	24.46	194.26^{e}
P-value	Density		NS	NS	NS	0.044	NS	NS	0.004
	Additives		NS	NS	NS	0.0001	NS	NS	0.0001
	Interaction		NS	NS	NS	0.0001	NS	NS	0.0003
SEM			1.02	1.17	0.465	0.994	0.593	0.762	0.077

SEM = Standard Error of Means; NS= Non-significant; 10 or 15 = number of chickens per square meter; $^{a-f}$ = means in the same column with different superscripts are different ($P < 0.05$); 0 = control without additives; 4a or 8a= means 4 or 8 millilitres of aqueous extract per litre of water; 4c or 8c= means 4 or 8 millilitres of alcoholic extract per litre of water.

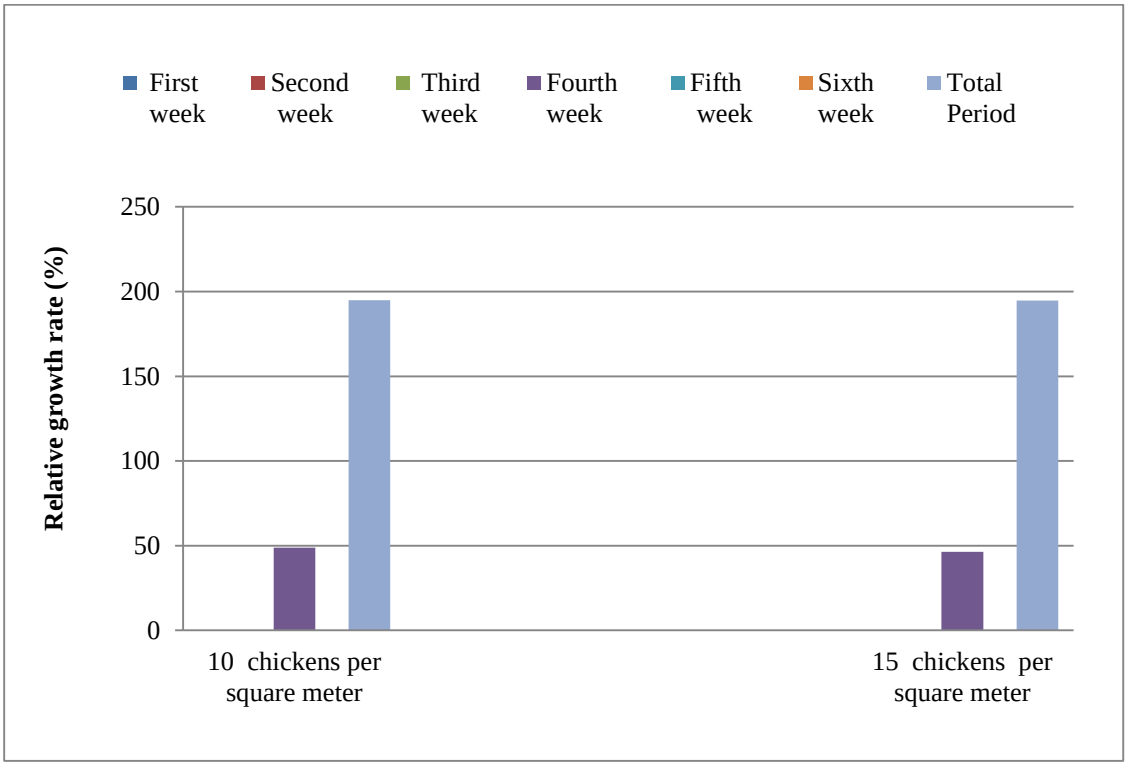


Figure 3.14. Effect of stocking density treatments on the relative growth rate of broiler

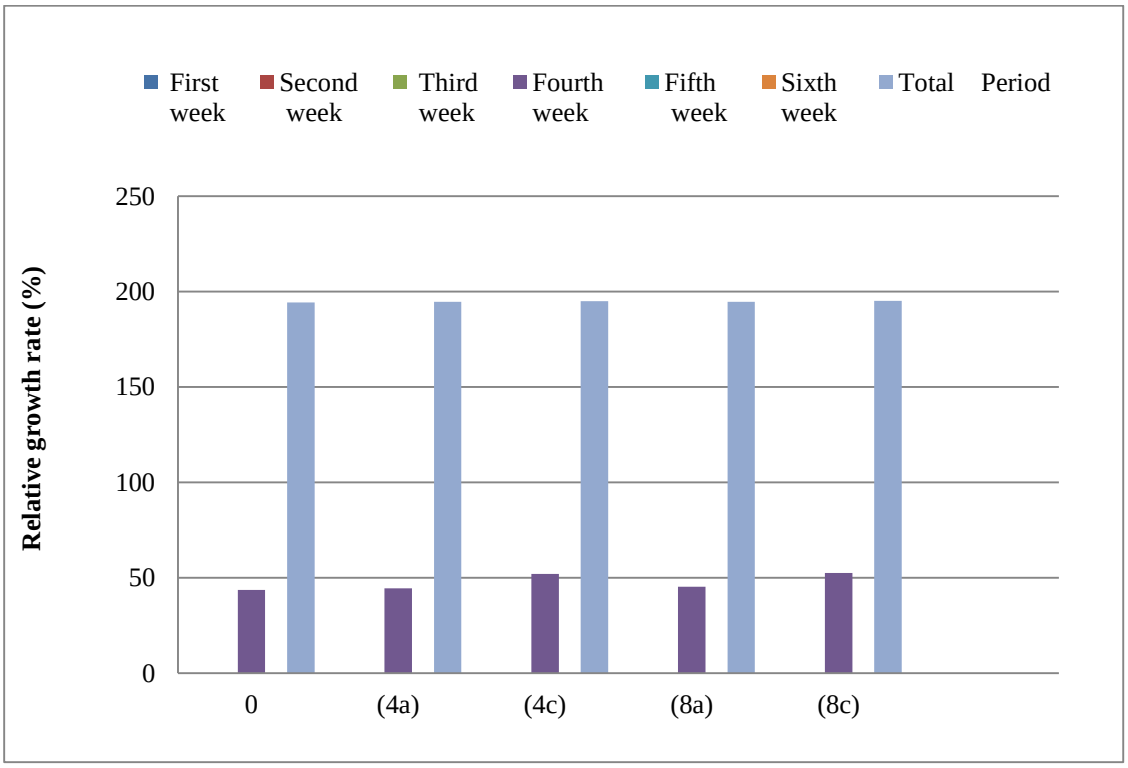


Figure 3.15. The effect of additives treatments on the relative growth rate of broiler

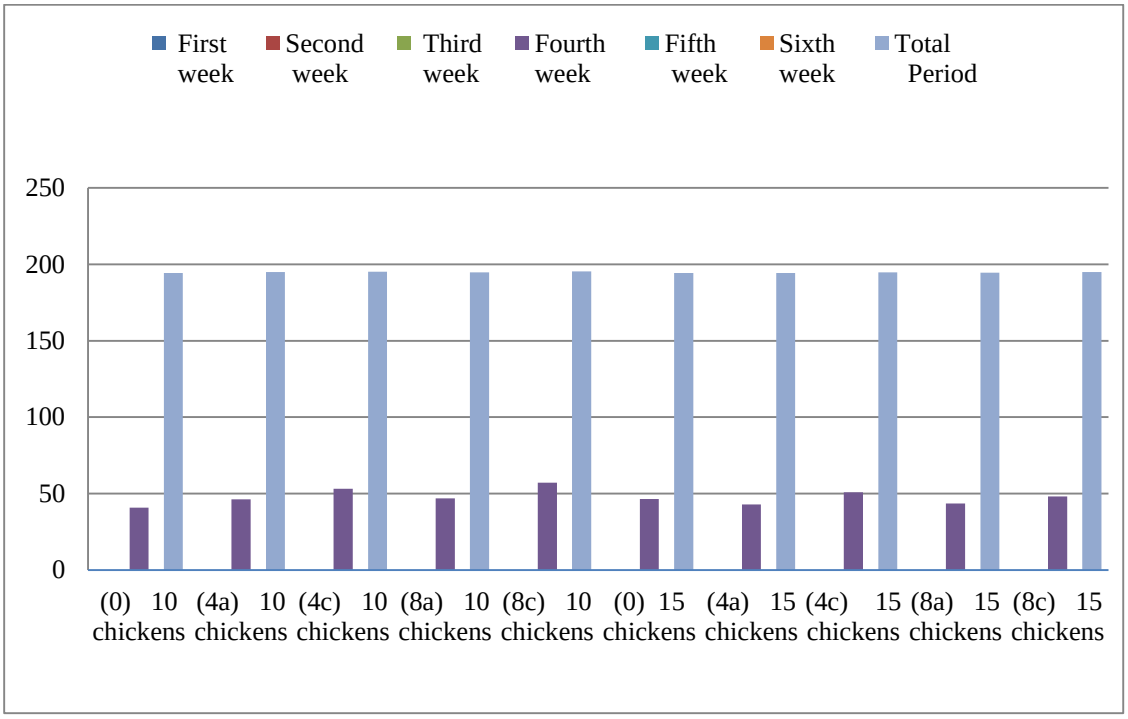


Figure 3.16. Efect of interaction between density and additives treatments on the relative growth rate of broiler

3.2.7. Production Index

The effects of stocking density treatments on the production index of broilers are given in Table 3.12. and Figure 3.17. The treatment of 10 chickens per square meter had a significant superiority (P≤0.05) Compared to the treatment of 15 chicks per square meter.

Effects of additive treatments on the production index of broilers are given in Table 3.12 and Figure 3.18. 4c and 8c treatments had a significant superiority (P≤0.05) compared to the control (0), 4a, and 8a treatments. Moreover, the 4a and 8a treatments had a significant superiority (P≤0.05) compared to the control (0) treatment.

Effects of interactions between stocking density and additive treatments on the production index of broilers are given in Table 3.12 and Figure 3.19. The treatments of 4c and 8c with a density of 10 chickens had a significant superiority (P≤0.05) as compared to all treatments with a density of 10 and 15 chickens. Moreover, all treatments, except for 4a with a density of 15 chickens, had a significant superiority (P≤0.05) as compared to the control treatment of (0) with a density of 10 and 15 chickens.

3.2.8. Economic index

Effects of stocking density treatments on the economic index of broilers are given in Table 3.12. There is a non-significant difference between the treatment of 10 chickens and 15 chickens per square meter.

The effects of additive treatments on the Economic Index of broilers are given in Table 3.12. and Figure 3.20. 4c and 8c treatments had a significant superiority (P≤0.05) compared to the control (0) and 8a treatments.

Effects of interactions between stocking density and additive treatments on the economic index of broilers are provided in Table 3.12 and Figure 3.21. The treatments of 4c and 8c with a density of 10 chickens and 8c with a density of 15 chickens had a significant superiority (P≤0.05) compared to the control treatment with a density of 10 and 15 chickens. Moreover, 4a and 8a treatments with a density of 10 chickens and 4c with a density of 15 chickens had a significant superiority (P≤0.05) as compared to the control treatment (0) with a density of 10 chickens.

Table 3.12. Effect of parsley (*Petroselinum crispum*) extract by dıfferent ways ın drınkıng water and stockıng densıty on production and economic ındex of broiler

Treatment			Production Index	Economic Index
Density		**10**	534[a]	542
		15	506[b]	518
Additives		0	440[c]	459[b]
		4a	484[b]	506[b]
		4c	578[a]	578[a]
		8a	498[b]	507[b]
		8c	600[a]	600[a]
Interaction	Density	Additives		
	10	0	428[f]	428[e]
		4a	511[d]	530[bcd]
		4c	598[ab]	598[ab]
		8a	508[d]	526[bcd]
		8c	626[a]	626[a]
	15	0	452[f]	490[cde]
		4a	458[ef]	483[de]
		4c	557[c]	557[abc]
		8a	488[de]	488[cde]
		8c	574[bc]	574[ab]
P-value	Density		0.0009	NS
	Additives		0.0001	0.0001
	Interaction		0.0001	0.0001
SEM			12.09	12.06

SEM = Standard Error of Means; NS= Non-significant; 10 or 15 = number of chickens per square meter; [a-f] = means in the same column with different superscripts are different (P < 0.05); 0 = control without additives; 4a or 8a= means 4 or 8 millilitres of aqueous extract per litre of water; 4c or 8c= means 4 or 8 millilitres of alcoholic extract per litre of water.

