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Phytochemical analysis and anticoccidial activity of aqueous and methanolic extracts of *Musa paradisiaca* corm against experimentally induced caecal coccidiosis in Broilers

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Abstract
The present experiment was planned to investigate the potential of aqueous and methanolic extracts of *Musa paradisiaca* corm against experimentally induced caecal coccidiosis in broilers. The experiment was divided in to two subheads: preparation, proximate analysis, phytochemical analysis, mineral estimation and therapeutic efficacy of *Musa paradisiaca* corm extract against experimentally induced coccidiosis in broilers. The proximate analysis of *Musa paradisiaca* corm powder contained dry matter (DM) 90.25%,total ash (TA)10.13%, organic matter (OM) 89.87%,crude protein (CP) 11.87%, ether extract (EE) 1.90%,crude fibre (CF)12.31% and nitrogen-free extract (NFE) 63.69%. The mineral concentration of the plant residues were rich in Ca, P, Mg, Fe, Cu and Zn. Phytochemical analysis of both the extract residues contains alkaloids, sterols, glycosides, phenols, protein, tannins, flavonoids and terpenoids. Preliminary acute toxicity test showed methanolic and aqueous extract did not produce any toxic signs and change in haemato biochemical parameters were noticed in any experimental broiler birds. Anticoccidial activity of methanolic extract of *Musa paradisiaca* @1000 mg/kg body weight for 7 days revealed better anticoccidial activity and restoration of haemato-biochemical and mineral content towards normalcy.

Keywords: Proximate analysis, Phytochemical analysis, Aqueous extract and Methanolic extract, *Musa paradisiaca*, *Eimeria tenella*.

Introduction
Coccidiosis is a global disease and cause huge economic losses on yearly basis, including prophylaxis as well as therapy, exceeds 2 billion Euros [1] which accounts for approximately 10% of the total investment made in poultry industry. The reason for great economic losses are cumulative effect of lower feed intake impaired feed conversion ratio, depressed growth rate, lower egg production and increased mortality rate [2]. Commercial broiler farmers are the foremost victims of losses inflicted by coccidiosis, estimating a total economic loss of 95.61 percent [3], whereas commercial layer industry shares 3.53 percent of the losses. Control of coccidiosis is very challenging because many species of *Eimeria* exist at the same time during incidence of the disease in the flock. The birds may contract infection from different species because there is no cross immunity between the different species of *Eimeria*. Coccidia have a very complicated life cycle involving various endogenous developmental stages in the host. It produces detrimental effects on the absorption of nutrients particularly amino acids and glucose and may produce deviation in various biochemical and enzymatic components/processes and loss of body condition. It also causes structural changes in the intestinal mucosa leading to haemorrhagic enteritis, anaemia, electrolyte imbalance. Poultry farmers use a number of coccidiocidal drugs during outbreak of disease but till date no drug has offered equal protection against all the species of *Eimeria*. Today the commercially available anticoccidials have not remained as effective as they were when first introduced, and therefore different type of drug designing includes drug rotation or shuttle programme has been adopted to reduce resistance. But the drawbacks associated with chemoprophylaxis include their high cost and the emergence of resistance to all coccidiostats which, in due course, limits their use [4, 5]. There are no new anticoccidial drugs in the market, therefore novel approach and alternative strategies are urgently required to reduce economic losses. Plant products are natural in origin and believed to be less toxic than chemical preparations.

Banana (*Musa paradisiaca*) is common plant grown by the farmers and unused part of the plant i.e. corm were use in experiment. The plants extracts are rich in mineral, phenols and flavanoid. The earlier workers also reported anticoccidial activity of the plant in rabbits and chickens [6, 7].The information about *Musa paradisiaca* corm extract against ceaceal coccidial in broiler was very scanty. Therefore, the objective of this experiment was to study the therapeutic efficacy of aqueous and methanolic extract of *Musa paradisiaca* corm extracts against experimental induced coccidiosis in commercial broilers chickens and its comparison to amprolium as a standard anticoccidial agent.

Materials and Methods

Collection and Identification of Plant material

Corms of *Musa paradisiaca* (Banana) were locally procured from the vicinity of Pantnagar. The collected specimen were identified and certified by the Medicinal Plants Research and Development Centre (MRDC) of the G.B.P.U.A.T., Pantnagar. In order to remove earthen particles and other extraneous materials from the corms of *Musa paradisiaca*, they were washed thoroughly, first with tap water and then with deionised water. Then the corms were chopped in to small pieces and shade dried for 28 day.The corm thus obtained were pulverised by mechanical grinder. The powder was sieved through a mesh (1mm) and the fine powder thus obtained.The powder was soaked separately for different solvents (methanol and distilled water) in the ratio of 1:10 (w/v) in glass beakers. The glass beakers with proper lid were kept at room temperature and stirred intermittently to dissolve the plant materials in to solvents properly. After 24 hrs the content were filtered through several layers of muslin cloth and then Whatman's filter paper no.1 using a funnel. The filtrate thus obtained was concentrated in vacuum rotator evaporator at 40-45 ^{0}C. Concentrated extract obtained was poured in to flat glass tray and kept in fan incubator for drying at temperature 35 to 40 ^{0}C for two days to get the final extract residue. The final extract residue was stored in dark coloured glass vials sealed with paraffin wax and stored at 4 ^{0}C in refrigerator.

Proximate Analysis: The crude powder of the herb was analyzed for proximate according to the method laid down by AOAC (1990) [8].

Estimation of minerals in herbal powder and their extracts: The crude powder of herbs and their aqueous and methanolic extracts were analysed for minerals namely calcium, iron, magnesium, copper and zinc through Atomic Absorption Spectrophotometer (AAS).

Preliminary Photochemical Analysis: Qualitative phytochemical analysis of aqueous and methanolic extracts of corms was done by standard method [9].

Preliminary Acute toxicity study of Herbal extract: The guidelines of OECD 2002 [10] were followed to adjudge the acute toxicity of the herbal extracts. Different parameters (general toxicity signs, body weight gain/loss, haematological parameters, biochemical parameters and histopathological examination) were studied after single oral dose of 1000, 2000 and 5000 mg/kg body weight of methanolic and aqueous extract of corm extract in commercial broiler chicks.

Experimental coccidian infection: Pure culture of *Eimeria tenella* was collected from Division of Parasitology, I.V.R.I., Izatnagar, Bareilly, U.P., India. For obtaining sufficient stock of oocysts for use in the experiment, four donor broiler of 4 week age, were infected by crop intubation with approximately 40 X 10^3 sporulated oocysts. From 5th to 7th day post infection (dpi) the total droppings were collected, sporulated and concentrated.

Experimental design: The experiment was conducted with 120 broiler chicks (day old) purchased from reputed hatchery. After receiving chicks from hatchery, they were arbitrarily divided into eight groups of 15 chicks each. All the chicks were reared under coccidia free environment in horizontal battery brooders and all the possible measures were adopted to keep the flock healthy. The chicks of different groups were reared in individual cage and group were designated as I to VIII (Table-1).

Table 1: Experimental treatments and their dose of administration

Group	No. of birds	Details of treatment intervention
I- HC	15	Healthy control (no any medication)
II- AC	15	Medicated control of Amprolium @250 mg/lit on 21 to 28 day.
III- MPAC	15	Medicated control of aqueous extract of *Musa paradisiaca* corm @1g/kg b.wt. on day 21 to 28 day.
IV- MPAI	15	Infected with 40,000 oocysts on day 21 and treated with aqueous extract of *Musa paradisiaca* corm @1g/kg b.wt. on day 0 to 7 DPI.
V- MPMC	15	Medicated control of methanolic extract of *Musa paradisiaca* corm @1g/kg b.wt. on day 21 to 28 day.
VI- MPMI	15	Infected with 40,000 oocysts on day 21 and treated with methanolic extract of *Musa paradisiaca* corm @1g/kg b.wt. on day 0 to 7 DPI.
VII- AI	15	Infected with 40,000 oocysts on day 21 and treated with Amprolium @ 250 mg/l water on day 0 to 7 DPI
VIII- IC	15	Infected control (no any medication)

On day 21 of experiment, broilers of IV, VI, VII and VIII groups were infected by inoculating 1 ml suspension containing 40,000 sporulated oocysts of *Eimeria tenella* species directly in the pharynx, using a long nozzle 2 ml plastic pipette. Broilers of healthy and medicated control groups (I, II, III, and V) were provided with 1 ml plain distilled water. Before the experimental infection, sub-clinical coccidial infection in broilers was ruled out by standard parasitological methods for 3 consecutive days.

