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Research Article

Aqueous Extracts of *Aloe vera* and *Carica papaya* Leaves: Impacts on Coccidiosis, Production and Haematology in Kabir Chickens in Buea, South West Cameroon

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Abstract

Background and Objective: The poultry industry is greatly impeded by coccidiosis and these parasites have developed resistant strains to most of the synthetic treatments applied. This study was conducted to evaluate the efficacy of aqueous leaf extracts of *Carica papaya* (*C. papaya*) and *Aloe vera* (*A. vera*) on parasitological and haematological parameters as well as growth performance of *Eimeria*-infected Kabir chickens. **Materials and Methods:** Fresh leaves were harvested and dried in gentle heat. Ground and sieved powder of fresh leaves was used to prepare the aqueous extracts. Chickens were infected with 3200 Eimeria oocysts until they began shedding oocysts in their faeces. The aqueous extracts were orally administered at doses of 0.32, 0.80 and 1.44 g^{-1} $chicken^{-1}$. There were 3 experimental groups per extract made up of T1-T3 and two control chambers (T4, T5). Chickens of T4 were infected but not treated while T5 was the neutral group. **Results:** The best anticoccidial effect was observed in the T3 group which was treated with *A. vera* extract at a concentration of 1.44 g $chicken^{-1}$ day^{-1}. Both extracts *(C. papaya* and *A. vera*) had similar effects on growth performance with non-significant differences. Though both extracts of *C. papaya* and *A. vera* had significant effect on haematological parameters like red blood cell (RBC) and white blood cell (WBC) counts as well as haemoglobin (Hb) values, the differences were however not significant. Both extracts significantly reduced the burdens of emeriosis in chickens. **Conclusion:** *C. papaya* and *A. vera* aqueous extracts had good anticoccidial properties and significantly reduced the oocyst counts and improved the RBC and WBC values in the chickens.

Key words: *Aloe vera*, coccidiosis, Kabir chickens, *Carica papaya* leaves, chicken growth

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Data Availability: All relevant data are within the paper and its supporting information files.

Correction made on March 24, 2021, after online publication: The affiliations of the authors have been added

INTRODUCTION

Eimeriosis is one of the most important protozoal infections in poultry, inflicting heavy economic losses in the form of high morbidity and mortality in affected flocks[1]. It is caused by different species of the genus *Eimeria*, belonging to the family *Eimeriidae*. Poor management such as damp litter, contaminated drinkers and feeders, high stock density and poor ventilation are the most important predisposing factors of this disease in intensive poultry production[2]. It has a negative impact on the production performance of affected birds in terms of retarded growth and poor feed conversion ratios in addition to high morbidity and mortality[3]. According to an estimate, it causes economic losses of up to three billion US dollars annually worldwide[4,5].

Many poultry farmers rely greatly on chemoprophylactic drugs to fight against this ailment since vaccines against coccidia are very rare. Misuse and over usage of these synthetic drugs in poultry have led to drug resistance in the fight against coccidiosis. Furthermore, these synthetic drugs are not always readily available and are sometimes very expensive, especially for small scale farmers[5,6].

Many alternative strategies are under investigation for the effective, economic and environment friendly control of coccidiosis, including the use of medicinal plants. In this context, two medicinal plants; *Aloe vera* and *Carica papaya* have been reported for promising immunomodulatory effects to control coccidiosis[5,6].

Among herbal products, *A. vera* is a well-known medicinal plant. It contains more than 75 bioactive compounds which have numerous applications and benefits[7,8]. It has pharmacological activities such as antibacterial, antiviral, antifungal, antiparasitic, analgesics and antioxidant[9]. *Aloe vera* has been be used in the form of extract, powder, ethanolic extract, aqueous extract in poultry industry[10,11].

Many studies have been conducted to evaluate the effects of *A. vera* on growth performance parameters and the immune response of broiler chickens and have shown different results. In some studies, *A. vera* has been used as feed additives in poultry production for different purposes, but the results have been inconsistent[12-14]. Preparation of *A. vera* extract is very easy, convenient and cheap for the poultry farmers who are not well educated. Therefore, this study was in an effort to use aqueous extract of *A. vera* as natural growth promoter and an effective tool for the control of coccidiosis in Kabir chickens.

