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RESEARCH ARTICLE

EFFECT OF CHICORY AND INULIN GROWTH PERFORMANCE, SERUM BIOCHEMICAL ANALYSIS AND INTESTINAL MICROBIAL POPULATION IN JAPANESE QUAIL (*COTURNIX JAPONICA*).

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Abstract

In the present study, chicory root powder (CRP) and inulin as growth promoter at 50mg and 100mg levels was supplemented in Japanese quail diet to investigate the growth performance, biochemical and intestinal micro flora concentration. Two hundred, one-day-old Japanese quail were used in a completely randomized design (CRD) with 5 treatments. At the end of each period, feed intake (FI), weight gain (WG), and feed conversion ratio (FCR) were measured. At the end of experiment (day 42), one bird per replicate was sacrificed for carcass weight, inedible organ weight and count the intestinal microflora. The FI increased by 100mg/kg of CRP in the 6th week of period ($p < 0.01$). The percentage of WG significantly increased at 100mg/kg of CRP ($p < 0.05$). The FCR increased in all treatment group compared to control ($p < 0.05$). The carcass weight and inedible percentage increased at 100mg CRP ($p < 0.05$). The biochemical analysis of serum glucose, protein, albumin, globulin, triglyceride cholesterol, calcium, phosphorus, as well as enzyme of GOT, GPT, alkaline phosphate, acid phosphate, creatinine and uric acid were non-significant ($p>0.05$) changes in all treated group. The supplementation with inulin 100mg/kg resulted significantly lower ($p < 0.01$) amount of *E. coli* in ileal content when compared to control. In conclusion, chicory root powder and inulin can improve growth performance in Japanese quail by enhancing food digestion and absorption through microflora.

Introduction:-

The efficiency of poultry to convert the feed into meat and egg plays a key role in economics of broiler industry. Therefore, it is highly essential to improve feed efficiency of poultry to produce meat and egg economically along with food safety is more seriously considered than before (Ashayerizadeh *et al*., 2011). Agriculture by-products are widely used as feed for livestock in the developing countries because of their availability and affordable price (Noorani & Rahmatnejad, 2014; Ali Asghar Saki *et al*., 2017). Japanese quail are the smallest farmed avian species. It was well known for its commercial egg and meat production with a short generation interval.

A huge amount of antibiotics have been used to control diseases and improve performances in livestock. However, due to growing concerns about antibiotic resistance and the potential for a ban for antibiotic growth promoters in many countries in the world, there is an increasing interest in finding alternatives to antibiotics in poultry production (Ying *et*

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al., 2017). One choice as prebiotic is non digestible food ingredients, whose beneficial effects on the host result from ayurveda has eight divisions dealing with different aspects of the art of healing, the selective stimulation of growth and is activity of members of the gut microbiota (Goyal *et al*., 2003).

Nowadays, poultry receive various supplementations such as antibiotics, growth promoters, vitamins, minerals and even phytogenic plants to improve their performance and immunity. Using antibiotics as food additives for long periods in poultry diets can lead to antibiotic resistance and high residue levels in animal products such as meat and egg (Convay *et al*. 1997; Montagne *et al*., 2003). Among the food additives, medicinal plants have drawn more attention these days due to their historical background and their prophylactic and growth promoter effects. Thus, the use of medicinal plants and probiotics in poultry diets for animal production and health has become more popular worldwide as an alternative to antibiotics (Gibson *et al*., 2004).

One of these plants is chicory (Cichoriumintybus, Asteraceae) known as a promoter for immune system and growth in ancient nations such as Iran. The genus of chicory comprises about 14 species of herbaceous plants used in indigenous medicines. Chicory typically contains inulin (68%), sucrose (14%), cellulose (5%), protein (6%), ash (4%), and other compounds (3%), including esculin, coumarins, flavonoids, and vitamins in dry matter (Meehye *et al*., 1997; van Loo, 2007). The tuberous root of this plant contains a number of medicinally important compounds, including inulin, bitter sesquiterpene lactones, coumarins, flavonoids and vitamins (Varotto *et al*., 2000). Inulin is a chain of fructans with non-soluble protein (NSP) which has minimal side effects and is a good source of energy in an animal's diet. Inulin regulates appetite and lipid-to-glucose metabolism with promising effects on body weight and fat mass development (Urias-Silvas *et al*., 2007). Inulin type fructans have been recognized as an interesting dietary fiber that improves intestinal functions through their probiotic properties (Roberfroid *et al*., 1998; Delzenne 2003). Therefore, in this study investigate that chicory and inulin to the medicinal plant powder supplementation on feed consumption, weight gain, biochemical analysis and microbial population of Japanese quail.

