Calcium and Total Protein Levels
In Rock Pigeon (*Columba livia domestica*)
And
Jungle Fowl (*Gallus gallus domesticus*)

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Dedication

I dedicate to:

My lovely parents for their support and encouragement.

Through the years

My Kind brothers who stood beside me

My sisters

All my friends

My teachers

And to all whom I love and everyone who helped me in this work.
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In the name of God, the merciful and the compassionate who gave me the strength to do this work.

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Abstract

The values of haematological indices in domestic and wild birds could be an important source of information with valuable diagnostic meaning. They could provide or support an objective assessment of the health status and could support the correct diagnosis in different pathological states. Moreover, it will provide a good reference for the nutritional value of the birds' meat. This study was carried out to provide reference values for serum calcium and total protein in *Columba livia* and *Gallus gallus*, compare the levels of serum calcium and total protein in the two species, and determine the nutritional value and quality of the meat for the two species.

20 birds were divided into two groups with 10 pigeon and 10 chickens in each group. Blood samples were drawn from the birds' left and right brachial vein, and biochemical tests were established using extracted serum. All samples were measured by the spectrophotometer.

The results of our study show that in the *Columba livia domestica* the mean of the protein concentration was 2626.00 mg/dl, and that of calcium was 8.88 mg/dl. Whereas in the *Gallus gallus domesticus* the mean of the calcium concentration was 15.693 mg/dl, and that of total protein was 6298.80 mg/dl. There is a significant difference between the calcium concentration in the *Columba livia* and *Gallus gallus*. And, there is a significant difference in the protein concentrations between the two species.

It is concluded that there is a significant in both calcium and total protein concentration in species. The difference in calcium level between the two species may be due to the amount of calcium in the diet provided to each species. The high total serum protein level may be a mechanism through which the birds try to maintain colloid osmotic pressure by increasing the total protein as result of a decrease in another parameter. This information must be taken into account in the nutrition of people suffering from serious diseases such as diabetes, heart diseases, gout and many other cases. Further studies with large population are required.

**How much is the standard for each species?**
Chapter One

Introduction and Literature Review

Poultry is the second most widely eaten meat in the world, accounting for about 30% of meat production worldwide. Poultry is a category of domesticated birds kept by humans for the purpose of collecting their eggs, or killing for their meat and/or feathers. These most typically are members of the superorder Galloanserae (fowl), especially the order Galliformes which includes chickens, quails and turkeys and the family Anatidae in the order Anseriformes, commonly known as "waterfowl" including domestic ducks, domestic geese and ceterim. Poultry also includes other birds which are killed for their meat, such as pigeons or doves or birds considered to be game, such as pheasants (Wikipedia (a)).

1.1. Chicken (*Gallus gallus domesticus*):

1.1.1. Scientific Classification:

Kingdom: Animalia

Phylum: Chordata

Class: Aves

Order: Galliformes

Family: Phasianidae

Genus: Gallus

Species: Gallus gallus

Subspecies: Gallus gallus domesticus
Figure 1.1: Chicken (*Gallus gallus domesticus*)

1.1.2. General Description

The chicken (*Gallus gallus domesticus*) is a domesticated fowl, a subspecies of the Red Junglefowl. Gallus gallus' plumage is gold, red, brown, dark maroon, orange, with a bit of metallic green and gray. There are also some white and olive feathers. On either side of the head there appear two white patches, shaped like an ear. In addition, Gallus gallus can be distinguish from other chickens by these white patches, and also by their grayish feet. The red junglefowl can measure up to 70 centimeters in length. They have a total of fourteen tail feathers. Gallus gallus rooster tails can be almost 28 centimeter in length. The rooster is said to be more brilliantly colored than its tame relative. During June to October, Gallus gallus moults into an eclipse plumage. An eclipse plumage is, for male, black long feather across the middle of his back and slender red-orange plumage on the rest of his body. For a female, an eclipse plumage cannot be distinguished, but she does moult. The female red is leaner than tame hens (North and Bell 1990; Stevens 1991, Peterson and Brisbin 1999; Gautier, 2002).