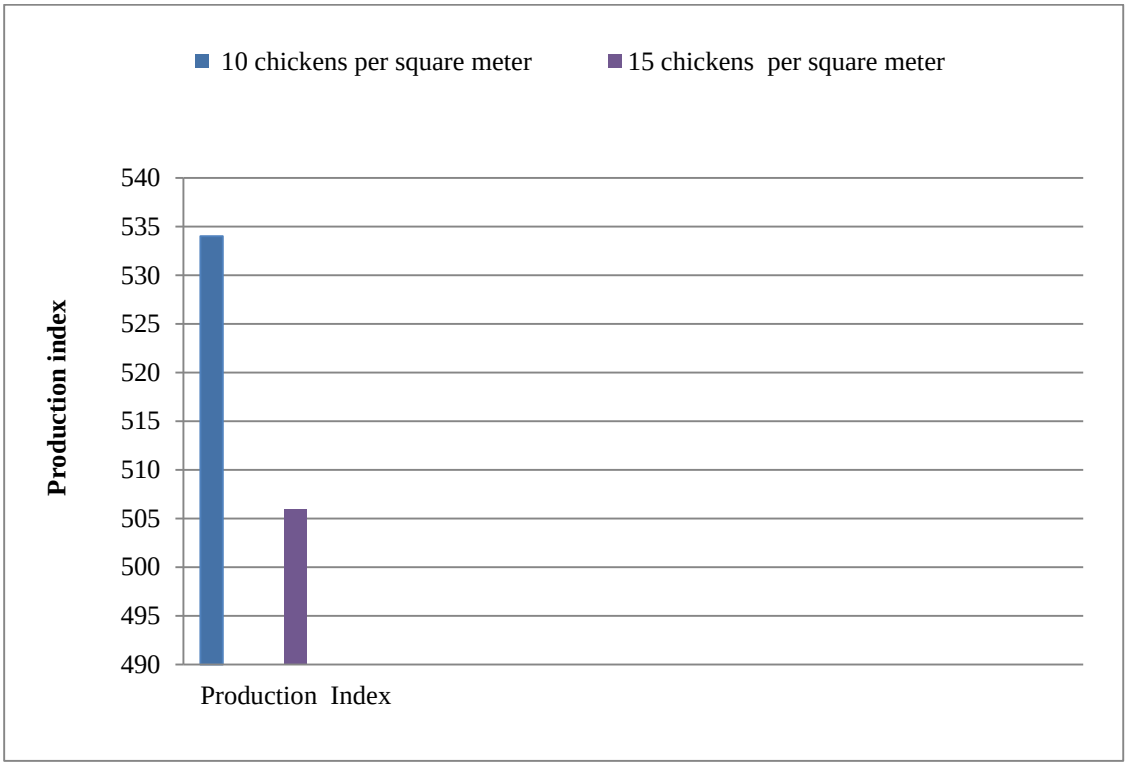


Figure 3.17. Effect of stocking density treatments on the Production Index of broiler

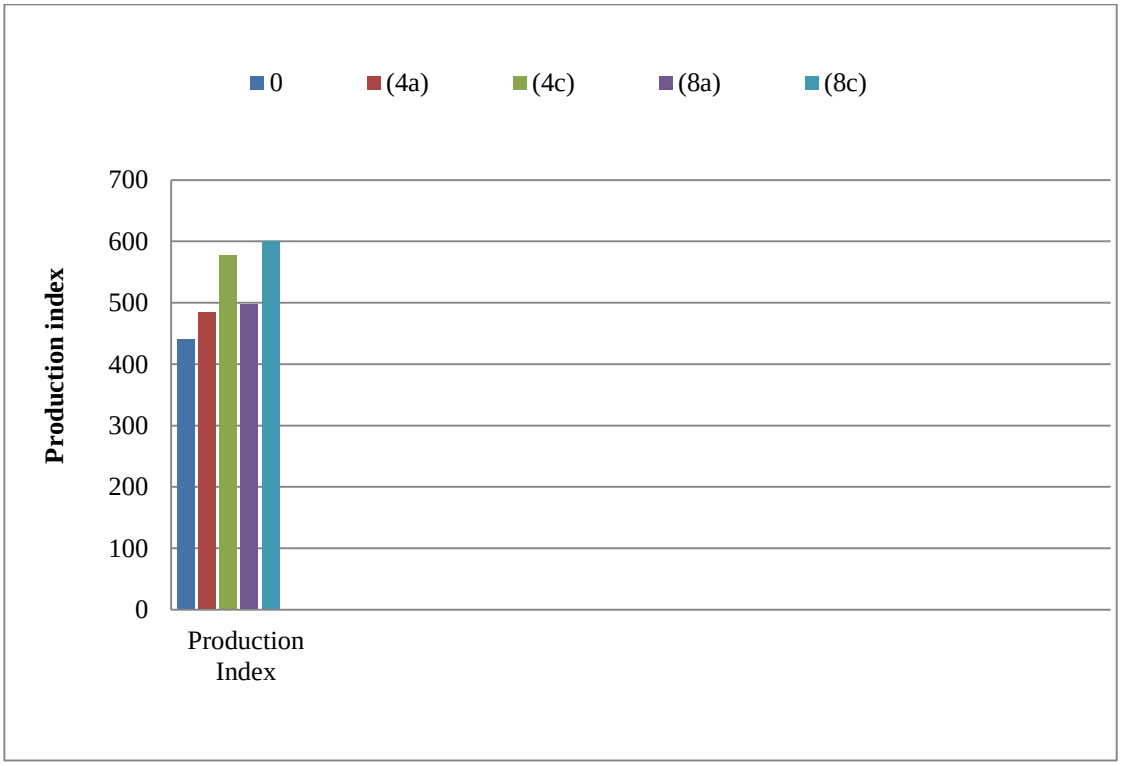


Figure 3.18. Effect of additives treatments on the production ındex of broiler

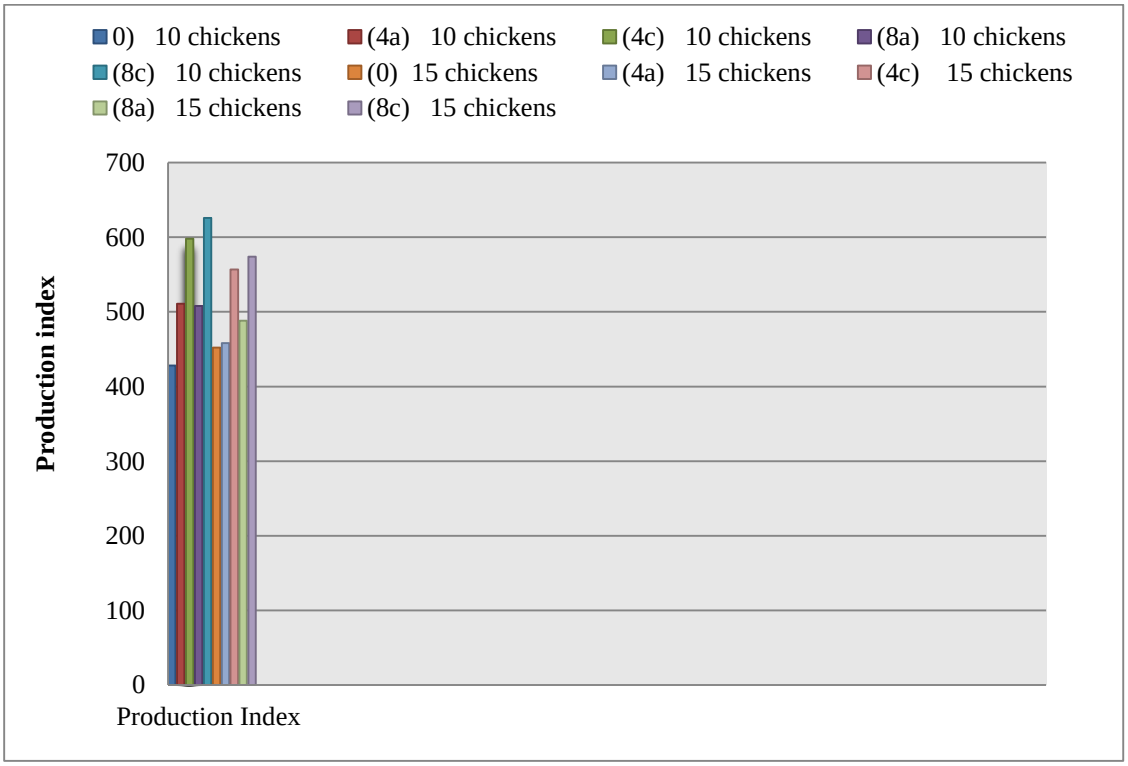


Figure 3.19. Effect of ınteraction between density and additives treatments on the production ındex of broiler

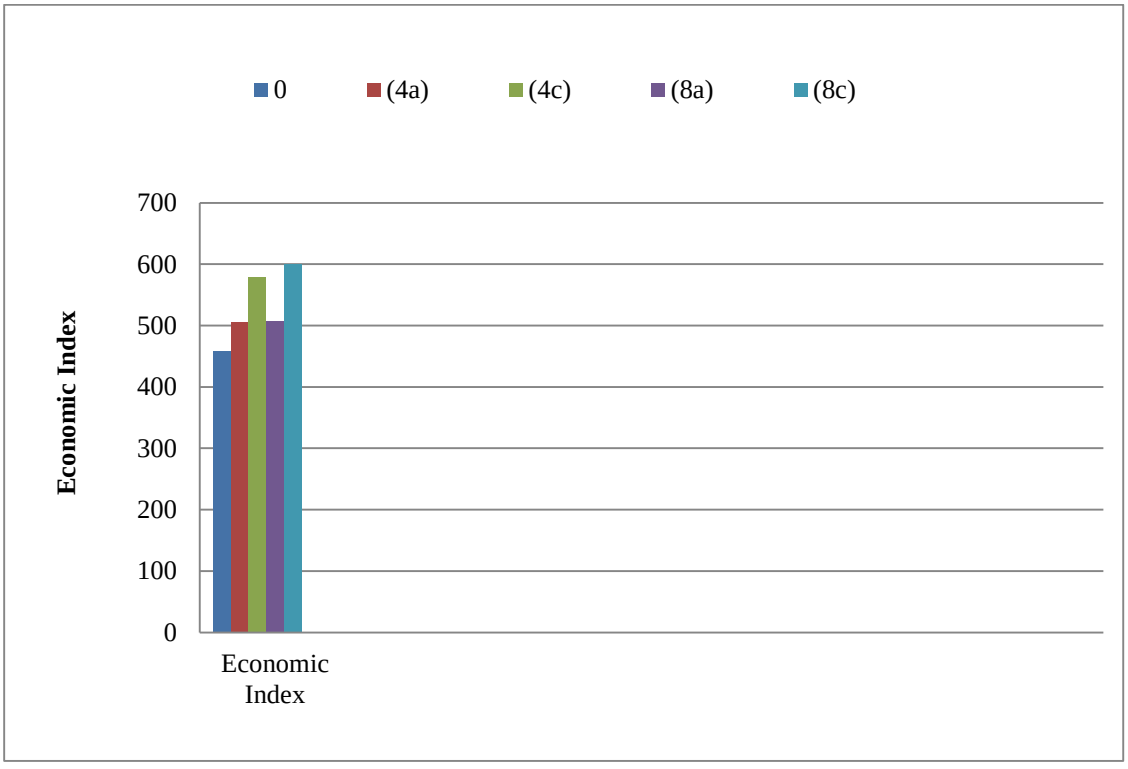


Figure 3.20. Effect of additives treatments on the economic ındex of broiler

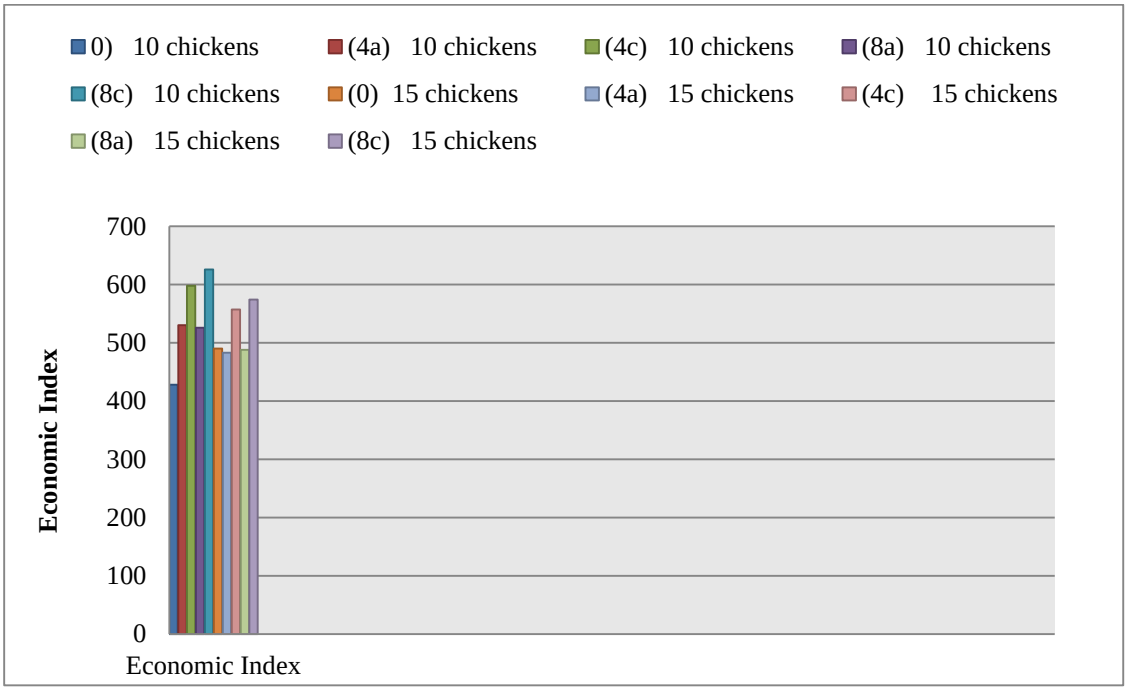


Figure 3.21. Effect of interaction between density and additives treatments on the Economic Index of broiler

3.3. Physiological Parameters

3.3.1. Cellular Blood Characteristics at Six Weeks of Age

Cellular blood characteristics include haemoglobin levels, packed cell volume, red blood cell count, white blood cell count, heterophile percentage, lymphocyte percentage, and the heterophile-to-lymphocyte ratio.