Clinical parameters

Clinical parameters including clinical signs; pre-patent period and mortality rate were recorded in all the infected groups (IV, VI, VII and VIII).

Parasitological parameters

Faecal score (FS) were determined by scoring the faecal dropping in every morning from 4th day to up to 10th day post-infection (DPI) [11]. Performance index [12] was calculated by adding percent survival, percent weight gain and percent

faecal score, Oocyst production, Oocyst count was done [13] from 4th to 14th day post-infection oocyst index was calculated [14] on 7 DPI in different groups and Percent protection against lesion [15]

Haematological parameters: Haemoglobin (Hb), packed cell volume (PCV), total erythrocyte count (TEC), total leukocyte count (TLC), erythrocytic indices MCV (fl), MCH (pg) and MCHC (%) and differential leukocyte count (DLC) were analysed as described by Jain (1986), microhaematocrit method and Natt and Herrick (1952) [16, 17] respectively.

Biochemical parameters: Alanine amino transferase (ALT), Aspartate amino transferase (AST), alkaline phosphate (ALP),total serum protein (TSP), serum albumin (SA), serum globulin (SG), albumin globulin ratio (A:G ratio) andserum glucose were analysed by using specific commercial diagnostic kits (ERBA/SPAN).

Estimation of minerals in serum: Analysis of serum samples for estimation of calcium, iron, magnesium, copper and zinc was done through Atomic Absorption spectrophotometer [18] and sodium and potassium were estimated by flame photometer.

Collection of sample for haemato-biochemical and mineral study: Blood (about 4 ml) from wing vein was withdrawn aseptically from five (5) broiler birds of each group on 21st, 25th, 27th 29th and 35th day in uninfected groups and on 0, 5th, 7th, 9th and 14th day post infection in infected groups. One ml of this blood was kept in sterile glass tubes containing EDTA as anticoagulant for haematological studies and remaining 2 ml was kept in the sterile clot activator tube. The tube was allowed to clot for six hours in a slanting position for separation of serum and preserved at-20 ^{0}C in deep freezer after proper labeling for biochemical studies. Efforts were made to complete the haematological estimation on same day.

Statistical Analysis: All the observations recorded in this study were subjected to statistical analysis by Snedecor and Cochran (1994) [19].

Results and discussions

Physical characteristics of aqueous and methanolic extracts of corm of *Musa paradisiaca* (Banana) varied in colour and consistency. The aqueous extract was solid in consistency and dark brown in colour while its methanolic extract was also solid in consistency with light brown in colour. The variation in colour and consistency of extracts residues depend on the plant and solvent used for extract preparation and geographical region in which plant is grown. The recovery from aqueous and methanolic extract was 10.3 and 9.45%, respectively. The results of proximate analysis revealed that *Musa paradisiaca* corm powder contained dry matter (DM) 90.25%, total ash (TA)10.13%, organic matter (OM) 89.87%, crude protein (CP) 11.87%, ether extract (EE) 1.90%, crude fibre (CF) 12.31% and nitrogen-free extract (NFE) 63.69% (Table 2). The Mineral estimation of the plant powder, aqueous and methanolic extract revealed variation in concentration of Ca, Mg, Fe, Cu and Zn (Table -3). The variation in mineral content may be due to change in variety, method of extraction, stage of plant, season and geographical region. The aqueous extract residue revealed the presence of alkaloids, sterols, phenols, protein, tannins, flavonoids, reducing sugar and saponins. The methanolic extract residue showed presence of glycosides, phenols, protein, tannins, flavonoids, reducing sugar and terpenoids (Table-4). The present findings are in agreement with earlier workers [20, 21, 22]. The phyto chemicals in the plant extract depend on the type of solvent used for extraction. It is postulated that plants which are rich in a wide verities of secondary metabolites are generally superior in their biological activities. Preliminary acute toxicity test showed that boilers chickens drenched with single oral dose of 1000, 2000 and 5000 mg/kg b. wt. of methanolic and aqueous extracts did not produce any toxic signs immediately after administration of extracts, birds of all tested sub groups remained alert, showed normal behaviour, normal gait and posture, moved normally in the cage. No mortality was found up to 14 days of observation period. The LD_{50} of all the extracts residues was more than 5,000 mg/kg body weight. Present findings are in accordance with Jha *et al*. (2011), Anosa and Okoro (2011) [7, 23] who also found that methanolic extract of *Musa paradisiaca* root given @ 5000 mg/kg body weight orally did not produced any lethality in rats. No significant ($P<0.05$) change in the average body weight was found in broiler chickens belongings to all extract drenched sub groups when compared to control group at 21th, 28th and 35th day of single oral administration of extract. There was non-significant ($P<0.05$) variation in Hb, PCV,TEC and TLC values in all the groups at 28th and 35th day of single oral administration of extract. The results of biochemical examination revealed non-significant ($P<0.05$) variation in the values of total protein, ALT, AST ALP, BUN and creatinine in all the groups at day 21 and 28 of giving extract. No histopathological changes were observed in liver, kidney and spleen of broiler chickens 21 days after giving single oral dose of 5000 mg/kg b. wt. of methanolic and aqueous extract. Therapeutic evaluation of aqueous and methanolic extract of the plant residues against caecal coccidiosis in broiler of different groups showed. Birds of group IV, VI, VII and VII challenged with sporulated oocyst showed varied in degree of clinical signs and bloody droppings with loose faeces were recorded and most severe clinical signs were recorded in group VIII. The pre-patent period, when oocysts were first detected in droppings was 6th dpi. Mortality in broiler birds of challenged groups started from 6th dpi and stopped on 8th dpi. Broiler birds treated by methanolic extract, aqueous extract, and amprolium showed 60 %, 73.33 % and 86.67 % survivability respectively (Table-5). Higher survivability percent noticed in broilers treated with methanolic extract supplemented groups may be due to presence of high antioxidant activity as compared to aqueous extract and also may be due to the anticoccidial property of these herbs as reported by earlier worker [20]. Broilers treated with amprolium, methanolic extract and aqueous extract had 78.57 %, 64.29 % and 35.71% faecal score respectively (Table 5). These results revealed the efficacy of methanolic extract of *M. paradisiaca* and amprolium in controlling coccidiosis. Anticoccidial effect of methanolic extract may be attributed to its anticoccidial property due to the presence of phenols and flavonoids contents which contribute to its antioxidant property and minimised coccidia induced damage to the intestinal wall during pro inflammation reaction and resulting in less damage to the gut [24]. Percent weight gain was recorded maximum in broilers of methanolic extract supplemented groups and minimum weight gain percent was recorded in broilers of infected control group (Table 4). Higher performance index of broilers was found in amprolium treated group followed by methanolic extract of *M. paradisiaca* than aqueous extract treated group. Highest average oocyst production per gram of faeces was found in