On the other hand, *C. papaya* has been reported to possess excellent medicinal properties for the treatment of different ailments. Different parts of the *C. papaya* plant (leaves, seeds, latex and fruit) have been used for its medicinal value. Latex from unripe papaya fruit contains the papain and chymopapain enzymes and a mixture of cysteine endopeptidases, chitinases and serine protease inhibitor. Phytochemical analysis of *C. papaya* leaf extract revealed the presence of alkaloids, glycosides, flavanoids, saponins, tannins, phenols and steroids which are useful for the treatment of different diseases including coccidiosis[15].

Information on the preparation and administration of these plant extracts in poultry birds would significantly enhance control of coccidiosis in poultry. In addition, *A. vera* and *C. papaya* are widely grown in Cameroon and the preparation and administration of these plants extracts to the birds is very easy and suitable training on the use of these plants will be an added advantage to the farmers. To avoid the drug resistance and extra cost of synthetic medications, the use of these plants will be economical and enhance poultry productivity. Furthermore, the effects of these plant extracts on haematological and growth parameters were also evaluated because they have positive effects on these parameters of poultry birds[16].

Kabir Chickens are local fowls raised by local farmers in Cameroon but these chickens are constantly infected by coccidiosis. In our previous studies, ethanolic extracts of these two plants was very effective but farmers complained of the difficulties in the preparation of the ethanolic extract and we have embarked on using aqueous extracts of the same plants to see if similar results can be obtained. If this happens, we will rather recommend the latter because it can be easily prepared by the farmers and similar results will be achieved. From the results obtained, this work will be of great importance to the local farmers who have small farms of few birds because, these plants are readily available, very effective, cheap to obtain and expenditure on synthetic medications to fight coccidiosis will be reduced thereby increasing profits.

MATERIALS AND METHODS

Study site: The plants (*A. vera* and *C. papaya* leaves) used for the extracts were collected from the Ekona Research Centre (IRAD), Buea, Fako Division, Southwest Cameroon and identified. The study was carried out in the Africa Brazil Market Place Project Poultry Farm located in Lyongo village, Buea, Southwest, Cameroon from April to November 2019. Fako Division is characterized by a long rainy season from March to November and a dry season which spans for the rest of the year. The Division is a typical mountainous area with some lowland settlements and very low temperatures during the peak of the rainy season. Map of the study area is shown in Fig. 1.