Materials and method:-

Plant Collection:-

The roots of chicory were collected from commercial market at Thanjavur district, Tamil Nadu, India. The collected root was dried under 25°C shadow. The dried samples were grounded into 3-5mm particles using a laboratory mill. Inulin (frutafit IQ) was provided by Connell bros. company (Malasiya) sdn. Bhd. After that the plant root were powder form and stored the black container.

Animal Collection:-

One day old, a total of 200 Japanese quail chicks were collected from the breeding farms of Tamil Nadu Veterinary and Animal Science University at Namakkal district, Tamil Nadu, India.

Experimental Design:-

The dietary treatment was started with 10 days old quail, which had been incubated for its growth for 6 weeks, were subjected to this experiment 5 treatment groups each treatment have 20 animals. Birds in each replicate were placed into cage having 50×45 cm in height for 6 weeks of experimental period. A lighting schedule was 24 hours for the first 2 weeks. Then, birds were allowed to access *ad labium* water and feed. The experimental design consists of 5 dietary treatments groups were basal diet as control (T0), basal diet with inulinpowder 50mg/kg (T1), basal diet with inulin powder 100mg/kg (T2) basal diet with chicorypowder 50mg/kg (T3) and basal diet with chicory powder 100mg/kg (T4). The basal diet was formulated according to National Research Council (NRC, 1994). It contained 17.7 % crude protein and 2817 Kcal ME/kg breeder diet (Table 1). Record with kept for body weight, feed consumption, feed conversion ratio through the experimental period. The quails were matured in 6 weeks (Two replicates).

Growth Performance:-

All birds were weighed individually at the end of each week of experimental period (6 weeks). Records for live body weight and feed consumption were obtained at the end of the period. Weight gain (Ramappa *et al*., 1975 and Sud, 1982), feed intake (Nahanshon *et al*., 1992) and feed conversion ratio (FCR) (Cavazzoni *et al*., 1998) were calculated. The carcass weight of liver, heart, lungs, proventriculus, kidney, intestine weight and gizzard was determined according to Gillespie (1960) and Ammerman *et al*. (1989).

Serum and Enzyme Biochemical Analysis:-
At the 6th week of experiment, 16 birds per treatment (8 birds/replicate) were randomly selected. Blood was collected and then separated the serum. The serums were analyzed biochemical changes as glucose (Blaedel and Uhl, 1975), total protein (Henry, 1974), albumin (Doumas *et al*., 1971), globulin (Robinson *et al*.,1937), triglyceride (Trinder, 1969), cholesterol (Richmond, 1973), calcium (Eardman, 1979), phosphorous (Berner *et al*., 1976), SGOT(Reitman and Frankel, 1957), SGPT (Reitman and Frankel, 1957), alkaline phosphates (kind and king, 1954), acid phosphates (king,1956), creatinine (Faqi *et al*, 1997) and uric acid (Caraway, 1955).

Microbial Populations in Jejunum, Ileum and Cecum Content:-
To determine microbial populations, strains of *E. coli* and lactic acid bacteria were cultured with chromogenic medium agar (CHROM agar TM ECC) and MRS medium (de Man Rogosa and Sharpe agar, Difco 288130), respectively. After anaerobic incubation at 37°C for 48 h, the micro floral counts were calculated. Bacterial populations were expressed as $\log_{10}$ CFU per gram of intestinal content.

Statistical Analysis:-
Data were analyzed by one-way ANOVA ($P<0.05$) with completely randomized design. Comparison of parameters was performed with the Duncan's multiple range test and data were analyzed using the SPSS® for windows (version 16.0, 2010) computing program (Duncan, 1955).

Results:-
During the experimental period of 6 weeks, the effect of chicory root powder and inulin were growth performance, blood serum biochemical, enzyme activity analysis and microbial population of Japanese quail.