Effects of stocking density treatments on Cellular blood characteristics of broilers are given in Table 3.13 and Figure 3.22. Treatment with a density of 15 chicks per square meter had a significant superiority in white blood cell counts, heterophile, and heterophile-to-lymphocyte ratios ($P < 0.05$) compared to treatment with a density of 10 chicks per square meter. As for lymphocytes (%), the treatment with a density of 10 chickens was significantly superior($P<0.05$) compared to the treatment with a density of 15 chickens per square meter. However, there is a non-significant difference among the treatments, with a density of 10 and 15 chickens per square meter, regarding haemoglobin levels, packed cell volume, and red blood cell count.

Effects of additive treatments on Cellular blood characteristics of broilers are given in Table 3. 13. None of the additive treatments had a significant effect on haemoglobin

levels, packed cell volume, red blood cell count, white blood cell count, heterophile percentage, lymphocyte percentage, or the heterophile-to-lymphocyte ratio.

Effects of interactions between stocking density and additive treatments on Cellular blood characteristics of broilers are given in Table 3.13 and Figure 3.23. Regarding the Heterophiles ratio exhibited, all treatments with densities of 10 and 15 chicks per square meter had significant superiority ($P<0.05$) compared to control (0), 4c, and 8c treatments with a density of 10 chicks per square meter. Lymphocyte ratio exhibited 4c and 8a treatments with 10 chicks per square meter densities compared to control (0), 4a,4c, and 8a treatments with 15 chicks per square meter. However, the levels of haemoglobin, packed cell volume, Red blood cells, white blood cells, and the heterophil-to-lymphocyte ratio had no significant difference between all treatments.

Table 3.13. Effect of parsley (*Petroselinum crispum*) extract by dıfferent ways ın drınkıng water and stockıng densıty on cellular blood characteristics of broiler chicks

Treatment			Hem (g/dl)	PCV (%)	RBC (10^6/µl)	WBC (10^6/µ)	H (%)	L (%)	H/L (%)
Density		**10**	10	32.2	5.20	9.24^b	33.4^b	55.6^a	0.654^b
		15	9.76	31.3	3.30	13.4^a	45.4^a	44.4^b	1.08^a
Additives		0	10.1	32.3	7.97	9.86	40.3	49.3	0.875
		4a	8.66	28	2.96	16.3	45.1	43.8	1.20
		4c	9.50	30.5	3.20	11.7	36.6	52.3	0.753
		8a	10.6	34.1	3.58	9.98	38	52.6	0.780
		8c	10.6	33.8	3.54	8.83	37	51.8	0.721
Interaction	Density	Additives							
	10	0	9.66	31	12.4	8.80	33.6b	55.6^{abc}	0.610
		4a	9.43	30	3.19	13.7	42^{ab}	46^c	1.053
		4c	10	32	3.34	8.16	28.3^b	60.6^{ab}	0.486
		8a	10.3	33	3.46	6.03	28.6^b	61.3^a	0.476
		8c	10.8	34.6	3.63	9.46	34.6^{ab}	54.3^{abc}	0.643
	15	0	10.5	33.6	3.54	10.9	39.3^{ab}	43^c	0.800
		4a	7.90	25.6	2.74	18.8	48.3^a	41.6^c	1.36
		4c	9	29	3.06	15.3	45^a	44^c	1.02
		8a	11	35.3	3.70	13.9	47.3^a	44^c	1.08
		8c	10.3	33	3.45	8.20	47^a	49.3^{abc}	1.14
P-value	Density		NS	NS	NS	0.021	0.007	0.0009	0.006
	Additives		NS	NS	NS	NS	NS	NS	NS
	Interaction		NS	NS	NS	NS	0.031	0.030	NS
SEM			0.283	0.855	0.905	0.992	1.83	1.77	0.078

SEM = Standard Error of Means; NS= Non-significant; 10 or 15 = number of chickens per square meter; $^{a-f}$ = means in the same column with different superscripts are different ($P < 0.05$); 0 = control without additives; 4a or 8a= means 4 or 8 millilitres of aqueous extract per litre of water; 4c or 8c= means 4 or 8 millilitres of alcoholic extract per litre of water; Hem = Hemoglobin; PCV = Packed Cell Volume; RBC = Red Blood Cells; WBC = White Blood Cells; H= Heterophiles; L= Lymphocytes; H/L= Heterophiles/Lymphocytes.

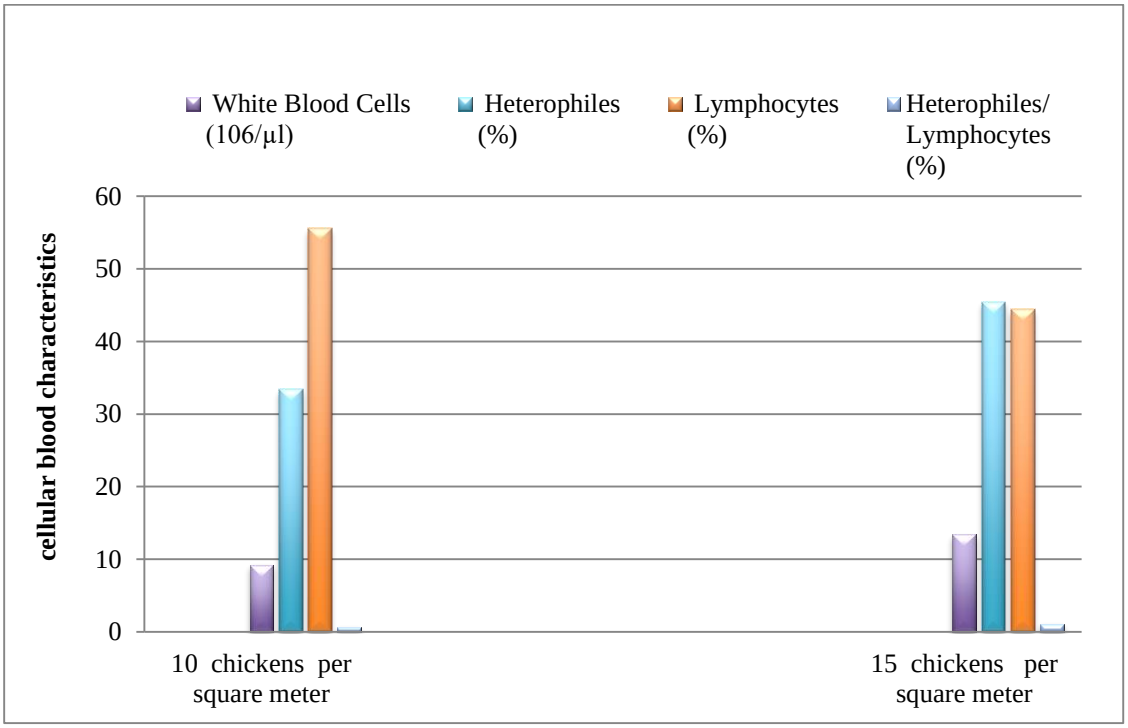


Figure 3.22. Effect of stocking density treatments on the cellular blood characteristics at six weeks of age of broiler

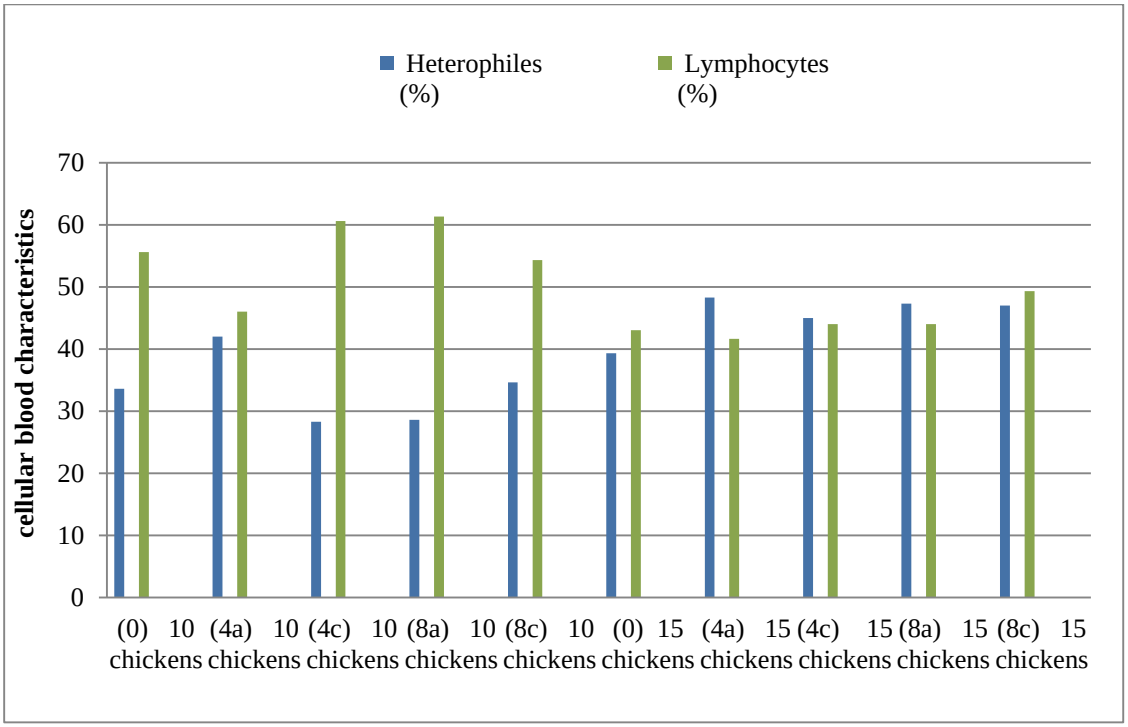


Figure 3.23. Effect of interaction between density and additives treatments on the morphological blood characteristics at six weeks of age of broiler

3.3.2. Biochemical Blood Characteristics at Six Weeks of Age

3.3.2.1. Glucose and Blood Plasma Proteins

The effects of stocking density treatments on the level of glucose and blood plasma proteins of broilers are given in Table 3.14 and Figure 3.24. Treatment with densities of 10 chickens per square meter had a significant superiority ($P<0.05$) compared to treatment of 15 chickens per square meter in total protein and globulin levels. However, the non-significant difference between the treatment with densities of 10 chickens and the treatment with densities of 15 chickens per square meter in the glucose level and albumin

Effects of additive treatments on the level of glucose and blood plasma proteins of broilers are given in Table 3.14. and Figure 3.25. Regarding the glucose level, 4c,8a, and 8c treatments had a significant superiority ($P<0.05$) compared to the 4a treatment. In terms of total protein, the control (0), 4a, and 8c treatments had a significant superiority ($P<0.05$) compared to the 4c and 8a treatments. In terms of globulin level, control (0), 4a, and 8c treatments had a significant superiority ($P<0.05$) compared to the 8a treatment. However, non significant difference among the treatments in the albumin level.