1.1.3. Geographic Range

Gallus gallus is native to Southern Asia, particularly the jungles of India. They spread all over the world when people domesticated the chicken (Stevens 1991, Peterson and Brisbin 1999).

1.1.4. Habitat

Gallus gallus lives in thick secondary forest or lush belukar. In the morning or evening, the bird can be found in an open area by wide earthen tracts or clearing, where the red jungle fowl finds food. Sometimes Gallus gallus can be seen in oil-palm estates (Gautier, 2002).
1.1.5. Behavior

Gallus gallus has very especial social system including a pecking order, with one dominating all, and one submitting to all. There is one pecking order for female and one for male.

The physical action for dominance is to raise the tail and head. Submission is shown when a Gallus gallus lowers his tail and head, crouches, and tilts the head to one side. The dominating cock Protects hens. In order to fight, hens must go at least ten feet away from the dominating cock. When a dominating cock dies, the next higher cock in the pecking order takes charge immediately. The pecking order is introduced to chicks when they are just a week old. An order is accomplished in about seven weeks. The dominating cock’s sphere of influence is about sixty to seventy feet (Limburg 1975; Gautier, 2002).

1.1.6. Diet

Gallus gallus is a herbivore and insectivore. They eat corn, soybean, worms, grass, and different kinds of grains found on the ground. They cannot detect sweet tastes. They can detect salt, but most of them do not like it (Damcow 1995, Limburg 1975, Gautier, 2002).

Scavenger chickens are usually self-reliant and hardy, capable of withstanding the abuses of harsh climate, minimal management, and inadequate nutrition. They live largely on weed seeds, insects, and feeds that would otherwise be a waste (Vietmeyer et al., 1991).

1.1.7. Domestication

Chickens (Gallus Gallus domesticus) were first domesticated from a wild form called red junglefowl (Gallus gallus), a bird that still runs wild in most of southeast Asia, likely hybridized with the grey junglefowl Gallus sonnerattii which present about 8,000 years ago. Recent research suggests that there may have been multiple origins
in distinct areas of South and Southeast Asia, including North and South China, Thailand, Burma and India.

Behaviorally, domesticated chickens are less active, have fewer social interactions, are less aggressive to would-be predators, and are less likely to go looking for foreign food sources than their wild ancestors. Other changes include increased adult body weight and simplified plumage; egg production starts earlier, is more frequent, and produces larger eggs (Hirsh, About.com).

According to Eklund and Jensen, (2011) domestication of chickens appears not to have significantly altered the relative frequencies of different activities or average inter-individual distances, but have caused some changes in behavioural synchronization and maintenance of activity-specific inter-individual distances in chickens. The changes may indicate an adaptive response to captivity and domestication.

1.1.8. Economic Importance

The domestic chicken (Gallus gallus domesticus) is the most important domestic avian species for the industrial production of meat and eggs. These birds are used mainly for eggs and meat production. Sometimes they are used for cock fighting or chicken competitions. Gallus gallus feathers were used for pillows and mattress (Limburg 1975, Peterson and Brisbin 1999).

Under natural conditions, chickens present seasonal reproduction, and their sexual activity is dependent on the daylight stimulation of the pineal gland. In order to obtain maximum progeny output in intensive poultry reproduction, fertility must be continuous during the birds’ adult life (Roche, et. al., 2009).