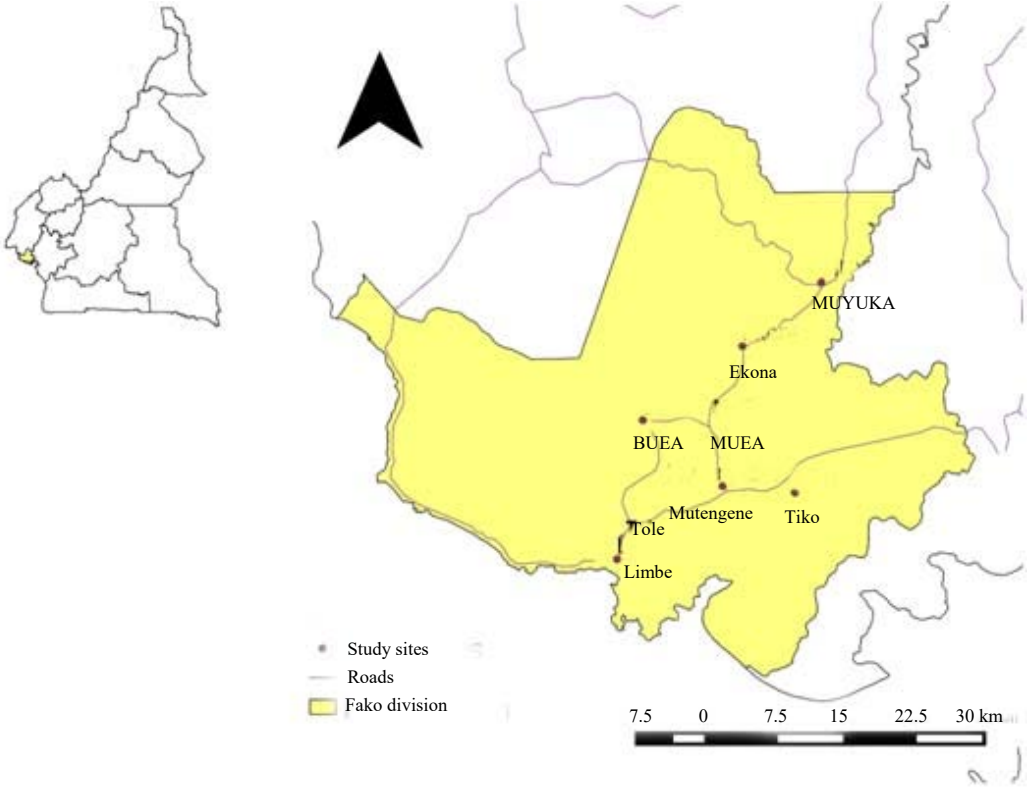

Fig. 1: Study sites in Fako Division (Map data © 2015 Google)

Table 1: Doses used for each plant extract administered against coccidiosis

	Plant extracts and doses administered in mg kg^{-1} BW chicken^{-1} day^{-1}	
	Aqueous extract	
Treatment	*A. vera* (mg)	*C. papaya* leaves (mg)
T1 (test group)	32	32
T2 (test group)	80	80
T3 (test group)	144	144
T5 (negative)	---	---
T6 (neutral group)	---	---

Table 2: Feed formulations used for experimental Kabir chickens

	Composition (%)						
Age of chickens (weeks)	Corn	Remoulage	5% Concentrate	Soya bean meal	Fish meal	Palm kernel	Bone
0-4	55	10	5	25	3	---	2
5-7	60	15	5	12.5	---	5	2.5
8 w	60	15	5	7		10	3

Study design: There were 3 experimental groups per extract made up of T1-T3 and two control chambers (T4, T5). The first experimental group (T1-T3) were administered aqueous extract of *A. vera* at concentrations of 0.32 g, 0.80 g and 1.44 g chicken^{-1} day^{-1} respectively while the second experimental group (T1-T3) were given the aqueous extract of *C. papaya* in different concentrations of 0.32 g, 0.80 g and 1.44 g chicken^{-1} day^{-1} respectively as shown in Table 1. T4 was the negative control group which was infected but not treated while T5 was the neutral group which was not infected at all and not given any extract but water. Each group had equal number of chickens, had the same feed intake and composition, under the same environmental conditions with *ad libitum* access to feed and water as shown in Table 2. They

Fig. 2: Hatching chicks from the incubator hatchery

were inoculated at their eighth week with the parasites and treatment started four days after inoculation and went on for 8 days. The chickens for each extract were inoculated orally with equal numbers of *Eimeria* oocysts (3200 oocysts per gram, OPG) except for the neutral group T5. The McMaster technique was used to monitor the oocyst load.

Production of the experimental chickens: Experimental chickens consisted of both naked-necked and normal-leathered breed Kabir chickens, displaying a variety of plumage colours. After leaving the hatchery the experimental chicks were grown under uniform brooder conditions from a day old to experimental ages. The birds were housed in a disinfected deep litter system with wood shavings being the bedding material. A total of 40 chickens were used for the experiments with 8 chicks per experimental group or treatment. The chickens used for the experiments were produced and hatched from the parent stocks in the farm (Fig. 2). They were groomed from day-old to 8 weeks when the experiment started.

Preparation and administration of the aqueous extract of *A. vera* and *C. papaya* plant extracts: These plants were harvested from the IRAD Ekona, Fako Division South West Region and Identified in the Department of Botany and Plant Physiology of the University of Buea, Cameroon. Fresh *Aloe* leaves were collected, cut into smaller sizes and dried in an electrical drier. The dried leaf was ground and dissolved in water and macerated after every 24 h for 4 days. This mixture was then sieved through whatmann paper and evaporated through the electrical oven at 40°C until all the water evaporated and the fine powder was used to prepare the extract.