Effects of interactions between stocking density and additive treatments on the level of glucose and blood plasma proteins of broilers are given in Table 3.14 and Figure 3.26. In terms of glucose level, 4c treatments with 10 chickens per square meter densities had significantly superior ($P<0.05$)compared to control (0), 4a, 8a, 8c treatments with densities of 10 chickens and control (0), 4a, and 4c with densities of 15 chickens per square meter, also, 4c treatment with densities of 15 chickens was significantly superior ($P<0.05$)compared to control (0) and, 4a treatments with densities of 15 chickens and 4a treatment with densities of 10 chickens per square meter. In terms of total protein level(g/dL), all the treatments with densities of 10 and 15 chickens per square meter had a significantly superior ($P<0.05$) compared to 4c and 8a treatments with densities of 15 chickens per square meter. In terms of total protein (g/dL) and Globulin level(g/dL), all the treatments of 10 and 15 chickens per square meter had a significantly superior ($P<0.05$) compared to the 4c and 8a treatments with densities of 15 chickens per square meter. However, non significant difference among the treatments regarding Albumin level(g/dL).

Table 3.14. Effect of parsley (*Petroselinum crispum*) extract by dıfferent ways ın drınkıng water and stockıng densıty on glucose andblood plasma proteins of broiler

Treatment			Glucose (mg/ dl)	Total Protein (g/dL)	Albumin (g/dL)	Globulin (g/dL)
Density		**10**	192	66.6^{a}	34	32.6^{a}
		15	189	56.8^{b}	32.1	24.7^{b}
Additives		0	184^{ab}	66^{a}	33.1	32.8^{a}
		4a	166^{b}	67^{a}	34.5	32.5^{a}
		4c	207^{a}	56.3^{b}	30.6	25.6^{ab}
		8a	200^{a}	53.3^{b}	32.5	20.8^{b}
		8c	193^{a}	66^{a}	34.5	31.5^{a}
Interaction	Density	Additives				
	10	0	180^{bc}	63.3^{a}	33	30.3^{a}
		4a	172^{c}	71.3^{a}	35.6	35.6^{a}
		4c	234^{a}	68.6^{a}	33.3	35.3^{a}
		8a	185^{bc}	62.3^{a}	35.3	27^{a}
		8c	188^{bc}	67.3^{a}	32.6	34.6^{a}
	15	0	172^{c}	68.6^{a}	33.3	35.3^{a}
		4a	161^{c}	62.6^{a}	33.3	29^{a}
		4c	181^{bc}	44^{b}	28	16^{b}
		8a	216^{ab}	44.3^{b}	29.6	14.6^{b}
		8c	198^{abc}	64.6^{a}	36.3	28.3^{a}
P-value	Density		NS	0.0001	NS	0.002
	Additives		0.026	0.0001	NS	0.009
	Interaction		0.016	0.0001	NS	0.001
SEM			4.86	1.85	0.665	1.64

SEM = Standard Error of Means; NS= Non-significant; 10 or 15 = number of chickens per square meter; $^{a-f}$ = means in the same column with different superscripts are different (P < 0.05); 0 = control without additives; 4a or 8a= means 4 or 8 millilitres of aqueous extract per litre of water; 4c or 8c= means 4 or 8 millilitres of alcoholic extract per litre of water.

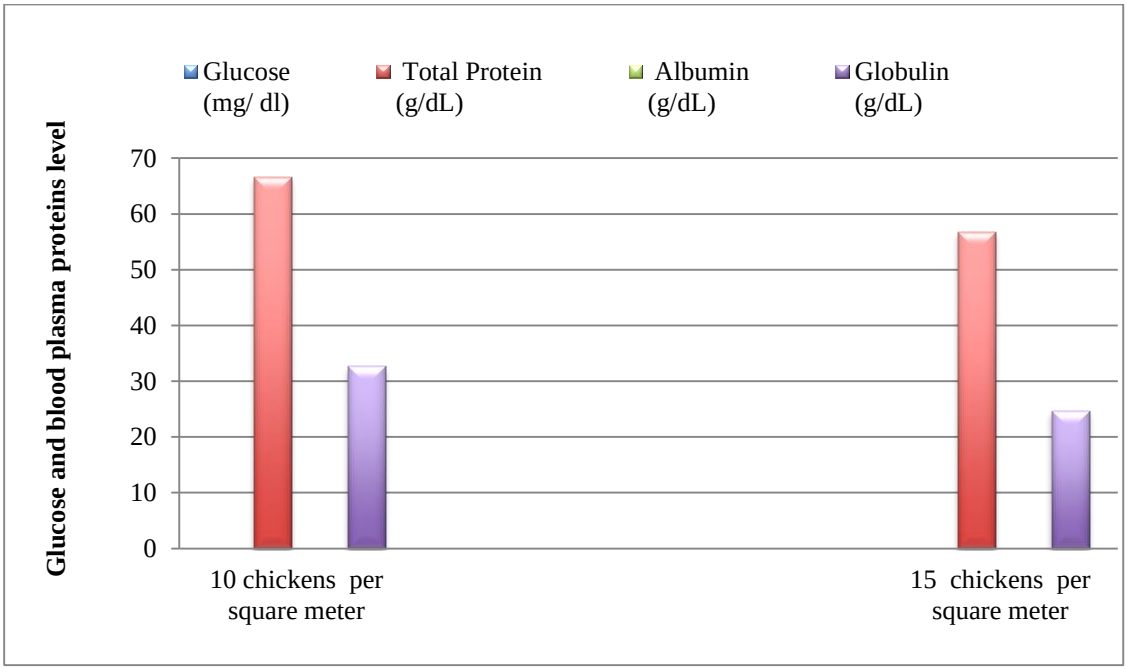


Figure 3.24. Effect of stocking density treatments on the glucose and blood plasma proteins at six weeks of age of broiler

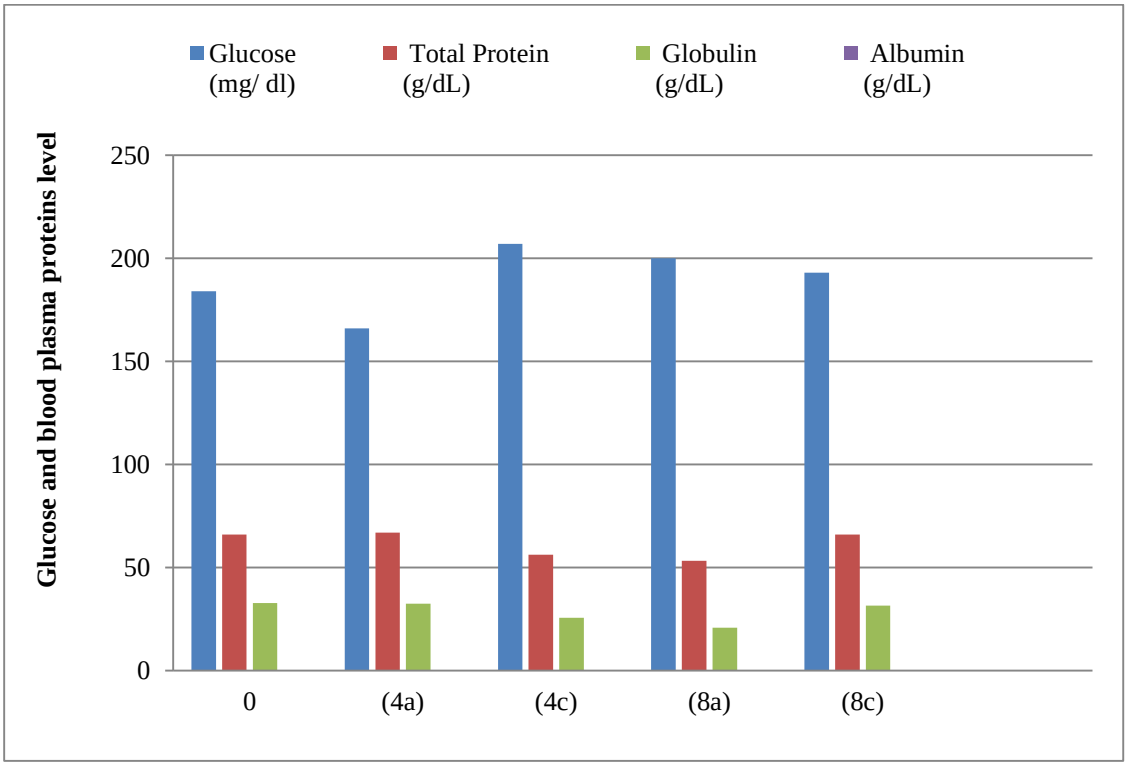


Figure 3.25. Effect of additives treatments on the glucose and blood plasma proteins at six weeks of age of broiler

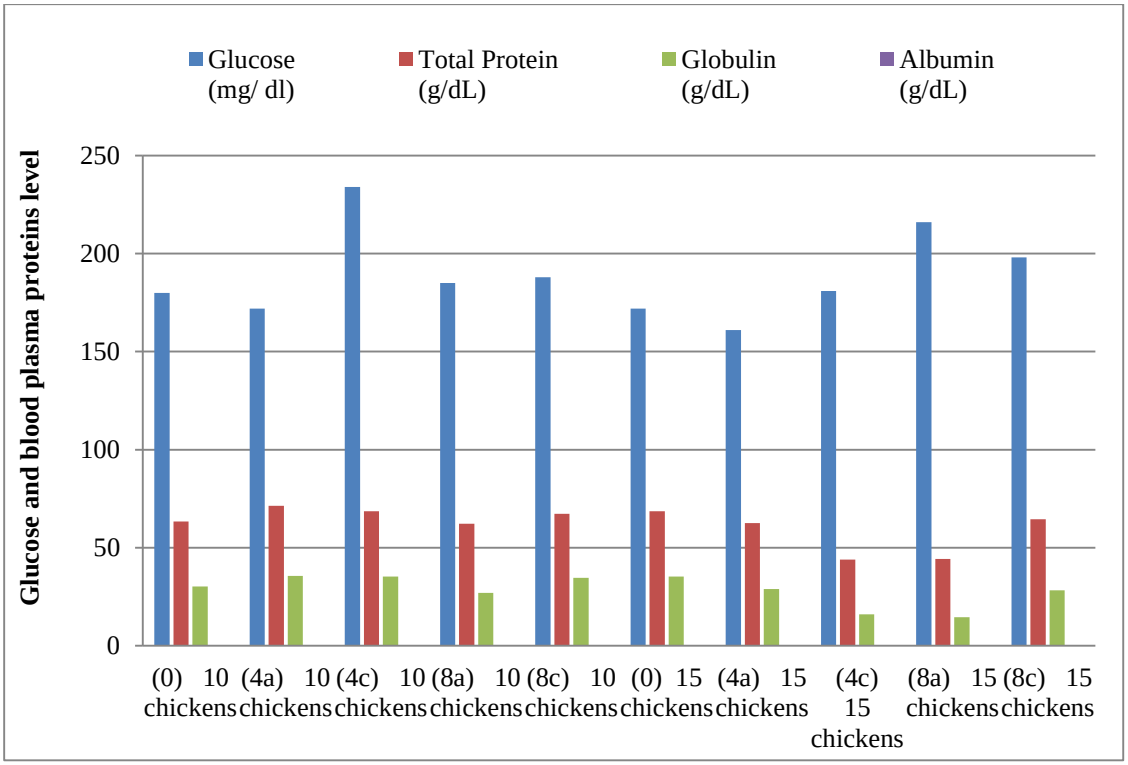


Figure 3.26. The effect of ınteraction between density and additives treatments on the glucose and blood plasma proteins at six weeks of age of broiler

3.3.2.2. Blood Lipid Profile

Effects of stocking density treatments on the level of blood lipid profile of broilers are given in Table 3.15. Non significant difference among the treatment with densities of 10 chickens and the treatment with 15 chickens per square meter in the Cholesterol, Triglyceride, HDL, LDL, and VLDL levels.

Effects of additive treatments on the level of blood lipid profile of broilers are given in Table 3.15 and Figure 3.27. In terms of HDL level,4c treatment had a significant superiority ($P<0.05$) compared to control (0), 4a, and 8a treatments. However, there is no significant difference between the treatments regarding cholesterol, triglyceride, LDL, and VLDL levels.

Effects of interactions between stocking density and additive treatments on the level of Blood Lipid Profile of broilers are given in Table 3.15 and Figure 3.28. In terms of Cholesterol levels, 4a, 4c, and 8c treatments with densities of 10 chickens and control (0), 4c, and 8c treatments with densities of 15 chickens had significantly superior ($P<0.05$) compared to 4a treatment with densities of 15 chicks per square meter. Regarding HDL, 4c with densities of 15 chicks exhibited significantly superior ($P<0.05$) compared to all the treatments with densıty of 10 and 15 chickens per square meter, except the 8c treatment with densıty of 15 chicks per square meter. However, at densities of 10 and 15 chicks, no significant differences were observed among the treatments in the levels of triglycerides, LDL, and VLDL.