Chickens in developing countries provide nutrition for the family, a small cash flow reserve for times of celebrations or need and in some areas contribute to religious ceremonies and recreation (Roberts, 1995). To the world’s poor, chickens are probably the most nutritionally important domestic animal species (Apuno, 2011).
In Khartoum State, commercial poultry production is divided into three farms systems namely: the modern closed system, the semi-closed system and the open system. The production of the modern closed system poultry is practiced by large companies under controlled environment and advanced managerial standards, while the closed system secures the optimum circumstances for the birds. The closed system is managed more scientifically than the other system, and the flocks are intensively reared in closed houses using air conditioners or ventilation fans to regulate the weather inside the houses, beside artificial day-length regulation using electricity. They concluded that, feed cost was the main cost item in different farm types and sizes. Besides, high percentage of mortality cost and prices of day-old chicks and (4 – 5 months) hens were also high. Moreover they mentioned that, the large size farm was more efficient than other sizes and type of farms (Emam, and Hassan, 2010).

1.2. Pigeon (*Columba livia*)

1.2.1. Scientific classification

Kingdom: Animalia

Phylum: Chordata

Subphylum: Vertebrata

Class: Aves

Order: Columbiformes

Family: Columbidae

Subfamily: Columbinae

Genus: Columba

Species: Columba livia
Figure 1.2: *Columba livia*

http://www.digitale-naturfotos.de/galerie/taubenvoegel-columbiformes.php
12.2. General Description

The Rock Dove (*Columba livia*) adult is 29 to 37 cm long with a 62 to 72 cm wingspan. Its weight ranges from 238 to 380 grams, although overfed domestic and semi-domestic individuals can exceed normal weights. It has a dark bluish-gray head, neck, and chest with glossy yellowish-greenish, greenish, and reddish-purple iridescence along its neck and wing feathers. The iris is orange, red or golden with a paler inner ring, and the bare skin around the eye is bluish-grey. The bill is grey-black with a conspicuous off-white cere, and the feet are purplish-red. Among standard measurements, the wing chord is typically around 22.3 cm, the tail is 9.5 to 11 cm, the bill is around 1.8 cm and the tarsus is 2.6 to 3.5 cm (David, et. al., 2010).

The adult female and male is almost identical, but the iridescence on the neck is less intense and more restricted to the rear and sides, while that on the breast is often very obscure (David, et. al., 2010). The best identification character of the pure rock dove is its white lower back, the two black bars on its pale grey wings are also distinctive. The tail has a black band on the end and the outer web of the tail feathers are margined with white. It is strong and quick on the wing, dashing out from sea caves, flying low over the water, its lighter grey rump showing well from above (Wikipedia (b)).

Young birds show little lustre and are duller. The pigeon eye colour is generally orange but a few pigeons may have white-grey eyes. The eyelids are orange in colour and are encapsulated in a grey-white eye ring. The feet are red to pink.

Pigeons, especially homing or carrier breeds, are well known for their ability to find their way home from long distances. Despite these demonstrated abilities, wild Rock Doves are sedentary and rarely leave their local areas (Wikipedia (b)).

1.2.3. Diet

Pigeons feed on the ground in flocks or individually. They roost together in buildings or on walls or statues. Food preference is for seeds from a variety of native and introduced plants. Rock Doves also scavenge for food scraps (Ecosure). When
drinking, most birds take small sips and tilt their heads backwards to swallow the water. Pigeons are able to dip their bills into the water and drink continuously without having to tilt their heads back. When disturbed, a pigeon in a group will take off with a noisy clapping sound (Wikipedia (b)).

1.2.4. Distribution and habitat

The Rock Dove has a restricted natural resident range in western and southern Europe, North Africa, and into South Asia. The Rock Dove is often found in pairs in the breeding season but is usually gregarious (David, et al., 2010). The species has a large range, with an estimated global extent of occurrence of 10 million km². It has a large global population, including an estimated 17–28 million individuals in Europe.

In their natural environment, Rock Doves nest in loose colonies on coastal cliffs and also mountain areas at altitudes as high as 14,000 feet in the Himalayas. They prefer open, unwooded country, steppe, farmland, and desert (Diamond Dove).