Growth Performance:-
The Body weight (BW) Body weight gain (BWG) of quails fed with the diet of chicory and inulin with different concentration which showed different results compared to control (**Table-2**). The result showed that the supplementation of chicory root powder 100mg/kg of body weight were significant increased (362±9.19) compared to control (316±5.46) and inulin 100mg/kg (353.2±3.70) of diet, respectively (**Table-2**).

Feed consumption and feed conversion ratio was better improvement on the chicory root powder and inulin 100mg/kg of higher concentration (25.7±0.59 and 24.50±0.70) when compared to low concentration of treatment group (24.90±0.67 and 24.70±0.66) and control (22.10±0.50), respectively (**Table 2**).

According to the data, there were significant differences in the carcass characters. However, there was a numerical difference among the tested parameters. The different levels of chicory root powder and inulin powder diet of giblet weights ware calculated shown **Table 3**. Inedible organ weight of lungs, proventriculus, kidney and intestine weight were significant ($P>0.05$) different than compared to control groups (**Table 4**).

Serum Biochemical Parameters:-
The results of serum biochemical parameters have been placed in **Table 5**. The results of the Total Protein, glucose, albumin, globulin, triglyceride, cholesterol were non-significantly different in all treatment groups when compared to control (**Table 5**). As well as the enzyme activity of calcium, phosphorus, SGOT and SGPT were non-modernized in all treatment groups while compared to control (**Table 6 &**7) and normal reference range.

Microbial population in Jejunum, Ileum and Cecum:-
The effects of dietary chicory and inulin supplementation on intestinal microflora are shown in Table 8. Treatment had significant effect on Lactic acid bacteria ($P<0.05$). Supplementation with inulin 100mg/kg resulted in significantly lower amounts of *E. coli* in ileum and cecum content compared to the control group ($P<0.01$). Chicory 100mg/kg treatment groups also significantly reduced *E. coli* concentration in cecum content when compared to the low concentration of treatment and control groups ($P<0.05$) (**Table 8).**

Discussion:-
Herbal medicines derived from the plant extracts are being increasingly utilized to treat a wide variety of clinical diseases, though relatively little knowledge about their mode of action is available (Mahesh *et al*., 2009). For the field of modern medical science, the herbal drugs are to be subjected for several processes such as identifications, isolation,

purification, characterization, structural elucidation and therapeutic evaluation (Venkatesan *et al*. 2005; Vasundradevi and Divyapriya, 2013). In this root powder supplemented performed significant (P<0.05) improvement in live body weight of Japanese quail compared to control. Prebiotic supplement marginally consumed more feed compared with control group, throughout the experimental period. The improvement in feed intake by dietary prebiotic supplementation has been the improved growth performance of broiler chicks.

However, the principle effects of prebiotic have been reviewed by Cummings and Macfarlane (2002) and include improvement of calcium and magnesium absorption, production of short-chain fatty acids and selective increases in the population of lactate producing bacteria like Lactobacillus and Bifidobacterium. It has been shown that increased lactate concentration often decreases intestine pH and is a potent anti-microbial substance to several pathogenic species such as *E. coli* (Samli *et al*., 2007). The Bifidobacterium and Lactobacillus colonizing the intestine have been reported to deliver enzymes, thus increasing the intestine digestive enzyme activity (Sissons, 1989). However, the *E. coli* may damage the villus and microvillus of intestinal mucosa and inhibit the secretion of digestive enzymes (Gao, 1998). Thus, prebiotic helps to balance the intestinal microflora of poultry, consequently an improved utilization of diet nutrients (protein and energy) and higher feed intake leading to better performance criteria. The several studies have shown that addition of prebiotics to the diet of quail, leads to improved performance through improving gut microflora and feed utilization (Spring *et al*., 2000 and Xu *et al*., 2003).

El-Gendy *et al*. (1996) reported that the improvement in feed conversion ratio with feeding herbal extract could be associated with improving the digestibility of dietary protein in the small intestine. The action of herbal extracts as antioxidants, anti bacterial, anti fungal and anti protozoa also add to the positive improvement in bird performance (Abo Omar *et al*., 2016). The results of herbal feed supplement on quail carcass characteristics are presented in Table 3. Furthermore, In this experiment showed that addition reduced abdominal fat, although there were no significant differences between the control and the other treatment groups (Falaki *et al*., 2010).