broiler of infected control group (2, 38980) and lowest was found in amprolium treated group (28, 234). Broilers treated with methanolic extracts showed lower average oocyst (38,203) production than aqueous extract (65, 545) treated groups (Table-4). Matekaire *et al*. (2005) [6] noticed significant decrease in oocyst output in both banana root powder and sulphadimidine sodium treated groups in rabbit. Average lesion score was very severe in infected control group VIII (3.75±0.25) and it was lower in broiler of group VII (1.00±0.09), which was treated with amprolium. Among *Musa paradisiaca* corm treated groups, lower average lesion score (1.50±0.29) was recorded in broilers treated with methanolic extract than lesion score (2.25±0.25) of aqueous extract treated groups (Table 5). It may be due to presence of high amount of phenols and flavonoids contents in methanolic extract, which contribute to its higher antioxidant property and minimise coccidia induced damage to the intestinal wall during pro inflammation reaction and resulting in less damage to the gut [24]. Higher performance index of broilers was found in amprolium treated group. Performance index of broilers of groups treated with methanolic extract were better than aqueous extract treated group. Average body weight gain on 0 dpi or 21st day of experiment differed non significantly ($P \leq 0.5$) among all groups. On 7 dpi or 28th day of experiment, significant ($P \leq 0.5$) reduction in average body weight gain was recorded in all treatment groups in comparison to respective control group. Lower body weight gain was recorded in infected control group (429.87±4.21). Among treated groups, lower reduction in average body weight gain was seen in methanolic extract treated birds. On 14 dpi or 35thday of experiment significant ($P \leq 0.5$) improvement in average body weight was observed in comparison to infected control group. In acute phase of disease (5 to 7 dpi) Hb, PCV, TEC, MCH, MCHC, heterophils and monocyte percentage were decreased, whereas MCV, lymphocytes and eosinophils percentage were increased in infected groups than respective uninfected groups. Maximum alterations in haematological parameters were observed in infected control group. Restoration in haematological parameters on 7 dpi was maximum in amprolium treated group followed by birds treated with methanolic extract. On 14 dpi maximum restorations of haematological parameters was observed in groups treated with methanolic extract (Table 6 and 7). The lower Hb concentration in acute phase of disease was more or less associated with the severe caecal haemorrhage resulting from the liberation of second generation merozoites, causing massive breakage of the mucosal blood vessels, sloughing of caecal mucosa and discharge of large quantity of blood [25]. It is further aggravated by release of large quantity of histamine from injured tissue resulting in increased blood flow and permeability of the blood vessel. Thereafter, with initiation of gametogenic multiplication the infected birds are on the way of to recovery and they rapidly compensate the blood loss. Consequently there was restoration of haematological parameters [17]. Restoration of haemoglobin in all extract groups may be due to the presence of phytochemicals like tannins, glycosides, alkaloids, saponins, flavonoids, polyphenols and reducing sugars in plant extracts which stimulate kidney to the formation or secretion of erythropoietin to stimulate haematopoiesis or could be due to the high iron content of the plant which helps in erythropoiesis [26]. Onyenekwe *et al*. (2013) [27] found that significant ($P>0.05$) increase in RBC, PCV and Hb levels and significant decrease in MCH and MCHC in rats after oral administration of *Musa paradisiaca* stem extrude aqueous extract for 28 days. Increase in lymphocytes, monocytes, and eosinophils and decline in heterophils was observed during the present study (Table 7 and 8). Earlier workers [28, 29, 30] also found monocytosis, lymphocytosis, heterophilia and eosinophilia in broiler chickens infected with *E. tenella* and *E. brunetti*. In coccidia infection, antibody mediated immune response plays a minor role whereas, cell mediated immune response plays a chief role to provide protection against coccidiosis. T lymphocytes appear in *Eimeria* infection through both cytokine production and a direct cytotoxic attack on infected cells [31, 32]. Eosinophilia generally observed in parasitic infestation and allergic reaction. The present eosinophilia is immunologically mediated. Eosinophils interacted with IgE, IgG, mast cells and basophils. T-lymphocytes and IgE on mast cells attract eosinophils to modulate inflammatory reaction. Increased monocyte count may be associated with inflammatory reaction. Monocytes, macrophages and dendritic cells are important haemopoietic cells that play essential role in body defence mechanism. Majority of inflammatory tissue macrophages arises from monocytes. Macrophages help in removal of dead tissue, defence against pathogens, promoting wound healing and tissue repairing [33]. In acute phase of disease (5 to 7 dpi) total protein, albumin, globulin and A: G ratio were significantly decreased and glucose level was significantly higher in infected control group (Table 9 and 10). Lesser reduction in total protein, albumin, globulin and A: G ratio was observed in amprolium treated group Among herbal groups, lesser reduction was noticed in group treated with methanolic extract of *M. paradisiaca*. The decreased levels of total protein, albumin, globulin and A: G ratio in coccidiosis might be attributed to caecal haemorrhage, reduced feed intake and impaired metabolism of proteins [34]. Patra *et al*. (2009) [35] mentioned that marked hypoprotenemia may be contributed by maldigestion and malabsorption of nutrient, liver change and severe haemorrhagic enteritis and also suggested that fall in total protein concentration might be due to acute stress that leads to cortisol release and resulting in catabolism of protein. In acute phase of disease, lower elevation in blood glucose level was noticed in birds treated with amprolium and methanolic extract. The activities of ALT, AST and ALP were significantly increased in infected control group at 5 and 7 dpi. Lower alteration in the values of ALT, AST and ALP was notice in amprolium treated group. Among other treated groups, lower values were recorded in birds treated *M. paradisiaca*. On 14 dpi, groups treated with amprolium and methanolic extract revealed almost normal levels of these enzymes. The activities of ALT, AST and ALP were significantly increased in infected control group at 5 and 7 dpi and gradually decreased on 9 dpi onwards (Table-9). Alteration in ALT activity may be due to less feed intake or due to the hepato cellular damage [36]. Hepato-renal protective effects of *Musa paradisiaca* aqueous root extract on arsenic-induced oxidative damage in rats [20]. Significantly reduction in ALT, AST, ALP, total protein, bilirubin, creatinine, urea, uric acid, blood urea nitrogen and electrolyte values were recorded. On 7 dpi lower Ca, P, Mg, Fe, Zn and Cu values were decreased in broilers of infected control group and it differed significantly from all the experimental groups (Table11 and 12). On 9 dpi or 29th day of experiment, serum Ca, P, Mg, Fe, Zn and Cu values was increased in all treatment groups and differed significantly ($P \leq 0.5$) from infected control group. On 14 dpi and 35th day of experiment Ca, P, Mg, Fe, Zn and Cu values level in groups was increased in metahanolic extract and amprolium treated group but differed non significantly ($P \leq 0.5$) with healthy control groups. Present findings are in accordance with Shukla and

Kumar (2005) and Freitas (2014) [37, 38].The quantitative variation in the level of minerals content in different treatment groups might be due to difference in severity of infection. The lower serum mineral concentration affects the performance of birds resulting in lower body weight in infected birds as compared to healthy control. Hypocalcaemia may be due to poor absorption and metabolism of calcium from intestine during acute phase of disease [39]. Hypophosphatemia during entire period of experiment was observed in all infected groups. The low Pi level in acute phase of coccidiosis is due to loss of erythrocytes resulting from extensive caecal haemorrhage and in later stage due to rapid compensation of erythrocytes loss by increased erytropoietic activity with greater utilization of the serum Phosphorus. This resulted in decreased serum Phosphorus level during the recovery phase. In this study, hypomagnesaemia was observed in broilers of all infected groups which is also reported by earlier worker [40]. Decrease in magnesium may be due to malabsorption and metabolism. Magnesium is the activator of several enzymes such as phosphatases and the enzyme catalysing reaction of ATP. The reduction in iron content was found in all infected groups and present finding is in accordance with Southern and Baker (1982) [41]. The reduction in iron level can be justified by the facts that infected birds showed anorexia and decrease absorption of iron from damaged cells of intestinal mucosa. Iron is also lost in haemorrhage as it is the integral component of haemoglobin. Decrease in concentration of zinc was observed on 7 dpi. It may occur due to trauma and haemorrhage [42]. There was progressively decline in copper level in all the infected groups. Hypocupraemia may be correlated with anaemic condition of the infected birds as observed in present study. Copper plays important role in haemoglobin production. Decrease Sodium and increase potassium level was recorded on 5th and 7th DPI in all treatment groups and infected control group (Table 12) and lower sodium level and higher potassium level was found in infected control group on 7th DPI. On 9 DPI or 29th day of experiment, sodium level was increased and decrease potassium level in all treatment groups and differed significantly *(P*≤0.5) from infected control group (Table 12). Hponatraemia and hyperkalaemia in present study is similar to the observations of earlier workers [37, 43]. During the acute phase of infection, severe haemorrhage in to intestinal lumen, damage of intestinal mucosa and hyperaemia might be depleting the total fluid volume. Sodium is predominant extracellular cations. Sodium ions do not move freely into the intracellular space and its depletion in plasma disturbs active passive transport of electrolytes. Hyperkalaemia in infected birds also indicates increased cellular permeability allowing release of potassium ion from intracellular to extracellular fluid as a result of haemorrhagic enteritis and necrotic changes occurring in intestinal epithelium.