Table 3.15. Effect of parsley (*Petroselinum crispum*) extract by dıfferent ways ın drınkıng water and stockıng densıty on blood lipid profile of broiler

Treatment			Cholesterol (mg/dL)	Triglyceride (mg/dL)	HDL (mg/dL)	LDL (mg/dL)	VLDL (mg/dL)
Density		**10**	252	161	43.06	174	32.1
		15	249	151	43.06	177	30.2
Additives		0	247	163	41.3^{bc}	166	32.6
		4a	225	144	40.3^{bc}	156	28.8
		4c	269	154	49.5^{a}	189	30.8
		8a	235	156	39.1^{c}	165	31.1
		8c	275	164	45^{ab}	201	32.5
Interaction	Density	Additives					
	10	0	235^{ab}	166	41.3^{bc}	146	33
		4a	260^{a}	179	40.6^{bc}	183	35.6
		4c	272^{a}	144	47^{ab}	197	28.6
		8a	238^{ab}	144	42.3^{bc}	166	29
		8c	255^{a}	174	44^{bc}	177	34.3
	15	0	260^{a}	161	41.3^{bc}	186	32.3
		4a	191^{b}	110	40^{bc}	129	22
		4c	266^{a}	164	52^{a}	181	33
		8a	233^{ab}	167	36^{c}	164	33.3
		8c	295^{a}	155	46^{ab}	224	30.6
P-value	Density		NS	NS	NS	NS	NS
	Additives		NS	NS	0.002	NS	NS
	Interaction		0.057	NS	0.012	NS	NS
SEM			6.93	4.95	1.007	6.91	1.0004

SEM = Standard Error of Means; NS= Non-significant; 10 or 15 = number of chickens per square meter; $^{a-f}$ = means in the same column with different superscripts are different ($P < 0.05$); 0 = control without additives; 4a or 8a= means 4 or 8 millilitres of aqueous extract per litre of water; 4c or 8c= means 4 or 8 millilitres of alcoholic extract per litre of water; HDL= High-Density Lipoprotein; LDL= Low-Density Lipoprotein; VLDL= Very Low-Density Lipoprotein.

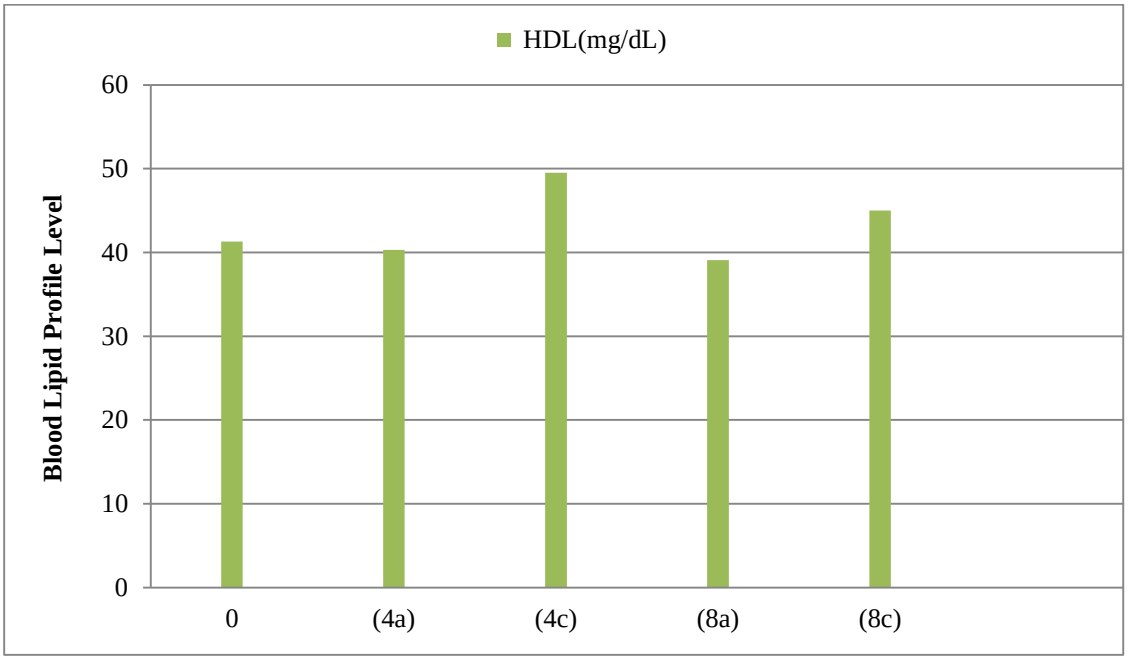


Figure 3.27. Effect of additives treatments on the blood lipid profile at six weeks of age of broiler

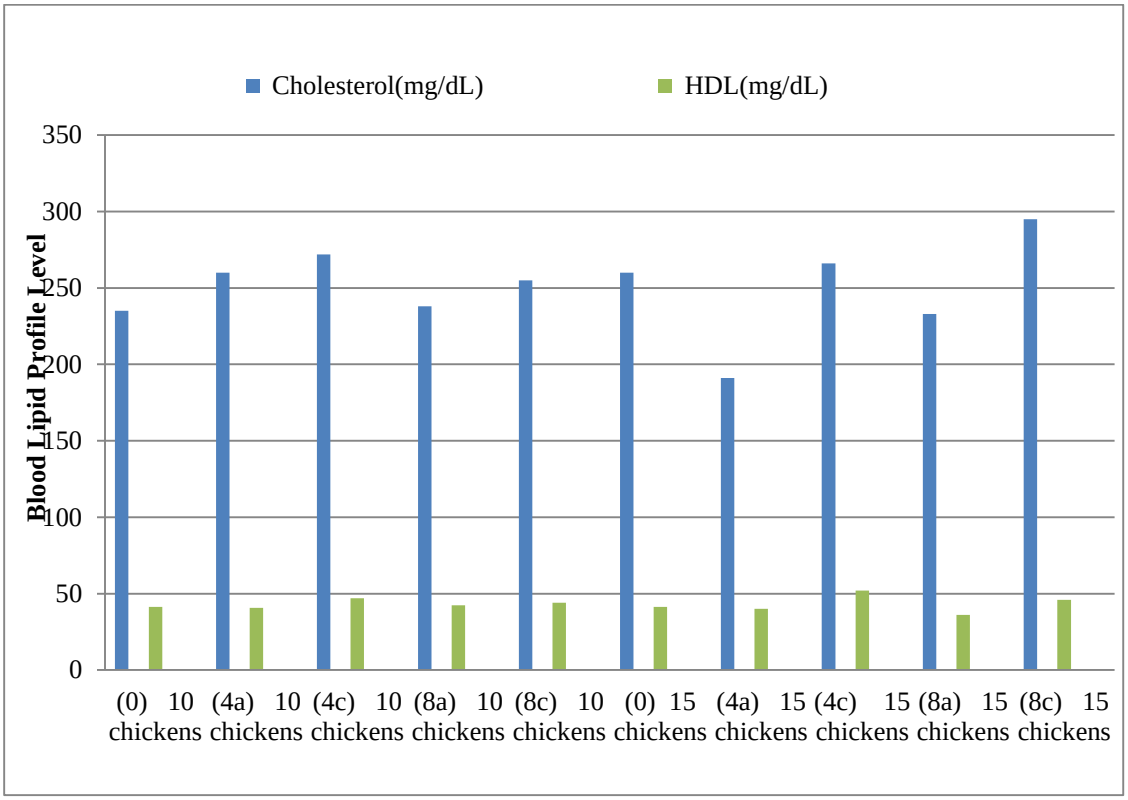


Figure 3.28. The effect of ınteraction between density and additives treatments on the blood lipid profile at six weeks of age of broiler

3.3.2.3. Liver Enzymes and Uric Acid

Effects of stocking density treatments on liver enzymes and uric acid levels of broilers are given in Table 3.16 Figure 3.29. The treatment with a density of 15 chickens per square meter exhibited a significant superiority (P<0.05)compared to the treatment with a density of 10 chicks in the GOT, GPT, and uric acid levels.

The effects of additive treatments on liver enzymes and uric acid levels of broilers are given in Table 3.16 and Figure 3.30**.** In terms of GOT levels, the 4c treatment exhibited a significant superiority (P<0.05) compared to the 4a and 8c treatments. Also, the 8a treatment had a considerable superiority (P<0.05) compared to the 8c treatment. In terms of GPT,4c and 8a treatments had a significant superiority (P<0.05) compared to control (0), 4a, and 8c treatments. Regarding Uric Acid,4c and 8a treatments exhibited a significant superiority (P<0.05) compared to 4a and 8c treatments.

Effects of interactions between stocking density and additive treatments on liver enzymes and uric acid levels of broilers are given in Table 3.16 and Figure 3.31.

Regarding GOT, GPT, and uric acid levels, 4c and 8a treatments with 15 chicks per square meter densities had significantly superior (P<0.05) compared to all treatments with 10 and 15 chickens per square meter.

Table 3.16. Effect of parsley (*Petroselinum crispum*) extract by dıfferent ways ın drınkıng water and stockıng densıty on liver enzymes and uric acid of broiler

Treatment			**GOT (UI/L)**	**GPT (UI/L)**	**Uric Acid (mg/dL)**
Density		**10**	277^{b}	25.9^{b}	1.55^{b}
		15	346^{a}	34.6^{a}	1.91^{a}
Additives		0	317^{abc}	17^{b}	1.69^{ab}
		4a	286^{bc}	17.33^{b}	1.49^{b}
		4c	363^{a}	42.8^{a}	1.92^{a}
		8a	340^{ab}	47.6^{a}	1.99^{a}
		8c	252^{c}	26^{b}	1.56^{b}
Interaction	Density	Additives			
	10	0	347^{b}	17.6^{c}	1.83^{b}
		4a	300^{bc}	23^{bc}	1.41^{b}
		4c	259^{bc}	23^{bc}	1.53^{b}
		8a	220^{c}	27^{bc}	1.46^{b}
		8c	260^{bc}	37^{b}	1.52^{b}
	15	0	288^{bc}	16.3^{c}	1.55^{b}
		4a	272^{bc}	11.6^{c}	1.58^{b}
		4c	466^{a}	62^{a}	2.32^{a}
		8a	460^{a}	67.6^{a}	2.53^{a}
		8c	244^{c}	15.6^{c}	1.60^{b}
P-value	Density		0.001	0.009	0.002
	Additives		0.013	0.0001	0.022
	Interaction		0.0001	0.0001	0.0007
SEM			17.2	3.68	0.079

SEM = Standard Error of Means; NS= Non-significant; 10 or 15 = number of chickens per square meter; $^{a\text{-}f}$ = means in the same column with different superscripts are different (P < 0.05); 0 = control without additives; 4a or 8a= means 4 or 8 millilitres of aqueous extract per litre of water; 4c or 8c= means 4 or 8 millilitres of alcoholic extract per litre of water; GOT= Glutamic Oxaloacetic Transaminase; GPT= Glutamic Pyruvic Transaminase.