The blood serum and enzyme biochemical analysis of Japanese quail were non significant different when compared to control. Treatments groups have significantly (p<0.05) higher glucose level than the control. Blood serum glucose levels are higher in birds than in cats and dogs. Glucose levels are elevated (increased) by stress or eating. Hyperglycemia is associated with diabetes mellitus, which is uncommon in birds. Hyperglycemia is a result of levels above 900 mg/dl. Glucose levels below 150 mg/dl are life-threatening. Hypoglycemia is rare in birds; it is not associated with starvation. The primary cause of hypoglycemia is septicemia (bacteria in the blood due to infection). Abnormal readings indicate severe liver disease, sepsis (blood infection), anorexia or pancreatic disease. Glucose level was accompanied by increased liver glycogen indicating a stimulated pancreatic activity which comes in agreement with the findings of Schulz (1940) who had reported that in pigeons, the pancreatic islets of Langerhans increased in size and number during the laying period of the female (Hassan, 2010).

Treatments groups have significantly (p<0.05) higher total protein, albumin and globulin level than compared to control. Total protein includes albumin and the globulins levels is an indicator of the health status. Poor measuring methods exist for albumin. Decreased values indicate malnutrition, malabsorption, renal disease or liver disease, cancer, parasitism, long-term stress. Elevated values indicate dehydration, immune stimulation, liver disease, gastrointestinal disease, or kidney disease, chronic infection, or leukemia (Sangoh and Park, 2012).

Albumin level have significant increased when compare to the control group. Kumari *et al*. (2012) reported that serum albumin was significantly (p<0.05) higher in herbal (1% methiorep) treated group as compared to control the group as observed in our results. Albuminis the largest single fraction in the healthy bird. It is the major reservoir and transporter of protein. It is the main contributor of colloidal osmotic pressure (pressure exerted by proteins in a blood vessel's plasma). It pulls water into the circulatory system. Albumin is involved in the acid-base balance. It acts as a transport carrier for small molecules such as vitamins, minerals, hormones and fatty acids. It functions primarily as an osmotic pressure regulator and protein transporter.

The results revealed higher level of globulin in the treatment groups when compared to control group. The entire group did not show a significant difference among themselves. Increase in the plasma globulin in the treatment groups may be due to feeding of root of chicory. Globulins increase with acute nephritis; severe, active hepatitis; active, systemic inflammation; inflammatory liver disease; malnutrition; lipemic artifact; systemic mycotic (fungal) disease; protein-losingenteropathies (diseases of the intestine); and the nephrotic syndrome, in which the damaged kidneys leak large

amounts of protein in the urine. Similar findings had been reported by earlier investigators Rekhate *et al*. (2010) and Kumari *et al*. (2012).

Similarly calcium and phosphorus have increased than the control group. Calcium value level is linked to protein levels. Calcium level deficiency is a result of poor bone quality, weakness, egg-laying, and poor diet. Hypocalcemia (low calcium levels) results in weakness and tetany. High levels are common in reproductively active females-as high as 25mg/dl. Elevated levels of calcium have been associated with Vitamin D3 toxicity, osteolytic bone tumors, renal adenocarcinoma or dehydration. Phosphorus has been shown that absorption across the intestinal brush border membrane involves both Na-dependent and Na-independent pathways (Hilfiker, 1998; Murer, 2004). The Na-dependent transport is not affected by changes in Ca concentration, therefore Ca and P transport seems to be operating separately (Murer, 1981; Matsumoto, 1980). The Na-independent transport in the intestine seems to be unregulated (Danisi, 1980; Katai, 1999). It has been suggested that a large phosphate concentration in digesta after a meal could induce paracellular transport (movement of ions along the gradient through spaces between cells from lumen to blood) that could become the predominant postprandial pathway largely responsible for overall phosphate transport. However, apparently, the intestinal epithelial wall is not readily permeable to phosphate (Cross *et al*., 1990). Trans epithelial active transport of P in renal tubules or intestinal tissue involves uptake of P through the apical brush border membrane by the Na-dependent co-transporter, translocation across the cell, and efflux at the basolateral membrane (Tenenhouse*et al*., 2005).