Table 2: Chemical composition (% dry matter basis) of *Musa paradisiaca* corm powder

Attributes (%)	*M. paradisiaca* corm
DM	90.25
Ash	10.13
OM	89.87
CP	11.87
EE	1.90
CF	12.31
NFE	63.79

(DM-dry matter, OM -organic matter, CP-crude protein, EE –ether extract, CF-crude fibre, NFE- nitrogen free extract)

Table 3: Concentration of different elements in crude powder, aqueous extract and methanolic extract of *M. paradisiaca* corm

Element(ppm)	*M. paradisiaca* corm		
	Powder	AE	ME
Calcium	1800	1200	1100
Magnesium	38.76	40.52	31.26
Iron	5.40	6.96	5.38
Copper	16.44	17.96	13.84
Zinc	16.00	16.68	16.08

(AE- aqueous extract residue, ME- methanolic extract residue)

Table 4: Phytochemical screening of different extracts of *M. paradisiaca* corm

Sl. No.	Constituents	Aqueous extract residue	Methanolic extract residue
1.	Alkaloids	+	-
2.	Sterols	+	-
3	Glycosides	-	+
4.	Phenols	+	+
5.	Protein	+	+
6.	Tannins	+	+
7.	Flavonoids	+	+
8.	Reducing sugar	+	+
9.	Saponins	+	-
10.	Terpenoids	-	+

Table 5: Effect of different therapeutic regimen on feacal score (%), weight gain(%), PI, av. oocyst production ,% reduction in OPG, av.oocyst index, av. lesion score, protection against lesion score(%), mortality(%) and survival (%), in experimental broiler chicks.

Group	Faecal score (%)	Weight gain (%)	PI	Average oocyst production	Percentage reduction in OPG	Average oocyst index	Average lesion score	Protection against lesion (%)	Mortality (%)	Survival (%)
IV- MPAI	35.71	88.0	183.7	65545	73.00	1.80±0.12	2.25±0.25	40.00	40.00	60.00
VI- MPMI	64.29	91.0	228.6	38203	84.00	1.36±0.10	1.50±0.29	60.00	26.67	73.33
VII- AI	78.57	90.0	255.2	28234	88.00	1.24±0.09	1.00±0.00	73.33	13.33	86.67
VIII- IC	0.00	82.0	128.7	238980	0.00	3.48±0.22	3.75±0.25	0.00	53.33	46.67

(MPAI- *Musa paradisiaca* aqueous extract, MPMI-*Musa paradisiaca* methanolic extract, AI-Amprolium, IC-Infective control)

Table 6: Effect of different therapeutics regimen on haemoglobin (g/dl), PCV (%) and TEC (x10^6/cu mm) in experimental broiler birds

Groups	Hb (g/dl)					PCV (%)					TEC (x10^6/cu mm)				
	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14
I- HC	11.90±0.14^{aA}	11.74±0.15^{aA}	11.62±0.20^{Aa}	11.98±0.13^{aA}	11.92±0.20^{aA}	36.80±0.49^{Aa}	35.60±0.40^{aA}	35.60±0.24^{aA}	36.40±0.24^{aA}	35.60±0.24^{aA}	3.12±0.04^{aA}	3.06±0.04^{aA}	3.06±0.06^{aA}	3.11±0.02^{aA}	3.09±0.02^{Aa}
II- AC	12.02±0.18^{aA}	11.78±0.16^{aA}	11.70±0.17^{aA}	11.74±0.15^{aA}	11.82±0.25^{aA}	36.70±0.49^{Aa}	35.80±0.20^{aA}	36.00±0.32^{aA}	36.40±0.24^{aA}	35.60±0.24^{aA}	3.17±0.04^{aA}	3.09±0.03^{aA}	3.07±0.04^{aA}	3.09±0.04^{aA}	3.08±0.02^{Aa}
III- MPAC	11.86±0.15^{aA}	11.36±0.13^{aA}	11.62±0.16^{aA}	11.62±0.16^{aA}	11.74±0.19^{aA}	36.40±0.40^{aA}	35.20±0.37^{aA}	35.60±0.24^{aA}	35.60±0.24^{aA}	35.40±0.40^{aA}	3.07±0.05^{aA}	3.07±0.04^{aA}	3.06±0.04^{aA}	3.06±0.06^{aA}	3.09±0.02a^{A}
IV- MPAI	12.00±0.20^{aA}	7.24±0.25^{cdC}	6.56±0.02^{cdD}	7.22±0.06^{dC}	9.44±0.09^{dB}	36.40±0.40^{aA}	30.60±0.40^{dB}	31.40±0.24^{cB}	29.40±0.24^{dC}	30.00±0.55^{dC}	3.18±0.03^{aA}	1.77±0.02^{dC}	1.63±0.12^{cC}	1.72±0.02^{eC}	2.39±0.05^{bB}
V- MPMC	11.78±0.12^{aA}	11.52±0.18^{aA}	11.98±0.26^{aA}	12.04±0.22^{aA}	12.08±0.26^{aA}	35.80±0.20^{aA}	35.60±0.24^{aA}	36.40±0.24^{aA}	36.60±0.24^{aA}	36.40±0.24^{aA}	3.09±0.04^{aA}	3.04±0.06^{aA}	3.13±0.02^{aA}	3.11±0.02^{aA}	3.14±0.01^{aA}
VI- MPMI	11.56±0.12^{Aa}	9.22±0.06^{bC}	8.10±0.12^{cD}	8.26±0.07^{cD}	10.50±0.18^{cB}	36.40±0.40^{aA}	30.60±0.24^{dC}	28.60±0.24^{cdD}	28.40±0.26^{cdD}	32.40±0.24^{cB}	3.05±0.03^{aA}	2.37±0.03^{bC}	2.15±0.07^{bD}	2.08±0.06^{dD}	2.72±0.07^{bB}
VII- AI	11.96±0.18^{aA}	9.34±0.07^{bBC}	8.58±0.15^{cC}	10.08±0.17^{bB}	11.28±0.05^{aA}	36.80±0.49^{aA}	29.60±0.24^{dBC}	28.60±0.24^{cdC}	31.80±0.20^{cB}	32.80±0.20^{cB}	3.16±0.01^{aA}	2.36±0.05^{bC}	2.18±0.04^{bC}	2.63±0.07^{bB}	3.03±0.06^{aA}
VIII- IC	11.54±0.20^{aA}	5.58±0.04^{fC}	5.28±0.07^{eC}	6.12±0.02^{dB}	7.56±0.02^{bF}	36.40±0.24^{aA}	25.60±0.24^{dC}	27.20±0.37^{eB}	27.60±0.24^{dB}	24.40±0.24^{eC}	3.04±0.04^{aA}	1.26±0.04^{dC}	1.20±0.05^{dD}	1.41±0.13^{fC}	1.79±0.06^{dB}

Mean bearing different upper superscript in a row differ significantly (P ≤ 0.5) and mean bearing different lower superscript in a column differ significantly ($P \leq 0.5$).

Table 7: Effect of different therapeutics regimen on MCV (fl), MCH (pg) (MCHC) (%) and TLC(x10^3/cu mm) in experimental broiler birds