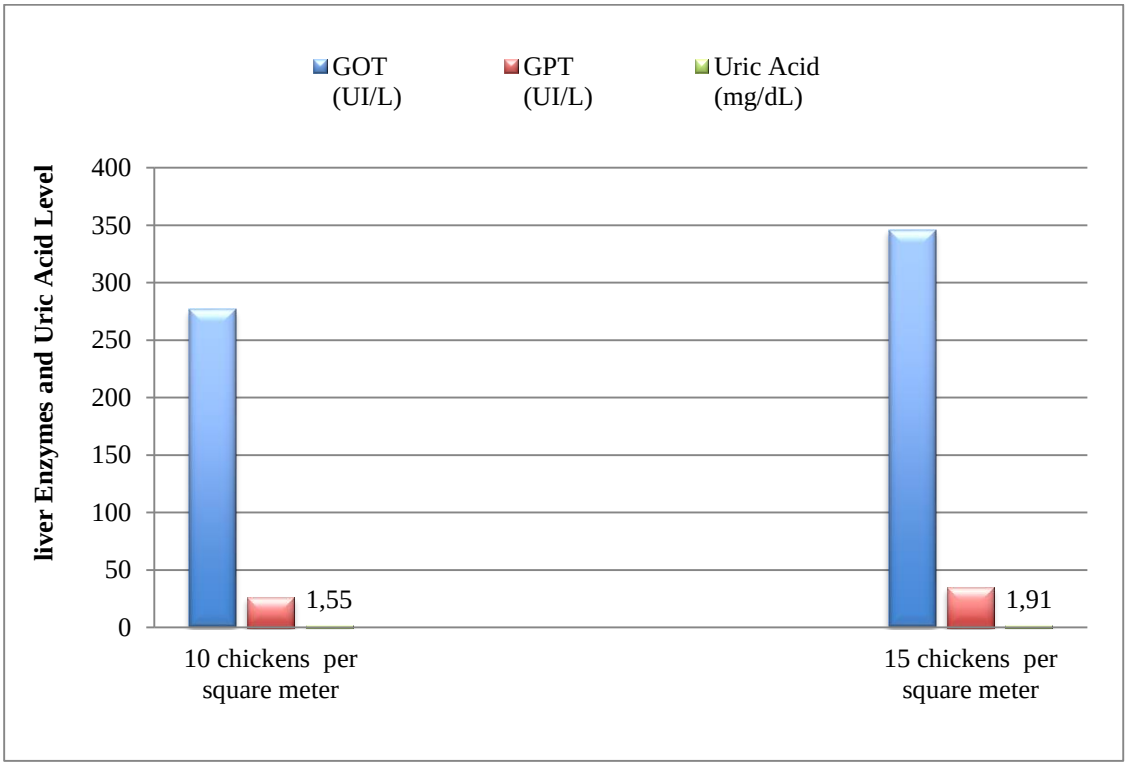


Figure 3.29. The effect of stocking density treatments on the liver enzymes and uric acid at six weeks of age of broiler chicks

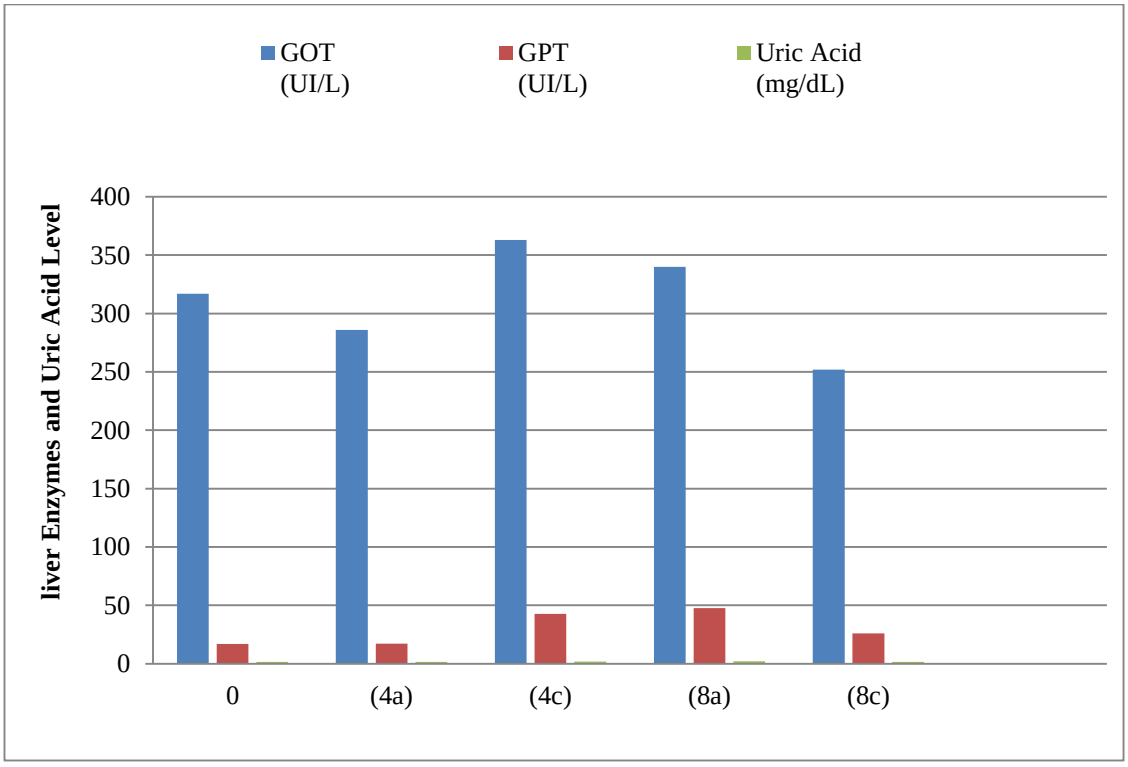


Figure 3.30. The effect of additives treatments on the liver enzymes and uric acid at six weeks of age of broiler

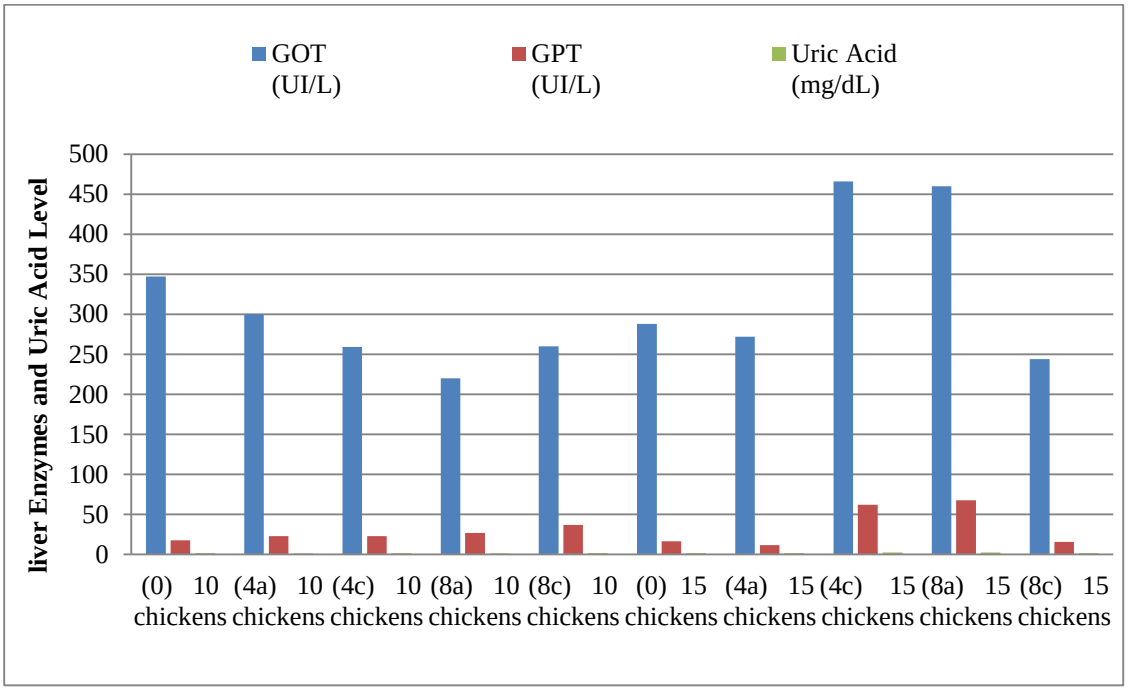


Figure 3.31. The effect of ınteraction between density and additives treatments on the liver enzymes and uric acid at six weeks of age of broiler

3.4. Antioxidant Status

The effects of stocking density treatments on the blood plasma antioxidant status of the broilers are given in Table 3.17. Figure 3.32. The treatment with densities of 10 chickens per square meter exhibited a significant decrease ($P<0.05$) compared to the treatment of 15 chicks per square meter in malondialdehyde, glutathione, and Catalase levels

Effects of additive treatments on the blood plasma antioxidant status of the broilers are given in Table 3.17 and Figure 3.33. In terms of malondialdehyde, all the treatments exhibited a significant decrease ($P<0.05$) compared to the control treatment (0). In terms of glutathione, 4c and 8c treatments exhibited a significant decrease ($P<0.05$) compared to control (0), 4a, and 8a treatments. As for catalase, 4a, 4c, and 8c treatments exhibited a significant decrease ($P<0.05$) compared to control (0) and 8a treatments.

Effects of interactions between stocking density and additive treatments on the blood plasma antioxidant status of the broilers are given in Table 3.17 and Figure 3.34. In terms of malondialdehyde and catalase levels, all treatments with a density of 10 and 15 chicks showed a significant decrease ($P<0.05$) compared to control (0) and 8a

treatments with a density of 15 chickens. As for the glutathione levels, all additives treatments with a density of 10 and 15 chickens showed a significant decrease (P<0.05) compared to the control treatment (0) with a density of 15 chicks, but 8a with a density of 15 chicks had not significantly different among control treatment (0) with a density of 15 chicks.

Table 3.17. Effect of parsley (*Petroselinum crispum*) extract by dıfferent ways ın drınkıng water and stockıng densıty on antioxidant status of broiler

Treatment			Malondialdehyde (nmol/mL)	Glutathione (U/mL)	Catalase (U/mL)
Density		**10**	0.442^{b}	38.2^{b}	1.24^{b}
		15	0.547^{a}	54.2^{a}	47^{a}
Additives		0	0.605^{a}	56.7^{a}	62.7^{a}
		4a	0.485^{b}	52.8^{a}	27.9^{b}
		4c	0.498^{b}	32.8^{b}	18.7^{b}
		8a	0.430^{b}	53.3^{a}	48.9^{a}
		8c	0.456^{b}	35.5^{b}	19.5^{b}
Interaction	Density	Additives			
	10	0	0.440^{b}	35.4^{c}	40.7^{b}
		4a	0.446^{b}	53.3^{bc}	18.1^{b}
		4c	0.430^{b}	31.4^{c}	20.6^{b}
		8a	0.410^{b}	34.1^{c}	21.3^{b}
		8c	0.486^{b}	36.9^{c}	19.7^{b}
	15	0	0.770^{a}	78^{a}	84.6^{a}
		4a	0.523^{b}	52.4^{bc}	37.7^{b}
		4c	0.566^{b}	34.1^{c}	16.9^{b}
		8a	0.450^{b}	72.4^{ab}	76.5^{a}
		8c	0.426^{b}	34.1^{c}	19.3^{b}
P-value	Density		0.002	0.001	0.0001
	Additives		0.016	0.004	0.0001
	Interaction		0.001	0.0003	0.0001
	SEM		0.022	3.52	4.83

SEM = Standard Error of Means; NS= Non-significant; 10 or 15 = number of chickens per square meter; $^{a-f}$ = means in the same column with different superscripts are different (P < 0.05); 0 = control without additives; 4a or 8a= means 4 or 8 millilitres of aqueous extract per litre of water; 4c or 8c= means 4 or 8 millilitres of alcoholic extract per litre of water.

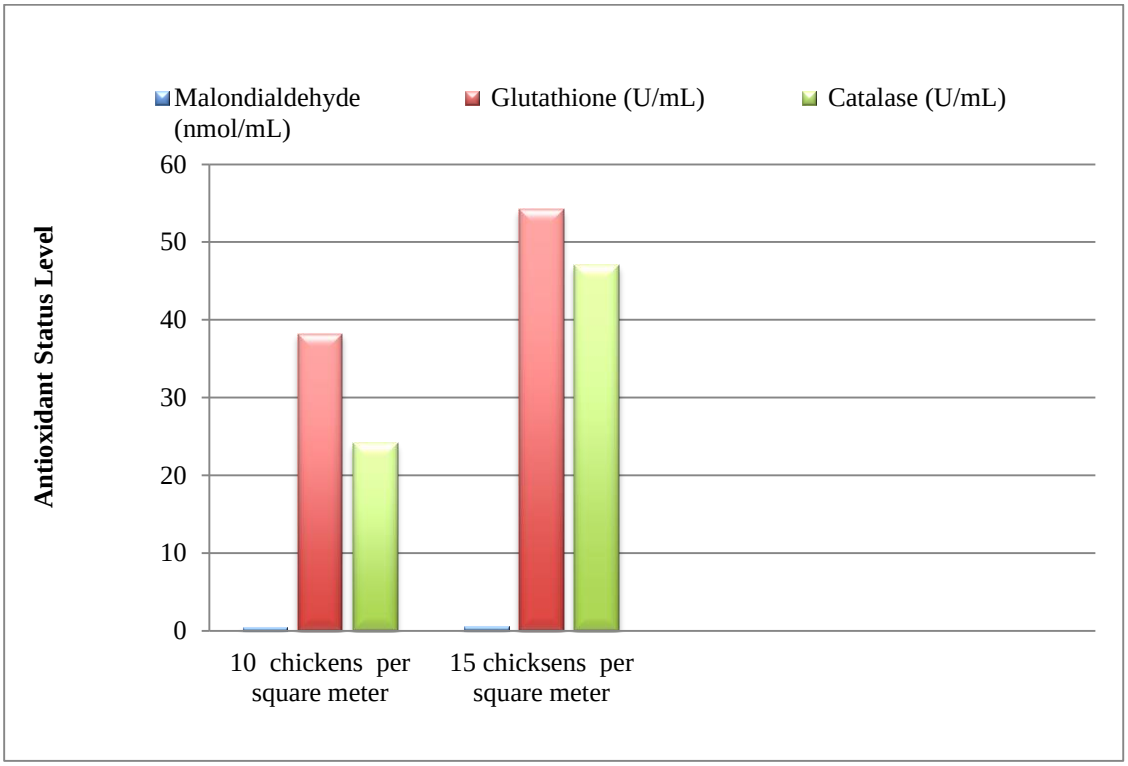


Figure 3.32. Effect of density treatments on antioxidant status at six weeks of age