The *C. papaya* plant leaves were harvested and dried in a hot and shaded area. After drying, unwanted particles and parts were separated from the leaves by hand picking and the preferred parts ground. Powders obtained were further sieved to obtain very fine dusty particles of the plant leaves. Aqueous extract was obtained from these fine powders as described above and used for administration during the experiments. The chickens were grouped into treatment groups (Tcp1-Tcp3) and the crude extract from papaya leaves were administered at doses of 32 mg, 80 mg and 144 mg chicken^{-1} day^{-1} respectively.

Statistical analysis: Data were analyzed using analysis of variance (ANOVA), followed by Duncan's Multiple-Range (DMR) test using the SPSS 20.0 Statistical Software Program (SPSS, Inc., IBM, Chicago, Illinois, USA). Differences of $p<0.05$ were considered statistically significant. The mean values that were calculated before and after the administration of different extracts were used to evaluate percentage in reduction, using the following formula[17]:

$$\text{Reduction rate} = \frac{\text{Initial oocyst counts - final oocysts counts}}{\text{Initial oocysts counts}} \times 100$$

Table 3: Reduction rate of *Eimeria* Oocyst counts in Kabir chickens treated with aqueous *A. vera* leaf extract

	Oocyst count				
Treatment-dose (mg kg^{-1} BW)	Initial	Final	Reduction (%)	Status	Statistics p-values
32	19562.50±4097	237.50±108.5	98.8	H-L	<0.0001
80	18800.00±2589.8	125.00±62	99.3	H-L	<0.0001
144	23337.50±3729.37	25.00±16.37	99.9	H-L	<0.0001
Negative	25262.50±5404.39	57412.50±8932.11	-127.00	H-H	NA
Neutral	NA	NA	NA	NA	NA

Statuses of T1, T2, T3 changed from heavy to light infections. H-L: Heavy to light and H-H: High to high. The two-tailed p<0.0001, considered extremely significant for the treated groups. T5 was tested but difference between initial and final oocyst counts gave negative values and the statistics could not be done. The different doses administered did not show significant percentage reduction between the treatment groups, p = 0.132

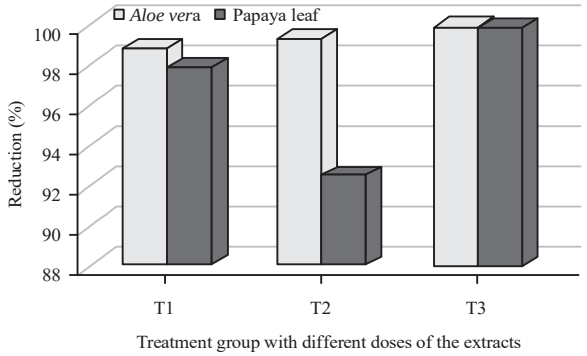

Fig. 3: Percentage oocyst reduction of *A. vera* and *C. papaya* leaf aqueous extracts

Also, some production parameters such as the average feed intake (FI) which is the total amount of feed consumed by the chickens from the day of the administration of the plant extract till the last day, average daily weight gain (AWG) between treatments were calculated. These parameters were calculated using the following formula:

$$\text{Average daily weight gain (AWG)} = \frac{\text{Total weight gain per chicken per group}}{\text{Total number of days}}$$

$$\text{Feed consumption rate (FCR)} = \frac{\text{FI}}{\text{Total AWG}}$$

Where

FI : Feed intake

AWG : Average weight Gain[17]

RESULTS

Efficacy of aqueous *A. vera* leaf extract against *Eimeria* spp. in Kabir chickens: There were significant reductions (p<0.0001) in oocyst counts in the treated chickens and the statuses changed from heavy infections to very light infections except for chickens of T5 group which were infected but not treated. Chickens of T5 group remained negative throughout the experimental time, meaning that there was no other source of infection apart from the ones inoculated. There was 99.9% reduction in T3, 99.3% in T2, 99.1% in T1 and -127% in T5 because the oocyst counts here were increasing instead of decreasing due to the fact that the chickens were infected but not treated. Overall, reduction of oocysts was positively correlated with extract dose. Details of the results are indicated in Table 3.