Groups	MCV (fl)					MCH (pg)					(MCHC) (%)					TLC(x10^3/cu mm)				
	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14
I- HC	118.09±1.88^{aA}	116.37±2.40^{eA}	116.48±2.22^{eA}	117.20±1.05^{eA}	115.24±1.39^{bA}	38.20±0.81^{Aa}	38.36±0.53^{aA}	38.07±1.38^{aA}	38.12±0.54^{aA}	38.29±0.77^{aA}	32.38±0.81^{aA}	32.99±0.45^{aA}	32.65±0.65^{abA}	32.92±0.53^{Aa}	33.49±0.63^{abA}	25.66±0.47^{aA}	25.00±0.55^{dA}	25.38±0.50^{eA}	25.42±0.69^{bcA}	25.12±0.67^{bcA}
II- AC	117.24±1.53^{aA}	115.98±1.40^{eA}	117.43±2.01^{eA}	117.92±2.27^{eA}	115.46±1.25^{bA}	37.92±1.00^{aA}	38.16±0.53^{aA}	38.17±0.89^{aA}	38.01±0.50^{aA}	38.32±0.75^{aA}	32.35±0.86^{aA}	32.91±0.42^{aA}	32.51±0.57^{abA}	32.26±0.42^{Aa}	33.21±0.78^{abA}	25.16±0.72^{aA}	25.06±0.60^{dA}	25.36±0.47^{eA}	24.90±0.67^{cA}	25.28±0.62b^{cA}
III- MPAC	118.68±2.95^{aA}	114.89±2.01^{efA}	116.52±2.15^{eA}	116.62±2.58^{eA}	114.76±1.88^{bA}	38.63±0.38^{aA}	37.09±0.81^{aA}	38.04±0.91^{aA}	38.09±1.16^{aA}	38.04±0.48^{aA}	32.60±0.56^{aA}	32.29±0.54^{aA}	32.64±0.42^{abA}	32.65±0.48a^{A}	33.20±0.92^{abA}	24.82±0.63^{aA}	25.10±0.56^{dA}	24.36±0.46^{efA}	25.20±0.48b^{cA}	26.20±0.61^{bA}
IV- MPAI	114.36±1.72^{aC}	172.59±3.20^{cB}	196.68±14.90^{bA}	171.22±1.86^{bB}	125.52±2.31^{abC}	37.70±0.70a^{AB}	29.88±1.78^{cdB}	28.10±3.16c^{dC}	28.15±0.48^{dC}	29.53±0.90^{dB}	32.98±0.63^{aA}	23.65±0.71^{dB}	20.90±0.19^{fC}	24.56±0.25^{Db}	31.52±0.81^{bcA}	25.14±0.59^{aBC}	29.10±0.21^{aA}	29.70±0.17^{bA}	27.10±0.23^{bB}	26.74±0.30^{abB}
V- MPMC	115.97±0.72^{aA}	117.35±2.45^{eA}	116.41±0.78^{eA}	117.69±0.58^{eA}	116.00±0.94^{bA}	38.15±0.31^{aA}	37.99±1.12^{aA}	38.33±0.95^{aA}	38.71±0.55^{aA}	37.89±0.73^{aA}	32.90±0.27^{aA}	32.37±0.68^{aA}	32.91±0.60^{aA}	32.90±0.61^{aA}	33.20±0.77^{abA}	25.28±0.71^{aA}	25.50±0.51^{cdA}	25.12±0.47^{eA}	25.50±0.51^{bcA}	25.78±0.59^{bcA}
VI- MPMI	119.40±1.83^{aAB}	129.38±1.59^{eA}	133.47±4.38^{dA}	137.93±4.93^{cdA}	119.21±2.69^{bAB}	37.92±0.55^{aA}	30.99±0.53^{cB}	29.79±1.22^{cC}	30.82±1.31^{cB}	37.63±0.95^{aA}	31.78±0.54^{aA}	30.13±0.13^{bAB}	28.32±0.37^{cdC}	28.89±0.33^{bBC}	32.81±0.60^{abA}	25.86±0.45^{aAB}	27.64±0.45^{bA}	28.60±0.45^{cA}	26.50±0.64^{bAB}	25.10±0.44^{bcAB}
VII- AI	116.47±1.34^{aAB}	125.63±2.56^{eA}	131.61±2.84^{dA}	121.24±3.16^{eA}	108.42±2.50^{bcB}	37.85±0.49^{aA}	32.65±0.92^{bC}	30.48±1.04^{bD}	34.96±1.36^{bB}	37.27±0.68^{aA}	32.52±0.63^{aB}	31.56±0.24^{abB}	30.02±0.67^{cBC}	31.91±0.59^{aB}	33.39±0.20^{aA}	25.18±0.60^{aA}	26.54±0.58^{cA}	26.96±0.24^{cdA}	25.14±0.54^{cA}	25.26±0.75^{bcA}
VIII- IC	119.75±1.76^{aD}	203.94±6.37^{aB}	227.61±8.96^{aA}	217.03±20.16^{aA}	136.80±5.81^{aC}	37.98±1.00^{aA}	27.44±1.20^{dC}	23.14±2.07^{fc}	27.22±4.86^{eB}	27.85±1.52^{eB}	31.71±0.62^{aA}	21.26±0.28^{dB}	19.44±0.49^{fgC}	24.06±0.18^{dB}	30.26±0.34^{cA}	24.86±0.49^{aC}	30.84±0.10^{aA}	31.60±0.26^{aA}	28.80±0.74^{aB}	27.72±0.46^{aB}

Mean bearing different upper superscript in a row differ significantly (P ≤ 0.5) and mean bearing different lower superscript in a column differ significantly ($P \leq 0.5$).

Table 8: Effect of different therapeutics regimen on heterophils (%), lymphocytes (%), eosinophils (%) and monocytes (%) in experimental broiler birds

Groups	Heterophils (%)					Lymphocytes (%)					Eosinophils (%)					Monocytes (%)				
	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14
I- HC	23.70±0.37^{aA}	24.20±0.73^{aA}	25.20±0.60^{bA}	25.20±0.37^{aA}	24.20±0.45^{aA}	70.60±0.24^{aA}	70.60±0.20^{dA}	70.20±0.49^{eA}	70.80±0.58^{dA}	70.60±0.24^{cA}	3.52±0.07^{aA}	2.92±0.06^{dB}	1.64±0.07^{eD}	1.28±0.04^{eD}	2.20±0.08^{deC}	2.28±0.53^{aA}	2.28±0.20^{cA}	2.56±0.19^{bA}	2.72±0.04^{aA}	3.00±0.53^{aA}
II- AC	23.80±0.37^{aB}	24.40±0.24^{aA}	24.60±0.20^{bA}	25.60±0.37^{aA}	24.00±0.71^{aB}	70.70±0.51^{aA}	70.40±0.49^{dA}	70.00±0.32^{eA}	70.20±0.37^{dA}	70.40±0.51^{cA}	3.45±0.04^{abA}	2.90±0.03^{dA}	1.70±0.07^{eAB}	1.54±0.08^{deB}	2.70±0.11^{dA}	2.35±0.24^{aA}	2.30±0.20^{cA}	2.50±0.18^{bA}	2.66±0.17^{aA}	2.90±0.30^{aA}
III- MPAC	22.90±0.37^{aB}	24.30±0.24^{aA}	24.20±0.37^{bA}	25.00±0.45^{aA}	24.10±0.84^{aA}	71.00±0.37^{aA}	71.10±0.32^{dA}	70.20±0.58^{eA}	70.90±0.32^{dA}	70.80±0.37^{cA}	3.52±0.07^{aA}	2.12±0.12d^{eB}	1.78±0.11^{eC}	1.80±0.07^{deC}	2.32±0.05^{deB}	2.48±0.42^{aA}	2.48±0.14^{bcA}	2.62±0.32^{bA}	3.00±0.23^{aA}	2.78±0.05^{aA}
IV- MPAI	23.10±0.37^{aA}	17.60±0.40^{cB}	15.60±0.49^{dC}	18.60±0.24^{efB}	21.40±0.24^{bcA}	70.80±0.58^{aB}	75.00±0.32^{bA}	76.20±0.20^{aB}	74.20±0.24^{aC}	72.40±0.58^{aB}	3.60±0.07^{aB}	4.60±0.07^{aA}	4.90±0.13^{bA}	4.28±0.21^{abAB}	3.82±0.14^{bB}	2.40±0.28a^{AB}	2.80±0.21^{bA}	3.80±0.31^{aA}	2.92±0.31^{aA}	3.38±0.04^{aC}
V- MPMC	23.20±0.58^{aB}	24.40±0.40^{aA}	24.20±0.49^{bA}	25.00±0.55^{aA}	24.00±0.55^{aA}	70.60±0.40^{aA}	71.20±0.37^{dA}	71.20±0.24^{cdA}	71.30±0.37^{cdA}	70.60±0.40^{cA}	3.36±0.08^{abA}	2.26±0.07^{dB}	1.76±0.05^{eC}	1.86±0.05^{deD}	2.62±0.13^{dB}	2.44±0.31^{aA}	2.14±0.28^{bcA}	2.54±0.20^{bA}	2.34±0.10^{abA}	2.78±0.20^{aA}
VI- MPMI	22.80±0.51^{aA}	19.20±0.32^{bB}	18.60±0.40^{cB}	21.80±0.37^{cA}	22.00±0.24^{abA}	71.60±0.37^{aA}	73.60±0.40^{bcA}	74.60±0.24^{cB}	71.60±0.24^{cB}	70.80±0.37b^{cA}	3.09±0.14^{abB}	4.10±0.14^{bA}	4.04±0.13^{cA}	3.62±0.15^{cB}	3.42±0.10^{bcB}	2.51±0.25^{aAB}	3.10±0.14^{bA}	2.96±0.35^{bAB}	2.98±0.24^{aAB}	3.78±0.15^{aA}
VII- AI	22.60±0.55^{aAB}	19.60±0.24^{bC}	19.00±0.32^{cC}	24.10±0.32^{abA}	23.50±0.68^{aA}	71.40±0.24^{aA}	73.40±0.24^{cA}	73.40±0.24^{cdAB}	70.80±0.37^{dB}	70.40±0.24^{bcA}	3.56±0.07^{aAB}	3.90±0.30^{bcA}	4.08±0.17^{cA}	2.26±0.18^{dC}	2.72±0.09^{dC}	2.44±0.26^{aC}	4.10±0.41^{aA}	3.52±0.23^{abA}	2.84±0.09^{abC}	3.38±0.12^{Aab}
VIII- IC	22.80±0.51^{abA}	14.80±0.37^{Dd}	14.10±0.32^{dCD}	16.20±0.20^{fgC}	20.10±0.55^{cB}	71.20±0.37^{aB}	76.60±0.37^{aA}	77.20±0.37^{aB}	75.20±0.40^{aC}	73.40±0.37^{aB}	3.46±0.14^{aC}	4.98±0.07^{aA}	4.90±0.07^{aA}	4.70±0.21^{aA}	4.28±0.17^{aB}	2.54±0.20^{aB}	4.62±0.26^{aA}	3.80±0.18^{aB}	3.70±0.30^{aB}	3.32±0.06^{Ab}