Its domesticated form, the feral pigeon, has been widely introduced elsewhere, and is common, especially in cities, where they nest on buildings, under various kinds of overhangs and open roof structures and frequent parks and other places were people go to eat in the open. A Rock Pigeon’s life span is anywhere from 3–5 years in the wild to 15 years in captivity, though longer-lived specimens have been reported (Wikipedia (b)).

1.2.5. Domestication

The Domestic Pigeon (Columba livia domestica) was derived from the Rock Pigeon. The Rock Pigeon is the world's oldest domesticated bird. Mesopotamian cuneiform tablets reported the domestication of pigeons more than 5,000 years ago, as do Egyptian hieroglyphics. Research suggests that domestication of pigeons was as early as ten thousand years ago (Andrew, 2007).

Domesticated pigeons used as pets as well as homing pigeons and carrier pigeons, and so-called war pigeons have served and played important roles during wartime, with many pigeons having received bravery awards and medals for their services in saving
hundreds of human lives: including, notably, the British pigeon Cher Ami who received the Croix de Guerre for his heroic actions during World War I, and the Irish Paddy and the American G.I. Joe, who both received the Dickin Medal, amongst 32 pigeons to receive this medallion, for their gallant and brave actions during World War II. There are numerous breeds of fancy pigeons of all sizes, colours and types (Wikipedia (c)).

1.2.6. Economic Importance

Columba livia eaten by humans and used for laboratory research (Root, 2001). They are bred for meat, generally called squab and harvested from young birds. Pigeons grow to a very large size in the nest before they are fledged and able to fly, and in this stage of their development (when they are called squabs) they are prized as food. For commercial meat production a breed of large white pigeon, named King pigeon, has been developed by selective breeding. Breeds of Pigeons developed for their meat are collectively known as Utility Pigeons (Wikipedia (c)).

Pigeon droppings deface and accelerate the deterioration of buildings and increase the cost of maintenance. Large amounts of droppings may kill vegetation and produce an objectionable odor. Pigeon manure deposited on park benches, statues, cars, and unwary pedestrians is aesthetically displeasing. Pigeons consume and contaminate large quantities of food destined for human or livestock consumption around grain handling facilities.

They may carry and spread diseases to people and livestock through their droppings. Pigeons ectoparasites include various species of fleas, lice, mites, ticks, and other biting insects, some of which readily bite people. Some insects that inhabit the nests of pigeons are also fabric pests and/or pantry pests. Pigeons located around airports can also be a threat to human safety because of potential bird-aircraft collisions (Williams, and Corrigan, 1994).
1.3. Calcium

Calcium represents the most abundant mineral in the body. The average adult body contains in total approximately 1 kg, 99% in the skeleton in the form of calcium phosphate salts. The extracellular fluid contains approximately 22.5 mmol, of which about 9 mmol is in the serum. Approximately 500 mmol of calcium is exchanged between bone and the extracellular fluid over a period of twenty-four hours (Marshall, 1995).

Calcium plays a variety of important functions in the body. It acts as a structural function-supporting material in bones. Present as calcium phosphate. It has signalling function, intracellular calcium functions as a second messenger for some hormones. Additionally, calcium acts as a coenzyme for clotting factors. Calcium also causes the release of Acetylcholine from Pre-synaptic terminal in the transmission of nerve impulse. Furthermore, it causes the contraction of muscles, removing the Tpl subunit from Myosin head which has ATPase activity to cause contraction (Wikipedia (d)).

The utilization and retention of calcium and phosphorus in birds is under direct control of vitamin D (Omdahl, and DeLuca, 1973), and vitamin D is the precursor of the hormone 1,25-dihydroxyvitamin D₃ (1,25-(OH)₂D₃; vitamin D₃ = cholecalciferol), which apparently directs the utilization of calcium and phosphorus (DeLuca, 1974; Kodicek, 1974). This hormone is synthesized in the kidney from 25-hydroxyvitamin D₃ (25-OH-D₃), the major circulating metabolite of vitamin D, which is synthesized in the liver from vitamin D₃ itself. The production of 1,25-(OH)₂D₃ by the kidney is tightly regulated; the 25-OH-D₃-1-hydroxylase is stimulated by the parathyroid hormone (Girabedian, et. al., 1972; Fraser, and Kodicek, 1973) and low serum phosphate (Tanaka, et. al., 1973; Baxter, and DeLuca, 1976) and is suppressed by phosphate and 1,25-(OH)₂D₃ itself (Tanaka, and DeLuca, 1973; Larkins, et. al., 1974; Tanaka, et. al., 1975).