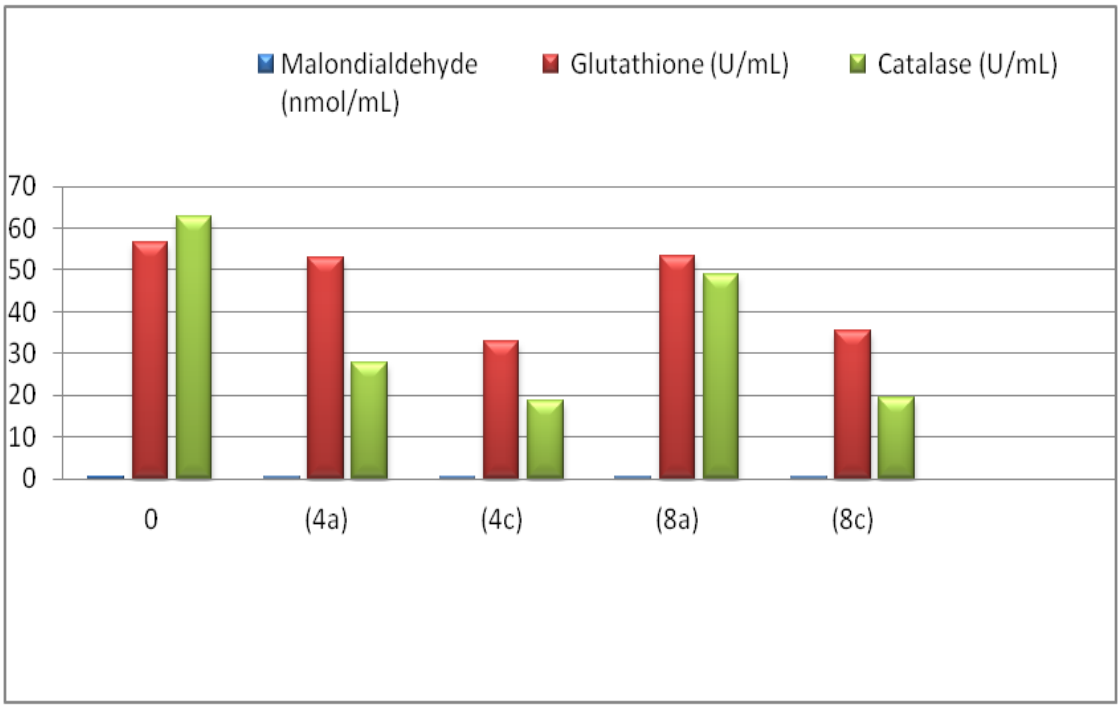


Figure 3.33. Effect of additives treatments on antioxidant status at six weeks of age of broiler

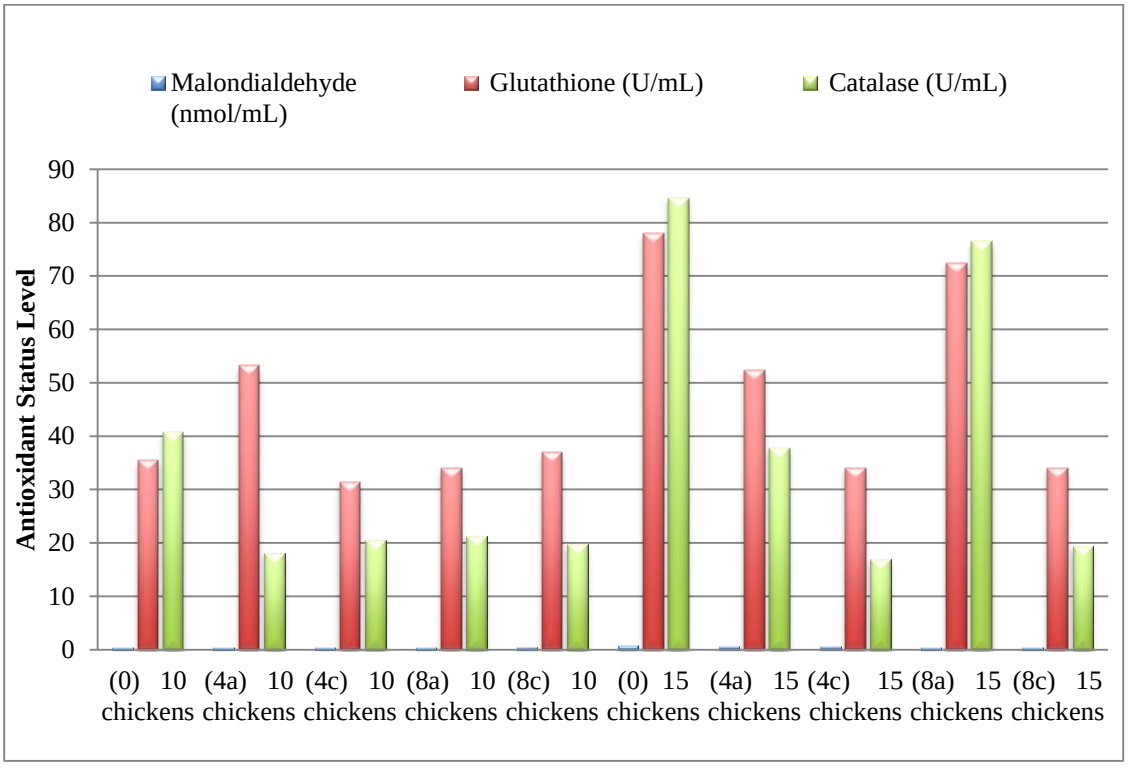


Figure 3.34. Effect of ınteraction between density and additives treatments on antioxidant status at six weeks of age of broiler

CHAPTER 4

DISCUSSION

4.1. Parameters of Chemical Evaluation of Parsley

The recent research results do not correspond with the findings reached by [97]. However, the results regarding moisture content aligned with certain studies; on the other hand, the protein and ash content percentages did not correlate with what was concluded by [113]. The notable differences could be attributed to genetic variations, as well as disparities in the growth cycle of the parsley plant. Furthermore, considering that most of these genetic patterns are cultivated in Northern Europe, this might indicate adaptation to cooler climates than those in the southern Mediterranean region. Such adaptations could be managed by selecting suitable growth locations and corresponding periods [68].

Regarding the Estimation and detection of oxides and some metallic elements of parsley, These results did not agree with what was reached by other authors, e.g. [114] and [115]. This might be brought on by the plant's genetic foundation, growth, and environmental factors [12]. As for detecting some active compounds in parsley aqueous and alcoholic extracts, both extracts' chemical compounds suggest exceptional pharmaceutical activities in conventional and traditional medicine [116]. The unique therapeutic and medicinal effects of plants also rely on the presence of their secondary metabolites. According to the previous plant chemical study, parsley extracts contain the same secondary metabolites, such as flavonoids, saponins, steroids, terpenoids, and glycosides [117]. Alkaloids represent the presence of organic nitrogen compounds with antibacterial properties. Flavonoids and saponins are the primary phenolic compounds that are anti-inflammatory, antimutagenic, antioxidant, and anticancer agents. Terpenoids have been identified as treatments for liver protection, antipyretic effects,

antidiabetic properties, pain relief, and relaxation therapies. Parsley is often used as a remedy for nausea, a laxative, and an anthelmintic for fever medications[118]. Determining some minerals and heavy metals in the aqueous and alcoholic parsley extracts, These results do not follow other authors [119], which may be attributed to genetic variations and other factors[119]. As for the GC-MS analysis of aqueous and alcoholic parsley extracts, these results indicated that the aqueous extract of parsley has many active compounds with diverse natures. These phytonutrients are present in all parts of the parsley plant. Recently, the entire plant contents of active compounds were thoroughly studied [80]. It is evident that sterols are the primary compounds in the alcoholic extract of parsley and compromise more than 80% of the active compounds in the plant. Compounds from flavonoid groups like apigenin, chrysin, and volatile oils are well-known in parsley [119].

4.2. Production Performance

This work was conducted to investigate the effects of *Petroselinum crispum* extract in different ways in drinking water and stocking density on the broiler's productive and physiological performance and antioxidant status. Medicinal plants possess therapeutic capabilities because of certain chemical compounds in their tissues that might impact the human body or animals. These chemicals include alkaloids, flavonoids, essential oils, and other bioactive molecules [120]. Medicinal plants contain flavonoids, potent chemicals known for enhancing health, reducing illness risk, and acting as antioxidants to combat free radicals [62]. One of these herbs is parsley, scientifically referred to as Petroselinum. It is a herb and medicinal plant characterized by leaves that possess a higher concentration of volatile oils than their roots. The foliage is saturated in mineral salts, iron, calcium, phosphorus, and vitamins A and C [10]. The reason for the significant superiority in body weight and weight gain in the additional treatments and the interaction between addiction and density in T 3 and 5 with 10 and 15 chickens per square meter in the rest of the treatments is parsley, which includes potent chemicals that enhance digestion [121]. Moreover, these chemicals function as growth stimulants (Apiole) and enhance the activity of digestive enzymes [10]. Therefore, the nutritious content of feed items should be maximized. Parsley may contribute to increased live weight by regulating digestion and metabolism, as its leaves contain flavonoids that serve as natural antioxidants. It activates enzymes like Glutathione Peroxidase, which

safeguards tissues against peroxides and inhibits the breakdown of body proteins, thus promoting body weight and weight gain in birds [122]. Also, dried parsley leaves contain volatile oil with active chemicals Myristicin and Apiole, which are the plant's active components [13]. This process enhances protein and fat digestion in birds by promoting the release of digestive juices in the digestive tract, maximizing the utilization of essential nutrients for vital functions and chemical reactions [123]. The potential enhancement in body weight and weight gain for the treatment of aqueous and alcoholic extracts may be attributed to active compounds, specifically phenolic compounds, which possess antioxidant properties akin to those of vitamin E. These compounds promote intestinal flora within the digestive tract, stimulating the activity of digestive enzymes such as amylase, trypsin, chymotrypsin, and lipase. Consequently, this enhances the efficiency of nutrient digestion and absorption, increasing body weight and weight gain [124]. Flavonoids also exhibit a structure and function similar to steroid hormones [125]. Steroid hormones boost nutritional metabolism by acting as structural hormones that enhance body growth, stimulate the production of structural proteins in muscles, and decrease protein breakdown [126]. As for feed consumption, the increase in feed consumption for parsley aqueous and alcoholic extract may be attributed to the elevated levels of active chemicals and flavonoids in the extract. These compounds exhibit antibacterial properties and possess the ability to disrupt the cellular membranes of pathogenic fungi, hence exhibiting antioxidant activity [12]. In addition, parsley is rich in apigenin, a powerful antibacterial compound that efficiently fights bacteria such as Escherichia coli, Salmonella typhi, and Candida albicans. This enhances digestive efficiency and promotes feed consumption by reducing the presence of pathogen microbes [10]. Parsley oil has properties that strengthen the immune system because it contains volatile oils such as α-pinene, a piol, and myristicin, which has shown effectiveness in transporting an enzyme glutathione-s-transferase Which helps bind glutathione with oxidative molecules that damage the cellular membrane [86].

Since parsley oil contains the compound limonene, which is rich in vitamin C, it is beneficial for birds' health, as it reduces stress and thus increases feed consumption. It also contains β-carotene, converted into Vitamin A, as it maintains the cell membrane of all tissues [86]. As for the food conversion Ratio, The observed enhancement in the feed conversion ratio in both the aqueous and alcoholic parsley extracts may be related to

active compounds that enhance the resilience of gut tissue. This, in turn, results in improved utilization of feed components and increased metabolic rates [127]. Additionally, there is an enhancement in the efficiency of digestive enzyme release in the digestive system and the maintenance of microbial equilibrium in the gut [128]. The observed reduction in mortality rates and improvement in relative growth may be attributed to active constituents in parsley. These constituents possess antimicrobial and antioxidant properties, which contribute to improving intestinal health and mitigating disease risk in broiler chickens. Consequently, this improvement in intestinal health facilitates enhanced nutrient absorption, promoting improved growth and overall health outcomes[10]. Medicinal plants contain flavonoids, potent chemicals known for enhancing health, reducing illness risk, and acting as antioxidants to combat free radicals; thus, they reflect positively on public health[62]. As for the production index and economic index, where the parsley plant includes unsaturated fatty acids like palmitic and oleic, along with phenolic substances such as carvacrol and geraniol, which contribute to its antioxidant properties, ability to combat free radicals, and function as an antidote against dangerous germs and fungus, parsley contains flavonoids, secondary metabolic products of plants that enhance digestion and absorption by stimulating the secretion of pancreatic enzymes such as amylase and protease, this process improves protein digestion, converting them into amino acids and increasing their absorption efficiency from the digestive tract, ultimately promoting body weight and weight gain, Enhancing the efficiency of food conversion and thus reflecting positively on the productive and economic indicator [87]. The reason for the moral superiority of the aqueous and alcoholic extract of parsley is due to the effectiveness and ability of parsley, which contains active compounds, nutrients, and vitamins, the most important of which is vitamin C, in addition to its ability to suppress harmful free radicals, which reduce harmful oxidative stress. In addition, its ability and the compounds it contains, such as citral, can hinder the growth of microorganisms. All of these worked to enhance the general health of broilers, improve digestibility, and increase the benefit of nutritional elements. This led to an increase in productive performance indicators such as live body weight, weight gain, and feed conversion, which reflected positively on the production index and the economic indicator [86]. Research has proven that including parsley in bird diets enhances the productive performance of broiler chickens [87].