Mean bearing different upper superscript in a row differ significantly ($P \leq 0.5$) and mean bearing different lower superscript in a column differ significantly ($P \leq 0.5$).

Table 9: Effect of different therapeutics regimen on total protein (g/dl), albumin (g/dl), globulin (g/dl) and A: G ratio in experimental broiler birds

Groups	Total protein (g/dl)					Albumin (g/dl)					Globulin (g/dl)					A: G ratio				
	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14
I- HC	3.54±0.07^{aA}	3.62±0.05^{aA}	3.67±0.03^{aA}	3.73±0.07^{Aa}	3.78±0.02^{aA}	1.85±0.14^{aA}	1.87±0.15^{aA}	1.95±0.09^{aA}	1.95±0.10^{Aa}	2.00±0.07^{aA}	1.69±0.08^{aA}	1.75±0.20^{aA}	1.72±0.08^{aA}	1.78±0.09^{aA}	1.78±0.06^{aA}	1.11±0.14^{aA}	1.13±0.22^{aA}	1.15±0.11^{aA}	1.11±0.10^{aA}	1.13±0.08^{aA}
II- AC	3.60±0.05^{aA}	3.67±0.05^{aA}	3.71±0.05^{aA}	3.70±0.05^{aA}	3.75±0.01^{aA}	1.82±0.02^{aA}	1.91±0.07^{aA}	1.96±0.09^{aA}	1.87±0.03^{aA}	1.93±0.03^{aA}	1.78±0.03^{aA}	1.76±0.06^{aA}	1.75±0.08^{aA}	1.83±0.06^{aA}	1.82±0.04^{aA}	1.03±0.01^{aA}	1.09±0.07^{aA}	1.13±0.10^{aA}	1.02±0.05^{aA}	1.06±0.04^{aA}
III- MPAC	3.47±0.07^{aA}	3.65±0.07^{aA}	3.72±0.03^{aA}	3.71±0.04^{aA}	3.74±0.02^{aA}	1.79±0.14^{aA}	1.97±0.11^{aA}	1.88±0.05^{aA}	1.88±0.09^{aA}	1.95±0.12^{aA}	1.68±0.18^{aA}	1.68±0.12^{aA}	1.84±0.06^{aA}	1.83±0.09^{aA}	1.79±0.13^{aA}	1.13±0.26^{aA}	1.20±0.14^{aA}	1.02±0.06^{aA}	1.04±0.10^{aA}	1.12±0.16^{aA}
IV- MPAI	3.54±0.04^{aA}	2.41±0.03^{bB}	2.36±0.03^{bcBC}	2.51±0.04^{cB}	2.72±0.02^{cB}	1.87±0.17^{aA}	1.12±0.01^{bB}	1.16±0.03^{bB}	1.19±0.01^{bcB}	1.25±0.04^{dB}	1.64±0.16^{aA}	1.29±0.04^{bB}	1.20±0.03^{bBC}	1.32±0.03^{bB}	1.47±0.03^{bB}	1.21±0.24^{aA}	0.82±0.04^{bB}	0.83±0.04^{bB}	0.86±0.02^{abAB}	1.06±0.05^{aA}
V- MPMC	3.45±0.15^{aA}	3.64±0.06^{aA}	3.71±0.04^{aA}	3.71±0.02^{aA}	3.72±0.02^{aA}	1.85±0.16^{aA}	1.98±0.10^{aA}	1.87±0.06^{aA}	1.85±0.06^{aA}	1.89±0.04^{aA}	1.60±0.10^{aAB}	1.66±0.14^{aA}	1.84±0.06^{aA}	1.86±0.04^{aA}	1.83±0.03^{aA}	1.18±0.16^{aA}	1.23±0.18^{aA}	1.02±0.06^{aA}	1.00±0.05^{aAB}	1.04±0.03^{aA}
VI- MPMI	3.57±0.08^{aA}	2.63±0.02^{bB}	2.55±0.02^{bB}	2.84±0.04^{bB}	3.41±0.03^{aB}	1.86±0.10^{aA}	1.30±0.02^{bB}	1.25±0.02^{bB}	1.39±0.03^{bB}	1.77±0.04a^{bA}	1.71±0.12^{aA}	1.33±0.04^{abB}	1.30±0.03^{bB}	1.45±0.04^{bAB}	1.64±0.06^{aA}	1.11±0.13^{aA}	0.95±0.05^{bA}	0.92±0.04^{abA}	1.06±0.05^{aA}	1.10±0.07^{aA}
VII- AI	3.31±0.04^{aA}	2.75±0.04^{bB}	2.71±0.02^{bB}	3.60±0.02^{aA}	3.68±0.03^{aA}	1.72±0.13^{aB}	1.34±0.02^{bC}	1.30±0.02^{bC}	1.81±0.04^{aAB}	1.95±0.10^{aA}	1.59±0.13^{aA}	1.41±0.04^{abAB}	1.41±0.04^{bAB}	1.79±0.04^{aA}	1.73±0.10^{aA}	1.12±0.20^{aA}	0.96±0.04^{bA}	0.92±0.04^{abA}	1.01±0.04^{aA}	1.14±0.13^{aA}
VIII- IC	3.44±0.12^{aA}	2.20±0.03^{cB}	2.04±0.04^{cB}	2.18±0.03^{dB}	2.54±0.02^{cA}	1.80±0.12^{aA}	0.99±0.07^{cB}	0.92±0.02^{cB}	0.95±0.01^{dB}	1.14±0.05^{deB}	1.64±0.14^{aA}	1.21±0.05^{bAB}	1.12±0.03^{bcAB}	1.23±0.04^{bcAB}	1.40±0.05^{bA}	1.13±0.15^{aA}	0.79±0.09^{bAB}	0.79±0.02^{abAB}	0.81±0.03^{abAB}	0.97±0.06^{aA}

Mean bearing different upper superscript in a row differ significantly ($P \leq 0.5$) and mean bearing different lower superscript in a column differ significantly ($P \leq 0.5$).