Efficacy of aqueous *C. papaya* leaf extracts against *Eimeria* spp. in Kabir Chickens: The mean oocyst counts before treatment and on the 8th day of treatment were calculated. Percentage reduction counts were calculated and the parasite status of each significantly (p<0.0001) changed from heavy infection to light infection or moderate. The highest reduction (99.8%) in oocyst count was recorded in T3 which received the highest concentration of extract while the least reduction (92.6%) in oocyst count was recorded in T2. A continuous increase in the oocyst count was recorded in the infected but untreated group (T5) (Table 4).

Comparing the efficacies of the two aqueous extracts of *A. vera* and *C. papaya* leaves against Eimeriosis: At the end of the study a comparative evaluation of the efficacy of the two extracts against Eimeriosis was done and it was observed that at the same dose, aqueous extract of *Aloe vera* was more efficient than aqueous leaf extract of *C. papaya* though the differences were not statistically significant at p<0.05. Details of the differences are presented in Fig. 3.

Effects of treating *Eimeria*-infected chickens with aqueous extract of *A. vera* leaf on feed intake, average weight gain, growth rate and feed conversion: The highest growth rate was recorded in T5 (negative control group of chickens), while the lowest was recorded in T2 but the differences were not statistically significant (p = 0.078). The highest feed conversion ratio was recorded in T5 (14.5%) while the lowest was in T3

Table 4: Variation in *Eimeria* oocyst counts of Kabir chickens treated with aqueous *C. papaya* leaf extract

	Oocyst count				
Treatment-dose (mg kg^{-1} BW)	Initial	Final	Reduction (%)	Status	p-values
32	3880±1439.2	80±37.4	97.9	M-L	<0.0001
80	9700±7357.5	720±381.3	92.6	M-L	<0.0001
144	9500±4824	20±44.7	99.8	M-L	<0.0001
Negative	3780±1325.7	25820±6588.7	-85.4	M-H	
Neutral	NA	NA	NA	NA	NA

H-L: Heavy to low, M-H: Moderate to high, Moderate to low Statuses of T1, T2, T3 changed from heavy to light infections. H-L: Heavy to light, H-M: High to moderate and H-H: High to high. The two-tailed p<0.0001, considered extremely significant for the treated group. T5 was tested but difference between initial and final oocyst count gave negative values and the statistics could not be done. The different doses administered showed no significant difference in percentage oocyst reduction between treatment groups, p = 0.201

Table 5: Effects of treating *Eimeria*-infected chickens with aqueous extract of *A. vera* leaf on growth rate and feed conversion

	Growth parameters			
Treatment dose (mg kg^{-1} BW)	AFI (g)	AWG (g)	AGR (%)	FCR (%)
32	483±44.7^{a}	181.3±27.3	11.7	12.8^{a}
80	586.7±60.4^{b}	201.5±14.2	8.7	15.3^{a}
144	535±47.7^{b}	182.6±15.1	8.8	7.5^{b}
Negative	666.7±77.1^{c}	220.3±13.8	12.2	13.5^{a}
Neutral	758.3±83.1^{d}	241.6±26.1	10.3	14.5^{a}
Statistics (p-values)	0.003	0.072	0.078	0.034

Different superscripts a, b, c and d along each column signify that significant differences exist at p<0.05

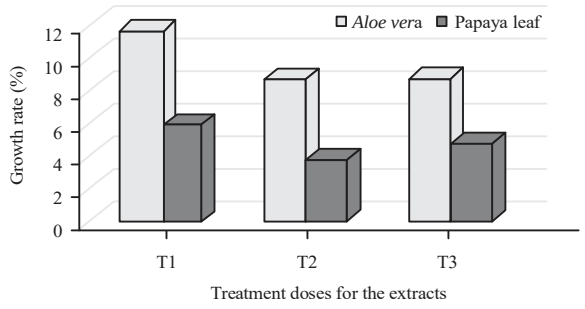

Fig. 4: Impacts of *A. vera* and *C. papaya* extracts on the growth of the Kabir Chickens