Different concentration of treatment groups have slightly modified in AST (GOT) level in comparison to control group. These finding are in close agreement with that of Pal *et al*. (2013) who reported that low AST (GOT) level in herbal tonic (Superlive, AV/SSL/12, liver tonic brand A and liver tonic brad B) treated group as compared to control, indicating normalization of liver functions in herbal liver tonic supplemented groups in broiler. The result indicates that blood ALT (GPT) level were non-significant in treatment groups as compared to the control group. Similar findings had been also reported by Marzouk*et al*., (2011) reported that ALT was not significantly affected in broilers treated with chicory leaf extract; however, Noreen (2009) reported a significant effect of supplementing chicory leaf extract on ALT and AST concentration in broilers.

Normally the liver enzymes are contained inside the liver cells (hepatocytes) where they perform their metabolic functions for the cells. These enzymes only leak into the blood stream when the liver cells are damaged. The higher the liver enzymes are above the normal range, the greater the degree of liver inflammation.

The enzyme biochemical indicates that alkaline phosphate was non-significant in treatment groups as compared to the control group. High alkaline phosphate (ALP) levels associated with the isozymic liver kidney bone (lkb) group have been observed in hypophosphatemic disorders (Yoshiko *et al*. 2007), suggesting that ALP expression in osteoblasts is regulated by P levels (Goseki-Sone*et al*., 1999; Yoshiko *et al*., 2007). The regular system could increase in ALP synthesis in response to reduced P levels and a decrease in the elevation of P levels has been observed in ALPs derived from different mammalian tissues (Orimo and Shimada 2008).

The creatinine and uric acid levels were non-significant different than other groups. This catabolite is directly related to increased muscle activity and volume. Younger and older broiler chickens have low levels of blood creatinine, according to Sandhu *et al*. (1998). Creatinine as located in the muscle cells and most elevations are related to muscle injury as well as rough handling, trauma, injections, muscle wasting or Central Nervous System disease. Abnormal counts indicate muscle damage; this test is used in conjunction with GOT to differentiate between liver and muscle damage. Uric acid is the main nitrogenous waste in birds and eliminated by the kidneys in the urates. Elevations occur after severe kidney disease or dehydration. It is the best indicator of renal health in most birds (Rabie *et al*., 2015).

Conclusion:-

Supplementation of different levels of chicory and inulin powder as growth promoter revealed better performance in Japanese quail in terms of body weight gain, efficiency of feed utilization, stabilization of serum metabolites with better immune response and microbial population, which ultimately decreased pathogen.

Table1:- Ingredients and chemical composition of experimental control diets (g/kg fed basis)

Ingredients	**Diet**
Maize	554.50
Soybean meal	364.00
Fish meal	51.00
Vegetable oil	11.00
Calcium corbonate	11.00
Dicalcium phosphate	3.50
Salt	2.50
Vitamin mineral premixa[@] a vitamin premix provided the following per kg diet: Vitamin A, 12500 IU; Vitam 500 IU; Vitamin E, 31.25mg; Vitamin K3, 3.75 mg; Vitamin B1, 2.5 mg; Vitamin B g; Niacin 25 mg.	2.50
Total	1000
Chemical analysis dry matter (DM) basis	
Crude protein (g kg^{-1})	241
Calcium (g kg^{-1})	8.1
Total phosphorus (g kg^{-1})	7.2
ME (MJKG-1)	12.129
Lysine	13.8
Methionine + Cysine (g kg^{-1})	8.0

Table 2:-Effect of inulin and chicory powder supplementation of growth performance of quails

Experiment	**Animal weight (g)**	**Weight gain (g)**	**Feed consumptions (g)**	**FCR**
Control T0	316 ± 5.46^{e}	268.6 ± 9.48^{e}	22.10 ± 0.50^{e}	2.60 ± 0.22^{e}
T1	332 ± 7.87^{d}	272.8 ± 7.78^{d}	24.90 ± 0.67^{c}	2.80 ± 0.24^{d}
T2	353.2 ± 3.70^{b}	294.1 ± 3.62^{a}	$25.7\ 0 \pm 0.59^{a}$	3.20 ± 0.29^{c}
T3	340.2 ± 2.70^{c}	281.3 ± 2.89^{c}	24.70 ± 0.66^{b}	3.50 ± 0.26^{b}
T4	362 ± 9.19^{a}	291.2 ± 4.52^{b}	24.50 ± 0.70^{d}	3.70 ± 0.21^{a}

*Values are expressed Mean ± S.E, T1 – inulin 50mg, T2- inulin 100mg, T3 – chicory 50mg, T4- chicory 100mg. Values not sharing a common marking (a, b, c) different alphabets columns differ significantly at $p<0.05$.