Table 10: Effect of different therapeutics regimen on glucose (mg/dl), ALT (IU/l)), AST (IU/l) and ALP (IU/l) in experimental broiler birds

Groups	Glucose (mg/dl)					ALT (IU/l)					AST (IU/l)					ALP (IU/l)				
	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14
I- HC	280.40±1.20^{aA}	281.00±4.83^{kA}	275.00±3.54^{iAB}	280.00±4.56^{ghA}	286.00±8.32^{aA}	7.88±0.27^{aB}	8.10±0.16^{jB}	8.14±0.27^{Jb}	7.72±0.20j^{B}	9.80±0.20^{kA}	62.58±0.33^{ab}	62.60±0.32^{ib}	64.30±0.11^{iA}	64.16±0.22^{jA}	63.72±0.33^{eA}	139.80±3.43^{aA}	141.40±5.87^{eA}	140.20±4.40^{eA}	139.20±5.22^{fiA}	139.40±4.45^{deA}
II- AC	278.00±1.58^{aAB}	277.20±8.64^{kAB}	281.00±7.19^{hiA}	276.00±7.80^{hAB}	287.00±10.29^{aA}	7.88±0.22^{aB}	7.92±0.23^{jB}	8.10±0.19^{Jb}	7.98±0.31^{jB}	9.70±0.18^{kA}	63.08±0.45^{aB}	63.42±0.68^{iB}	63.88±0.26^{iB}	65.06±0.21^{jA}	63.44±0.13^{eB}	142.20±5.30^{aA}	142.40±5.78^{eA}	142.60±8.01^{eA}	141.60±7.63^{fA}	138.40±4.77^{deA}
III- MPAC	278.80±2.06^{aB}	281.00±2.42^{kB}	279.60±2.02^{iB}	277.00±7.25^{hB}	286.60±4.79^{aA}	7.72±0.18^{aB}	8.28±0.17^{jB}	8.06±0.15^{Jb}	7.86±0.18^{jB}	9.94±0.38^{kA}	64.40±0.49^{aA}	63.36±0.71^{iA}	64.60±0.50^{iA}	64.70±0.07^{jA}	63.56±0.10^{eA}	137.00±6.30^{aA}	143.80±7.72^{eA}	139.60±5.47^{eA}	143.20±6.29^{fA}	138.80±5.47^{deA}
IV- MPAI	278.00±1.87^{aE}	372.00±1.58^{cC}	438.00±1.58^{cA}	380.00±6.77^{bcB}	285.40±3.91^{aD}	7.94±0.22^{aD}	78.04±3.08^{cB}	96.08±0.46^{cA}	79.08±0.29^{cB}	56.74±0.19^{cC}	63.40±0.74^{aE}	189.68±0.28^{cB}	210.94±0.35^{cA}	176.04±0.40^{cC}	78.84±0.23^{cD}	136.80±5.14^{aD}	198.80±1.25^{cB}	236.40±2.26^{aA}	190.20±1.97^{bB}	174.40±3.67^{bC}
V- MPMC	281.60±0.97^{aB}	281.20±0.95^{kB}	270.00±3.16^{ijC}	279.00±3.16^{hB}	287.20±4.63^{aA}	7.66±0.17^{aB}	7.92±0.15^{jB}	8.16±0.30^{jB}	8.04±0.40^{jB}	10.12±0.15^{kA}	63.68±0.88^{aB}	63.72±0.39^{iB}	64.76±0.21^{iA}	65.12±0.15^{jA}	63.58±0.16^{eB}	140.40±5.78^{aA}	141.60±8.19^{eA}	141.60±6.12^{eA}	143.00±5.74^{fA}	142.60±7.15^{dA}
VI- MPMI	278.60±1.20^{aD}	312.00±1.58^{iB}	328.00±1.58^{fA}	310.00±2.42^{eB}	286.60±3.15b^{aC}	7.82±0.21^{aE}	57.74±0.27^{fB}	62.80±0.30^{gA}	41.70±0.30^{gC}	33.90±1.12^{fD}	63.40±0.49^{aD}	148.10±0.35^{gB}	170.36±0.09^{gA}	144.84±0.25^{gC}	64.16±0.99^{eD}	138.60±5.53^{aD}	181.40±2.44^{cdB}	196.00±2.48^{cA}	164.00±3.39^{eC}	145.80±2.96^{dD}
VII- AI	280.00±1.58^{aB}	293.00±1.58^{iA}	288.00±1.58^{hA}	284.00±5.55^{gAB}	287.40±2.66^{aA}	7.82±0.28^{aE}	42.92±0.30^{iB}	44.98±0.36^{iA}	32.02±0.44^{iC}	22.10±0.71^{jD}	63.52±0.69^{aE}	134.96±0.25^{iB}	152.02±0.38^{hA}	95.88±0.43^{iC}	63.82±0.19^{eD}	137.20±5.44^{aC}	170.00±2.04^{dAB}	182.40±0.88^{dA}	147.80±3.88^{efA}	142.40±3.23^{dC}
VIII- IC	282.00±1.58^{aE}	460.00±2.04^{aB}	473.00±3.76^{aA}	388.20±5.81^{Ac}	288.60±2.73^{aD}	7.60±0.27^{aE}	102.96±1.26^{aC}	117.82±0.29^{aA}	94.56±0.21^{aB}	66.00±0.61^{aD}	63.40±0.81^{aE}	218.18±2.02^{aB}	227.52±0.90^{aA}	188.96±0.27^{aC}	94.96±0.19^{Ad}	138.60±5.88^{aE}	233.60±0.97^{aB}	248.60±3.55^{aA}	199.80±1.75^{aC}	181.00±3.63^{aD}

Mean bearing different upper superscript in a row differ significantly ($P \leq 0.5$) and mean bearing different lower superscript in a column differ significantly ($P \leq 0.5$).

Table 11: Effect of different therapeutics regimen on calcium (mg/dl), phosphorus (mg/dl), magnesium (mg/dl) and iron (µg/ml) in experimental broiler birds

Groups	Calcium (mg/dl)					Phosphorus (mg/dl)					Magnesium (mg/dl)					Iron (µg/ml)				
	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14
I- HC	10.64±0.64^{aAB}	10.72±0.72^{Aab}	11.30±0.59^{Aa}	11.52±0.38^{aA}	11.76±0.46^{aA}	5.20±0.23^{aA}	5.32±0.31^{aA}	5.28±0.33^{aA}	5.38±0.34^{abA}	5.44±0.24^{aA}	2.04±0.14^{aAB}	2.10±0.07^{abAB}	2.22±0.05^{aA}	2.28±0.05^{aA}	2.28±0.05^{aA}	1.45±0.08^{aA}	1.50±0.03^{aA}	1.43±0.06^{aA}	1.47±0.07^{aA}	1.52±0.12^{bA}
II- AC	10.86±0.81^{aA}	10.96±0.67^{Aa}	11.14±0.47^{aA}	11.54±0.93^{aA}	11.50±0.62^{aA}	4.98±0.31^{aA}	5.42±0.27^{aA}	5.12±0.38^{aA}	4.94±0.34^{abA}	5.34±0.30^{Aa}	2.05±0.17^{aAB}	2.18±0.11^{aA}	2.18±0.05^{aA}	2.32±0.03^{aA}	2.30±0.04^{aA}	1.47±0.11^{aA}	1.45±0.04^{aA}	1.48±0.05^{aA}	1.47±0.08^{aA}	1.54±0.10^{bA}
III- MPAC	10.46±0.56^{aAB}	10.96±0.61^{Aa}	11.32±0.61^{aA}	11.36±0.69^{aA}	11.80±0.68^{aA}	4.90±0.26^{aA}	5.38±0.37^{aA}	5.04±0.33^{aA}	5.12±0.36^{abA}	5.60±0.09^{aA}	2.04±0.10^{aAB}	2.26±0.07^{aA}	2.16±0.03^{aA}	2.22±0.05^{aA}	2.30±0.06^{aA}	1.48±0.03^{aA}	1.50±0.02^{aA}	1.48±0.07^{aA}	1.46±0.07^{aA}	1.57±0.12^{abA}
IV- MPAI	10.62±0.69^{aA}	7.62±0.38^{cdBC}	6.40±0.37^{cD}	7.14±0.28^{cC}	8.24±0.42^{cB}	5.06±0.31^{aA}	3.26±0.23^{cB}	2.98±0.30^{cC}	4.04±0.10^{cBC}	4.21±0.14^{bcBC}	2.02±0.16^{aA}	1.44±0.06^{cC}	1.34±0.03^{dC}	1.64±0.03^{cdB}	2.00±0.06^{abA}	1.46±0.02^{aA}	1.17±0.02^{cC}	1.00±0.03^{cdD}	1.27±0.01^{bB}	1.41±0.04^{cA}
V- MPMC	10.70±0.61^{aA}	10.70±0.72^{Aa}	11.32±0.42^{aA}	11.56±0.56^{aA}	11.68±0.46^{aA}	4.92±0.34^{aA}	5.62±0.21^{aA}	5.36±0.21^{aA}	5.68±0.25^{aA}	5.46±0.33^{aA}	2.06±0.18^{aC}	2.14±0.09^{aC}	2.20±0.04^{aAB}	2.36±0.07^{aA}	2.34±0.03^{aA}	1.45±0.03^{aB}	1.49±0.02^{aB}	1.46±0.07^{aB}	1.46±0.07^{aB}	1.75±0.10^{aA}
VI- MPMI	10.68±0.66^{aA}	8.98±0.47^{bB}	8.40±0.38^{bBC}	9.62±0.43^{abAB}	10.83±0.34^{aA}	4.64±0.29^{aA}	4.22±0.14^{bB}	4.16±0.13^{bB}	4.18±0.21^{cBC}	4.44±0.12^{bcAB}	2.02±0.09^{aAB}	1.78±0.05^{bC}	1.74±0.03^{bC}	2.12±0.03^{abA}	2.18±0.03^{aA}	1.41±0.03^{aB}	1.34±0.01^{abBC}	1.22±0.03^{bC}	1.34±0.01^{abAB}	1.55±0.01^{bA}
VII- AI	10.84±0.65^{aB}	9.78±0.44^{abBC}	9.20±0.40^{bBC}	10.10±0.27^{bB}	12.38±0.32^{aA}	5.02±0.29^{aA}	4.52±0.37^{bAC}	4.40±0.18^{bC}	4.42±0.21^{cC}	4.60±0.21^{bAB}	2.08±0.09^{aAB}	1.84±0.03^{bC}	1.86±0.03^{bC}	2.14±0.03^{abA}	2.22±0.05^{aA}	1.43±0.07^{aA}	1.30±0.03b^{AB}	1.19±0.02^{bcC}	1.39±0.02^{aA}	1.50±0.02^{bA}
VIII- IC	10.12±0.60^{aA}	6.10±0.51^{dC}	5.26±0.37^{dCD}	6.14±0.49^{dC}	7.84±0.19^{dB}	5.02±0.28^{aA}	3.50±0.12^{cB}	2.78±0.21^{cC}	3.08±0.15^{dC}	3.68±0.25^{cB}	2.08±0.10^{aA}	1.44±0.03^{cC}	1.20±0.03^{deCD}	1.32±0.05^{dC}	1.76±0.03^{cC}	1.45±0.07^{aA}	0.98±0.04^{dD}	0.70±0.05^{eE}	1.05±0.05^{cC}	1.24±0.04^{dB}