Chicken is an important source of protein for human consumption. Additionally, its bones are rich in calcium, which is an essential mineral for normal body function (e.g. bone growth, blood clotting and neurotransmission) (Nordin, et. al., 1998). Calcium is distributed throughout the body, 99% in the bone and 1% in the blood circulation with the plasma level of 8.5-10.5 mg/dL. Lack or an insufficiency of
calcium can cause osteoporosis, heart disease and hemorrhage (Phiraphinyo, et al., 2006). Therefore, chicken bones can be used as a food supplement to enhance the calcium content in various kinds of foods (Pearson and Dutson, 1992; Steimmetz, 1999).

Serum calcium fluctuations in doves and chickens have been associated with egg shell formation or ovarian activity. Serum calcium in doves rises during the follicular phase of the ovarian cycle. In hens it has been correlated with the size of the egg. Nevertheless, it was not until 1936 that estrogens were demonstrated to cause a rise in blood calcium. It has reported that many female pigeons have solid bones, while males uniformly have marrow-filled bones. The condition of the bones was correlated with the size of the ovarian follicles. When the follicles were 2 mm or less in diameter, the femurs contained large marrow spaces. Osseous tissue partially invaded the marrow in birds in which the follicles were more than 4.5 mm in diameter, and bony spicules filled the marrow cavities when the follicles were 10.0 mm or larger in diameter (Pfeiffer, and Gardner, 1938).

Moreover, Sendroy Jr, et al., (1961) mentioned that at times of egg laying the serum of female pigeons showed a marked, significant increase in β-globulin and total calcium over the normal values found at all other times throughout the reproductive cycle, and at all times for the male. The relationship of calcium bound to β-globulin concentration was roughly in agreement with similar values calculable from previous work done by other methods.

1.4. Total protein

Proteins are high-molecular nitrogen containing organic compounds that are responsible for the membrane transport, form the colloid osmotic pressure, maintain blood pH in a narrow range, participate in blood clotting and have a structural role (Griseinger and Scans, 1986; Saier, 1996).

Serum total protein or plasma total protein, is a biochemical test for measuring the total amount of protein in blood plasma or serum. Protein in the plasma is made up of albumin and globulin. The globulin in turn is made up of α1, α2, β, and γ globulins.
These fractions can be quantitated using protein electrophoresis, but the total protein test is a faster and cheaper test that estimates the total of all fractions together (Wikipedia (e)).

Blood plasma proteins play important roles in the maintenance of colloid osmotic pressure, as a rapid substitute for indispensable amino acids, assuring glucose through gluconeogenesis in transport of minerals and hormones, in build of enzymes and immune system in the organism. Therefore, blood plasma proteins have an exceptional significance in homeostasis maintenance. Total concentration of blood serum proteins of birds is about the same as half its value in mammals (Kaneko, 1997; Griminger and Scanes, 1986). Its cause is most probably the extremely high concentration of glucose in bird blood, approximately 14 mmol/L (Gylsterff, 1983) as an exceptionally osmotic active substance, which in total the maintenance of colloid-osmotic pressure diminishes protein concentration.