Table 3:-Effect of inulin and chicory powder supplementation of giblet weight of Japanese quails

Carcass weight	**Control**	**Inulin**		**Chicory**	
	T0	**T1**	**T2**	**T3**	**T4**
Liver (g)	7.01 ± 0.26^{e}	7.08 ± 0.23^{c}	7.20 ± 0.20^{b}	7.06 ± 0.20^{d}	7.28 ± 0.21^{a}
Heart (g)	2.1 ± 0.27^{e}	2.4 ± 0.22^{c}	2.55 ± 2.32^{a}	2.30 ± 0.13^{d}	2.48 ± 0.12^{b}
Gizzard (g)	4.79 ± 0.20^{e}	5.92 ± 0.20^{a}	5.27 ± 0.18^{b}	4.95 ± 0.13^{d}	5.1 ± 0.17^{c}

*Values are expressed Mean ± S.E, T1 – inulin 50mg, T2- inulin 100mg, T3 – chicory 50mg, T4- chicory 100mg. Values not sharing a common marking (a,b,c,d,e) different alphabets row in differ significantly at $p<0.05$.

Table 4:-Effect of inulin and chicory powder supplementation of inedible organ weight of quails

Treatment	**Control**	**Inulin**		**Chicory**	
		50mg	**100mg**	**50mg**	**100mg**
Blood Weight (g)	10 ± 0.35^{e}	11 ± 0.98^{c}	10.90 ± 5.65^{b}	11.20 ± 0.58^{b}	12 ± 0.41^{a}
Feather Weight (g)	28.56 ± 0.92^{e}	34.70 ± 0.60^{d}	35.56 ± 4.54^{c}	36.70 ± 0.66^{b}	37.10 ± 0.72^{a}
Lungs (g)	1.90 ± 0.23^{e}	2.1 ± 0.17^{d}	2.32 ± 0.15^{a}	2.14 ± 1.25^{c}	2.24 ± 0.10^{b}
Proventriculus (g)	1.04 ± 0.11^{d}	1.22 ± 0.13^{c}	1.45 ± 0.14^{a}	1.25 ± 0.12^{b}	1.44 ± 0.12^{a}
Kidney (g)	1.49 ± 0.15^{e}	1.19 ± 0.06^{d}	2.07 ± 0.24^{b}	1.94 ± 0.13^{c}	2.45 ± 0.11^{a}
Reproductive organ (g)	8.07 ± 0.11^{d}	7.61 ± 0.14^{e}	8.18 ± 0.08^{c}	7.43 ± 0.33^{b}	8.21 ± 0.08^{a}
Intestine (g)	11.97 ± 0.31^{e}	12.17 ± 0.3^{c}	12.62 ± 0.20^{b}	12.11 ± 0.20^{d}	12.67 ± 0.22^{a}

*Values are expressed Mean ± S.E, T1 – inulin 50mg, T2- inulin 100mg, T3 – chicory 50mg, T4- chicory 100mg. Values not sharing a common marking (a,b,c,d,e) different alphabets row in differ significantly at $p<0.05$.

Table 5:-Effect of inulin and chicory powder supplementation of serum biochemical of quails

Experiment	Glucose (mg /dl)	Total protein (g /dl)	Albumen (g /dl)	Globulin (g /dl)	Triglyceride (mg/dl)	Cholesterol (mg/dl)
Normal Reference Range	200 – 450	3.5 – 5.5	3.8 – 4.4	2.00 –4.50	50 - 150	35 – 150
Control	253.8±2.84	4.5 ± 0.14	3.1 ± 0.10	1.05±0.02	74.4 ± 0.87	64.8 ±0.81
Inulin 50mg	346.6±3.38	5.24 ±0.16	3.89±0.18	1.12±0.06	70.9 ± 0.45	61.7±0.57
Inulin 100mg	360.4±2.32	5.65 ±0.48	4.1 ± 0.20	1.04±0.10	65.5 ± 1.01	58.3±0.36
Chicory 50mg	349.9±2.58	4.8±0.24	3.73±0.24	1.09±1.02	69.9±0.47	59.7±0.47
Chicory 100mg	370.9±8.27	5.87±0.16	4.21±0.20	1.43±0.08	63.5±0.60	54±0.74

Values are expressed in MEAN ± S.E. Values are non- significant different (P>0.05).