Mean bearing different upper superscript in a row differ significantly ($P \leq 0.5$) and mean bearing different lower superscript in a column differ significantly ($P \leq 0.5$).

Table12: Effect of different therapeutics regimen on zinc (µg/ml), copper (µg/ml) sodium (mmol/l) and potassium (mmol/l) in experimental broiler birds

Groups	Zinc (µg/ml)					Copper (µg/ml)					Sodium (mmol/l)					potassium (mmol/l)				
	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14	0	5	7	9	14
I- HC	5.31±0.58^{aA}	5.67±0.46^{Aa}	5.49±0.57^{aA}	5.11±0.15^{abA}	5.90±0.32^{aA}	1.04±0.13^{aA}	1.16±0.12^{aA}	1.10±0.07^{aA}	1.07±0.05^{aA}	1.15±0.03^{aA}	142.00±2.04^{aA}	143.80±2.53^{aA}	142.60±2.73^{aA}	141.20±0.48^{aA}	143.80±1.11^{aA}	4.75±0.52^{aA}	4.70±0.45^{cA}	4.71±0.37^{cA}	4.90±0.34^{bcA}	4.91±0.33^{abA}
II- AC	5.13±0.60^{aA}	5.64±0.29^{aA}	5.41±0.45^{aA}	5.43±0.45^{aA}	5.45±0.43^{aA}	1.00±0.12^{aA}	1.17±0.12^{aA}	1.17±0.09^{aA}	1.08±0.05^{aA}	1.17±0.04^{aA}	143.20±1.89^{aA}	142.00±2.74^{aA}	142.00±2.42^{aA}	141.60±2.85^{aA}	143.20±2.29^{aA}	4.77±0.57^{aA}	4.69±0.47^{cA}	4.72±0.38^{cA}	4.95±0.36^{bcA}	4.96±0.34^{abA}
III- MPAC	5.61±0.65^{aA}	5.47±0.36^{aA}	5.61±0.52^{aA}	5.51±0.43^{aA}	5.73±0.45^{aA}	1.06±0.12^{aA}	1.17±0.13^{aA}	1.16±0.11^{aA}	1.10±0.06^{aA}	1.16±0.05^{aA}	142.40±2.33^{aA}	142.00±3.51^{aA}	142.40±1.94a^{A}	141.20±2.90^{aA}	143.60±1.20^{aA}	4.75±0.57^{aA}	4.67±0.46^{cA}	4.73±0.38^{cA}	4.93±0.34^{bcA}	4.98±0.33^{abA}
IV- MPAI	4.57±0.45^{aA}	2.80±0.25^{bBC}	2.13±0.42^{bC}	3.50±0.14^{cAB}	4.23±0.24^{bA}	1.06±0.11^{aA}	0.73±0.04^{bcB}	0.63±0.03^{bcC}	0.91±0.04^{abA}	1.05±0.02^{aA}	142.20±1.70^{aA}	128.00±0.91^{cB}	124.20±1.32^{dC}	130.00±1.96^{cB}	130.60±0.97^{bB}	4.79±0.58^{aC}	6.60±0.37^{aB}	7.73±0.47^{aA}	6.38±0.18^{abB}	5.56±0.42^{aBC}
V- MPMC	5.27±0.37^{aA}	5.14±0.34^{aA}	5.47±0.46^{aA}	5.75±0.47^{aA}	5.82±0.24^{aA}	1.06±0.12^{aA}	1.19±0.12^{aA}	1.18±0.07^{aA}	1.13±0.04aA	1.17±0.04^{aA}	141.80±3.71^{aA}	141.80±1.32^{aA}	141.60±0.97^{aA}	141.40±1.90^{aA}	142.80±0.75^{aA}	4.78±0.57^{aA}	4.79±0.35^{cA}	4.74±0.44^{cA}	4.95±0.34^{bcA}	4.94±0.31^{abA}
VI- MPMI	5.03±0.55^{aA}	4.06±0.09^{abB}	4.03±0.38^{abB}	4.95±0.16^{abAB}	5.71±0.41^{aA}	1.06±0.12^{aA}	0.87±0.03^{bB}	0.79±0.03^{bB}	1.05±0.03^{aA}	1.14±0.03^{aA}	142.40±2.33^{aA}	136.00±0.91^{bB}	133.60±0.77^{bcB}	141.80±1.11^{aA}	141.60±0.88^{aA}	4.80±0.54^{aB}	5.94±0.12^{abA}	6.41±0.15^{abA}	5.75±0.10^{bA}	4.97±0.36^{abB}
VII- AI	5.13±0.45^{aA}	4.71±0.32^{aB}	4.62±0.31^{aB}	5.29±0.17^{aA}	5.68±0.41^{aA}	1.03±0.16^{aA}	0.91±0.02^{abAB}	0.81±0.03^{bB}	1.07±0.03^{aA}	1.17±0.03^{aA}	142.00±1.73^{Aa}	140.10±1.20^{abA}	137.60±1.05ab^{AB}	141.40±1.20^{aA}	142.20±0.95^{aA}	4.84±0.60^{aB}	6.10±0.26^{bA}	6.51±0.42a^{bA}	5.32±0.26^{bAB}	4.91±0.34^{abB}
VIII- IC	4.91±0.57^{aA}	2.91±0.27^{bC}	2.41±0.32^{Bcd}	2.95±0.22^{dC}	3.92±0.27^{bcB}	1.03±0.15^{aA}	0.68±0.04^{bcB}	0.51±0.09^{cC}	0.72±0.03^{bB}	0.94±0.02^{abA}	142.60±2.73^{Aa}	121.40±1.66^{Dc}	120.40±0.66fC	129.00±1.68^{cB}	136.60±1.51^{bB}	4.79±0.63^{Ad}	7.09±0.09^{aB}	8.51±0.37^{aA}	7.45±0.21^{aB}	6.03±0.10^{aC}

Conclusion

It was concluded that amprolium was an effective drug against *E. tenella* infection in broiler. Methanolic extract of *M. paradisiaca* moderately effective against *E. tenella* infection in broilers. Methanolic extract of *M. paradisiaca* has tremendous potential to be developed as safe and potential natural alternative to the hazardous and unsustainable chemical anticoccidial drugs.

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