The relation between individual fractions of proteins reflects the functional, metabolic and health status of birds. Serum proteins' electrophoresis is one of diagnostic techniques that provide information about the healthy status of animals. If correctly interpreted, it could give information about the systemic health and the relationship between the biological response and each serum protein (Tobio, et. al., 1995). The importance and reliability of the routine application of serum protein electrophoresis in diagnostics of various disorders in birds was pointed out by Werner and Reavill (1999). The same authors also pointed out the importance of determining the referent values that are specific for species, age and sex of birds. Other researches on concentration of proteins in bird blood mostly indicate total values and ratio of albumins to globulins (Griminger and Scanes, 1986), as well as individual fractions in different pathological conditions (El Jack, et. al., 1978).
1.5. The objective

The values of haematological indices in domestic and wild birds could be an important source of information with valuable diagnostic meaning. They could provide or support an objective assessment of the health status and could support the correct diagnosis in different pathological states. Moreover, it will provide a good reference for the nutritional value of the birds' meat. This study was carried out to:

a. Provide reference values for serum calcium and total protein in *Columbia livia* and *Gallus gallus*.

b. Compare the levels of serum calcium and total protein in the two species.

c. Determine the nutritional value and quality of the meat for the two species.
Chapter two

Materials and method

2.1. Study area

This study was conducted in Khartoum. Khartoum is the capital of Sudan and of
Khartoum State. It is located at the confluence of the White Nile flowing north from
Lake Victoria, and the Blue Nile flowing west from Ethiopia (Latitude:
15° 34' North Longitude: 32° 36' East).

2.2. Animals

Two bird species were involved in this study. The chickens (Gallus gallus
domesticus) and pigeons (Columba livia domestica). Chickens were taken from the
wehdaa market, and pigeons from Omdurman market.

2.3. Study population

A total of twenty birds were used in this study. They were divided into two groups.
Each group includes 10 healthy chickens (Gallus gallus domesticus), and 10 healthy
pigeons (Columba livia domestica).

2.4. Blood sampling

The blood samples were taken from sleeved chicken and from the left and right
brachial vein of the rock pigeon by disposable syringe. The blood samples were put
into two types of tubes, one of the tube contained EDTA which is an anticoagulant
used for protein samples, and the other one without anticoagulant that was used for
calcium samples because the anticoagulant chemicals like EDTA will strongly
chelated calcium. The blood samples were centrifuged at 5000 rpm for 14 minutes and serum was obtained. Serum was kept in covered container at -4°C and used later for calcium and protein analysis.

2.5. Determination of Blood Calcium

2.5.1. Method Principle

The measurement of calcium in the sample is based on the formation of color complex between calcium and O-cresolphthalein in alkaline medium. The intensity of the color formed is proportional to the calcium concentration in the sample.

2.5.2. Principle of the reaction

\[
\text{Ca}^{++} \quad \text{O-cresolphthalein} \rightarrow \text{colored complex} \quad \text{"OH+ medium"}
\]

2.5.3. Reagents

Ethanolamin = 500mmol/l, O-cresolphthalein = 0.62mmol/l, 8-hidroxyquinolcin = 69 mmol/l, calcium aqueous primary standard = 10mg/dl.

2.5.4. Procedure

2.000 μl of R1 and one drop of R2 were put into labeled test tubes. 20 μL of standard in addition to 20 μL of samples were pipette into the same test tubes. The tubes were mixed thoroughly and kept in the room temperature for 5 minutes. The absorbance of the standard and samples against the blank reagent were measured at wave length of 570 nm.
2.6. Determination of Blood Total Protein

2.6.1. Method Principle

Total protein reagent is based on the biuret reaction, where divalent copper reacts with the peptide bonds of protein under alkaline conditions to form the characteristic pink to purple biuret complex.

2.6.2. The principle of the reaction

Protein + Cu$^{++}$ → Cu–protein complex "Alk-PH medium"

2.6.3. Reagents

Sodium hydroxide = 0.2 N, EDTA$^2-$ = 18 mmol, Cupric sulfate = 12 mmol/l

2.6.4. Procedure

1000 μL of the reagent were pipetted into labeled test tubes, then 20 μL of standard and 20 μL of the specimen were put into the same test tubes. The tubes were mixed thoroughly and incubated at room temperature for 5 minutes. The absorbance of sample and standard against reagent blank were measured at wavelength 570 nm.