Table 6:-Effect of inulin and chicory powder supplementation of serum biochemical of quails

Experiment	Calcium (mg /dl)	Phosphorous (mg /dl)	SGOT(12U/L)	SGPT(4U/L)
Normal Reference Range	8 – 14 mg %	3.3 – 3.8	AST =12U/L	ALT = 4U/L
Control	9.14 ± 0.29	2.92 ±0.23	11.06 ± 0.17	3.63 ± 0.13
Inulin 50mg	10.30 ± 0.34	3.05 ± 0.07	10.38 ± 0.22	2.39 ± 0.18
Inulin 100mg	11.05 ± 1.16	3.29 ± 0.04	10.11 ±0.24	1.92± 0.03
Chicory50mg	9.74±0.41	3.08±0.09	10.25±0.37	2.04±0.08
Chicory100mg	11.35±0.44	3.31±0.11	10.05±0.24	1.84±0.07

Values are expressed in MEAN ± S.E. Values are non- significant different (P>0.05)

Table 7: Effect of inulin and chicory powder supplementation of serum biochemical of quails

Experiment	Alkaline Phosphate (mg/dl)	Acid Phosphate (mg/dl)	Creatinine (mg/dl)	Uric Acid (mg/dl)
Normal Reference Range	2 – 3.8	9 - 22	35 – 141	2 – 10
Control	3.12 ± 0.09	17.15 ± 0.21	79.8 ± 3.51	4.01 ± 0.12
Inulin 50mg	3.65 ± 0.10	16.59 ± 0.29	72.9 ±2.61	3.54 ± 0.14
Inulin 100mg	2.9 ± 0.08	15.89 ± 0.23	63.9 ± 1.66	4.03 ± 0.19
Chicory50mg	2.88 ± 0.23	15.67 ± 0.23	84.2 ± 3.58	3.82 ± 0.22
Chicory100mg	2.83 ± 0.07	15.38 ± 0.95	86.4 ± 3.78	3.5 ± 0.24

Values are expressed in MEAN ± S.E. Values are non- significant different (P>0.05)

Table 8:-Effect of chicory and inulin supplementation on intestinal microflora concentration of Japanese quail

Item		Experimental diet				
		Control	Chicory		Inulin	
			50mg	100mg	50mg	100mg
Lactic acid (Log_{10} CFU/g)	Jejunum	5.26±1.02 ^{e}	5.47±1.21 ^{c}	5.80±0.21 ^{a}	5.42±0.21 ^{d}	5.44±0.37 ^{b}
	Ileum	8.84±1.54 ^{e}	8.94±1.76 ^{c}	9.20±1.62 ^{b}	8.86±1.41 ^{d}	9.52±1.66 ^{a}
	Cecum	11.27±2.68^{e}	11.89±1.98 ^{c}	11.94±1.84 ^{b}	11.74±1.27 ^{d}	11.96±1.84 ^{a}
***E. coli* (Log_{10} CFU/g)**	Jejunum	4.12±1.12 ^{a}	4.02±0.22 ^{b}	3.82±0.36 ^{d}	4.0±0.21 ^{c}	3.64±0.32 ^{e}
	Ileum	7.52±1.62 ^{a}	7.32±1.23 ^{b}	7.21±1.02 ^{d}	7.44±1.68 ^{c}	7.17±1.52 ^{e}
	Cecum	8.47±1.89 ^{a}	8.40±2.17 ^{b}	8.38±2.12 ^{c}	8.23±2.08 ^{d}	8.19±2.04 ^{e}

*Values are expressed Mean ± S.E, Values not sharing a common marking (a,b,c,d,e) different alphabets row in differ significantly at $p<0.05$.

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