4.3. Physiological Performance

4.3.1. Cellular Blood Characteristics

In general, adding parsley aqueous and alcoholic extract to drinking water significantly improved this study's heterophiles (%) and lymphocytes (%). This improvement in blood parameters can be explained by parsley being a good source of iron, beta-carotene, and vitamin C, which are beneficial for promoting general health [129]. According to studies, parsley increases blood volume because of its high iron level and vitamin C content, facilitating iron absorption. Parsley is a fantastic digestive aid. It facilitates better protein and fat digestion, which increases intestine absorption as well as liver assimilation and storage [91]. The reduction in stress resulting from the use of the aqueous and alcoholic extract of parsley also leads to an improvement in the immune balance, which is reflected in the percentage of heterogeneous cells (%) and lymphocytes (%). The extract reduces oxidative and inflammatory stress, decreasing the percentage of heterogeneous cells (%), which is associated with increased stress in birds. In contrast, this effect contributes to raising the percentage of lymphocytes (%), which enhances the immune response and the body's ability to resist environmental and pathological stresses. Therefore, the improvement in these percentages reflects the extract's effectiveness in reducing stress and enhancing the physiological and immune performance of birds[129]. Parsley contains enzymes such as amylase, protease, and lipase, which aid in the breakdown of carbohydrates, proteins, and fats, respectively.

Additionally, it is rich in antioxidant enzymes, including superoxide dismutase (SOD) and catalase, which support cellular health and metabolism [123]. Studies have shown that the high concentration of important fatty acids, vitamin B_{12}, beta carotene, vitamin C, and chlorophyll in parsley improves immunity. As a green plant and one of the most vital herbs for giving the body vitamins, parsley is a multivitamin and mineral complex that boosts immunity [91]. Nevertheless, it was established that parsley mitigates stress through its ability to improve overall health and immune function [130]. Previous studies have demonstrated that the administration of Zearalenone, a non-steroidal estrogenic mycotoxin found in maize, to mice, results in significant stress on the testis and endocrine function, affecting both the testis and the pituitary gland indirectly; nevertheless, the researchers observed that administering parsley to these mice led to

notable enhancements in all the examined parameters [131]. According to the researchers' findings, parsley exhibits a significant abundance of myristicin, which demonstrates a notable capacity to stimulate the detoxifying enzyme glutathione S–S-transferase (GST) inside mice's hepatic and intestinal mucosa [132]. Previous studies have reported the presence of flavonoids (apiin, luteolin, and apigenin glycosides), essential oils (apiol and myristicin), coumarins (bergapten and imperatorin), and vitamin C in parsley. The antioxidant properties of parsley can be attributed to its high concentration of flavonoids, which can neutralize free radicals and upregulate the synthesis of glutathione s-transferase (GST) [133]. The researchers have that parsley extract may possess protective effects against diabetes-induced hepatotoxicity, owing to its antioxidant capabilities.

Additionally, it is believed to exhibit free radical scavenging and membrane-protecting actions [85]. According to researchers, the application of parsley oil led to elevated levels of glutathione reductase and superoxide dismutase and enhanced overall antioxidant activity [134]. Parsley chlorocompounds frequently exhibit notable biological actions, such as antibiotic, antitumor, antiviral, antibacterial, anti-inflammatory, antihepatotoxic, and pesticidal antioxidant properties. These activities collectively contribute to improving overall bodily health [135]. Adding parsley to poultry increased concentrations of the enzyme glutathione reductase and superoxide and increased antioxidant activity [87].

4.3.2. Biochemical Blood Characteristics

Glucose and blood plasma proteins, medicinal plants exhibit therapeutic properties due to specific chemical compounds inside their tissues, which can affect humans and animals. The chemical above compounds encompass alkaloids, flavonoids, essential oils, and other bioactive substances [120]. Flavonoids are powerful molecules renowned for improving health, lowering the risk of sickness, and serving as antioxidants to battle free radicals. Flavonoids are found in medicinal plants [62]. The herb parsley, also called Petroselinum, is one of these herbs and medicinal plants. Its leaves have a higher volatile oil content than its roots. Iron, calcium, phosphorus, mineral salts, and vitamins A and C are all in the leaves[10]. According to studies, parsley improves blood parameters, including protein and glucose levels and lowers cholesterol [130].

The excellent outcomes may be attributed to the presence of potent chemicals in the aqueous and alcoholic extracts of parsley. Parsley is recognized as a rich source of iron, and its leaves also contain vitamin C, which aids in iron absorption [130]. Hence, it effectively mitigates avian stress by augmenting the production of the hormone thyroxine, thereby enhancing metabolic activity and accelerating biochemical reactions within the body. Consequently, this promotes muscle tissue development, resulting in a sustained elevation of total protein and globulin levels in the serum—avian blood. Parsley is rich in essential elements like iron, calcium, salt, and potassium. It is also a source of vitamins such as A and C, riboflavin, and amino acids derived from the plant's active compounds [13]. The increase in "globulin concentration" in Parsley (Third and Fourth Treatment) may be attributed to the therapeutic characteristics of the Parsley plant, which significantly contribute to the elevation of globulin immunological serum levels. This phenomenon demonstrates its capacity to augment cellular immunity, bolster the body's immune response, and sustain overall health [130].

Regarding the Blood Lipid Profile, HDL functions as a carrier for cholesterol, reversing its movement from different organs in the body and bringing it back to the liver, where it is converted into bile acids [136]. A high quantity of HDL indicates that metabolic processes are functioning well since it is a carrier. It facilitates the metabolism and excretion of cholesterol from bodily tissues to the liver. Thus, HDL plays a crucial role in decreasing the occurrence of atherosclerotic illnesses [137]. The significant increase in HDL may be attributed to the effect of the active substances present in dried mint leaves, which are Apiole and Myristicin, which work to activate the lipase enzyme and the 7-α-hydroxylase enzyme, which is responsible for converting cholesterol into bile acids [138].

On the other hand, it was found that parsley leaves are rich in phenolic substances, which prevent the oxidative decomposition of fats [139]. Studies have shown that active compounds such as glycosides, flavonoids, and alkaloids can inhibit and eliminate free radicals and decrease fatty acids in the blood plasma, reducing glycerides [140]. Concerning liver enzymes and Uric acid, research suggests that the inclusion of medicinal herbs in the diet of broiler chickens enhances their health by decreasing the levels of liver enzymes GPT and GOT in their blood plasma [6]. The low levels of liver enzymes seen in birds treated with medicinal plants may be attributed to the plant's

capacity, as well as the active chemicals they contain, to repair liver tissue or restore cellular permeability that cytotoxic agents may disrupt. These two enzymes, GOT and GPT, are found in several tissues of broiler chickens. The liver, heart, skeletal muscles, and kidneys have a high concentration of GOT, whereas the blood serum has a lesser quantity. Thus, any physiological variation or injury impacting these tissues and organs will result in a greater percentage rise of this enzyme in the blood serum [141]. As for uric acid, the reason for the significant superiority of the coefficients may be due to parsley containing effective antioxidant substances that enhance the role of antioxidants that are abundant in body fluids and tissues, such as glutathione or ubiquinone, which are present inside cells, while uric acid is an antioxidant that is distributed in a balanced manner, Throughout the body, when it rises steadily above the physiological values permitted in living organisms, it can cause some diseases [142].

4.4. Antioxidant Status

By the existence of certain chemical substances inside their tissues, medicinal plants have the potential to be therapeutically effective. These chemicals may affect the human body or animals. For example, alkaloids, flavonoids, essential oils, and other bioactive compounds are included in this category of chemicals [120]. Flavonoids are powerful molecules renowned for improving health, lowering the risk of sickness, and serving as antioxidants to battle free radicals. Flavonoids are found in medicinal plants [62].

Some of these therapeutic plants and herbs include the herb parsley, which is also referred to as Petroselinum. The leaves of this plant contain more volatile oils than the roots. In addition to vitamins A and C, the leaves provide a source of mineral salts, iron, calcium, and phosphorus [10]. The decrease in Malondialdehyde may be due to the treatments in which the aqueous and alcoholic extract of parsley was used because parsley is an antioxidant, and parsley leaves contain many active substances that, in turn, act as antioxidants. It is rich in vitamin C and phenolic substances (Phenols And Flavonoids) [10]. Antioxidants work to restrict free radicals within the body, including their containment of hydroxyl groups [143].

Additionally, antioxidants can inhibit the activity of enzymes involved in oxidative processes, such as NAD(P)H oxidase, xanthine oxidase, and protein kinase, which are components of the electron transport chain. By targeting these enzymes, antioxidants

can help prevent lipid peroxidation [144]. As for the glutathione and Catalase levels in blood serum, the decrease in glutathione levels may be due to it being the first line of defence against oxidative stress [145]. Glutathione is one of the most important antioxidant compounds that protect cells from free radicals. Its decrease in blood serum glutathione may be due to its association with fat oxidation products [145]. This is, on the one hand, and on the other hand, glutathione (GSH) is often converted by cells in hydrolysis into amino acids or individual peptides and then contributes to the construction of proteins, and this, in turn, is reflected in the body weight and thus an increase in body weight [144]. As for the non-significant increase in antioxidant enzymes, research has shown that the effectiveness of antioxidant enzymes varies from one strain to another [146].

CHAPTER 5

CONCLUSION AND RECOMMENDATION

It is concluded from this field study that stocking density had an essential effect on the overall performance of poultry. Treatments 4c and 8c showed better results at a density of 10 chickens as compared to 15 chickens, where the density of 10 chickens contributed to improving productive performance indicators, such as weight gain and feed conversion efficiency, in addition to enhancing the antioxidant status in blood plasma and reducing oxidative stress. However, the density of 15 chickens also had a positive role, as it contributed to reducing oxidative stress and improving the overall health of poultry, albeit to a lesser extent than the density of 10 chickens. Based on these data, it can be recommended to adopt a relatively low stocking density, about 10 chickens, to maximize the overall performance of poultry, taking into account the importance of using additive treatments such as 8c to achieve optimal results. Also, the density of 10 chickens showed superiority in the percentage of Heteroophiles, glucose levels, total protein and globulin, and cholesterol levels in some treatments. Density of 15 chickens: showed superiority in HDL levels, liver enzymes, and uric acid. Therefore, if the aim is to improve blood health and protein and lipid levels, a density of 10 chickens may be the best. However, if the goal is to improve HDL levels and liver health, a density of 15 chickens may be more effective. The best treatment in terms of overall performance was treatment (4C), which showed superiority in glucose levels, total protein, and globulin and achieved good results at densities of 10 and 15 chickens. To further optimize the study, it is recommended to utilize both aqueous and alcoholic extracts at varying concentrations, as well as different stocking densities, to evaluate their effects on egg production. It is also concluded from this laboratory study that the parsley plant is an herbal plant that is useful as a rich source of many nutrients. This

plant contains protein and little amount of oil. The ash content of this plant is fairly good. Sodium, potassium, calcium, iron, manganese, copper, zinc, and other elements are present in the plant. Various types of active compounds are present in each of the aqueous and alcohol extracts of plant leaves. The aqueous extract has many esters and volatile compounds, and the alcohol extract has sterols as the main compounds. These findings support the established medicinal properties of parsley and warrant further research into its potential applications in different fields.

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PUBLICATIONS

Ali, I. M., Nafea, H. H., & Ilbas, A. I. 2025. Aqueous and alcoholic parsley (*Petroselinum crispum*) extracts supplemented into drinking water and stocking density affect productive performance and antioxidant status of broilers. **J. Anim. Plant Sci., 35** (1): 1-12. https://www.thejaps.org.pk/Volume/2025/35-01/14.php

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