2.7. Calculations

Serum concentration (mg/dL) =

\[
\frac{\text{Absorbance of Sample}}{\text{Absorbance of standard}} \times \text{Concentration of standard}
\]
2.8. Statistical Analysis

The statistical analysis was performed with a personal computer using the statistical package for social science (SPSS). Descriptive statistics were based on the observed data. The results of biometric and biochemical variables expressed significance was taken as $P < 0.05$ and as mean (mean $\pm$ SD) with the independent T test.
Chapter Three

Results

This study was carried out to compare between the blood parameter; calcium and protein in rock pigeons and jungle fowls and to define a reference values for these two parameters in Sudanese species, and to show the nutritional value of the meat of the two species.

Method

20 birds were divided into two groups with 10 pigeon and 10 chikens in each group.

In the *Columba livia domestica* group the mean of the total protein concentration was 2626.00 mg/dl, and that of calcium was 8.882 mg/dl.

In the *Gallus gallus domesticus* group the mean of total protein was 6298.800 mg/dl and that of calcium concentration was 15.693 mg/dl.

There is a significant difference between the calcium concentration in the rock pigeons and jungle fowl, P<0.05 (Figure 3.1).

There is a significant difference in the protein concentrations between the two species, P<0.05 (Figure 3.2).
Figure 3.1: Mean calcium concentrations among the two independent groups of birds.
Figure 3.2: Mean total protein concentrations among the two independent groups of birds.
Chapter Four

Discussion

The values of haematological indices in domestic and wild birds could be an important source of information with valuable diagnostic meaning. They could provide or support an objective assessment of the health status and could support the correct diagnosis in different pathological states. Moreover, it will provide a good reference for the nutritional value of the birds' meat. This study was carried out to provide reference values for serum calcium and total protein in Columba livia and Gallus gallus, compare the levels of serum calcium and total protein in the two species, and determine the nutritional value and quality of the meat for the two species.

The results of our study show that in the Columba livia domestica the mean of the protein concentration was 2626.00 mg/dl, and that of calcium was 8.88 mg/dl, Whereas in the Gallus gallus domestica the mean of the calcium concentration was 15.693 mg/dl, and that of total protein was 6298.80 mg/dl. There is a significant difference between the calcium concentration in the Columba livia and Gallus gallus. And, there is a significant difference in the protein concentrations between the two species.

Systematic published researches in the comparison of the concentration of calcium and total proteins and their fractions in blood serum of pigeons and chickens are very scarce to date especially in Sudan.

Besler, et al., (2001) and Abdel-Fattah, et al., (2008) in their study in chicken reported a calcium level near to that found in our study; nevertheless we found a high total protein level than reported by them. Similar results were shown by Simaraks, et al., (2004) in chicken and Pop, et al., (2010) in pigeons, who reported a calcium level near to that found by us while the total protein level in our study is higher than that reported by them. Nevertheless, Kokosharov, (2006) reported a total protein level in the control healthy chicken near to that found in our study.
that reported by them. Nevertheless, Kokosharov, (2006) reported a total protein level in the control healthy chicken near to that found in our study.

The difference in calcium level between the two species may be due to the amount of calcium in the diet provided to each species. The high total serum protein level reported in our study may be a mechanism through which the birds try to maintain colloid osmotic pressure by increasing the total protein as result of a decrease in another parameter.
1.4. Conclusions and recommendations:

It is concluded that there is a significant difference in both calcium and total protein concentration in both species *Columba livia* and *Gallus gallus*.

This information must be taken into account in the nutrition of people suffering from serious diseases such as diabetes, heart diseases, gout and many other cases. Further studies with large population are required to illustrate the reason for the high total protein level noticed in the studied birds.
5. References


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