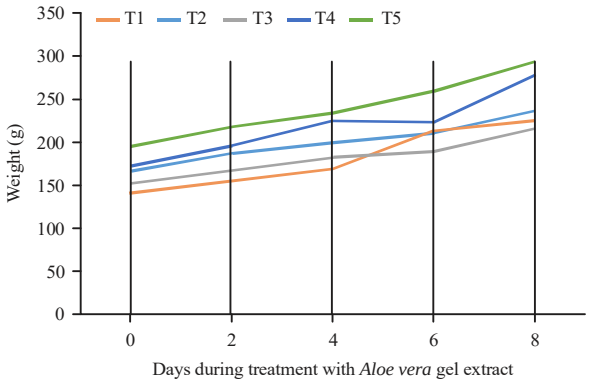

Fig. 5: Growth evolutions of *Eimeria*-infected Kabir chickens treated with aqueous *A. vera* extract

(7.5%) at the dose of 144 mg kg^{-1} body^{-1} weight and the difference was statistically significant (p = 0.034). Using Turkey multiple comparison test, differences between treatment groups were spotted out with superscripts (Table 5).

Effects of treating *Eimeria*-infected chickens with aqueous extract of *C. papaya* leaf on feed intake, average weight gain, growth rate and feed conversion: The highest growth rate was recorded in chickens of neutral group (9.1%) while the lowest was recorded in negative group (3.1%) and the differences were statistically significant (p = 0.046). The highest feed conversion ratio was recorded in T4 (8.1%) while the lowest was in T2 (1.6%) and the difference was statistically significant (p = 0.031) (Table 6).

Comparative impacts of the two extracts on the growth of chickens: Figure 4 summarises the impacts of aqueous extracts of *A. vera* and *C. papaya* on the growth of Kabir chickens. It was observed that extract of *A. vera* significantly promoted growth of Kabir chickens compared to those consuming papaya leaf extract as shown in Fig. 4.

Growth evolution curves of chickens treated with *A. vera* extract for coccidiosis: The highest growth evolution was observed in T5 group of chickens (from 172.9-280.5 g) while the lowest was observed in T4 group (from 175.9-247.9 g) - the steeper the gradient, the higher the growth evolution (Fig. 5).

Table 6: Effects of treating *Eimeria*-infected chickens with aqueous extract of *C. papaya* leaf on feed intake, average weight gain, growth rate and feed conversion

	Growth parameters			
Treatment dose (mg kg^{-1} BW)	AFI	AWG	AGR (%)	FCR (%)
32	784.2±28.1	499±19.4	5.9^{b}	3.8^{b}
80	778.3±22.3	497.9±21.6	3.8^{a}	6.3^{c}
144	751.7±18.3	587.5±15.3	4.8^{b}	1.6^{a}
Negative	817.5±37	498.8±7.8	3.1^{a}	8.1^{d}
Neutral	734.2±23.8	470.2±36.7	9.1^{c}	4.1^{b}
p-values	0.061	0.057	0.046	0.031

Differences in superscripts a, b, c in each column and d signify that significant differences existed at p<0.05

Table 7: Effects of treating *Eimeria*-infected chickens with aqueous extract of *A. vera* on haematological parameters

	Different Blood parameters					
Experiment (mg kg^{-1} BW)	WBC (10^{9} µL)	RBC (10^{12} µL)	HGB (g µL^{-1})	HCT (%)	MCV (×10^{6} µL^{-1})	PLT (10^{3} µL)
32	48.7±3^{a}	4.7±0.6^{a}	22.6±3.4^{b}	56.7±8.4^{b}	121.6±2.2	69.0±0.1^{d}
80	38.3±0.6^{a}	2.7±0.7^{a}	13.5±3.9^{a}	33.8±9.4^{a}	125.4±0.4	2.7±2.7^{b}
144	35.1±4.9^{a}	2.1±0.1^{a}	10.4±0.2^{a}	27.0±0.9^{a}	130.9±1.7	1.0±1^{a}
Negative	27.8±3.2^{a}	2.7±0.3^{a}	13.0±1.5^{a}	32.1±3.8^{a}	119.2±1.2	29.0±11^{c}
Neutral	19.4±10.2^{a}	1.5±0.4^{b}	7.6±2.8^{a}	19.6±4.8^{a}	133.0±6.6	4.0±.1^{b}
P-values	0.062	0.038	0.007	0.029	0.271	0.001

Different superscripts a, b, c and d each column means significant difference existed at p<0.05

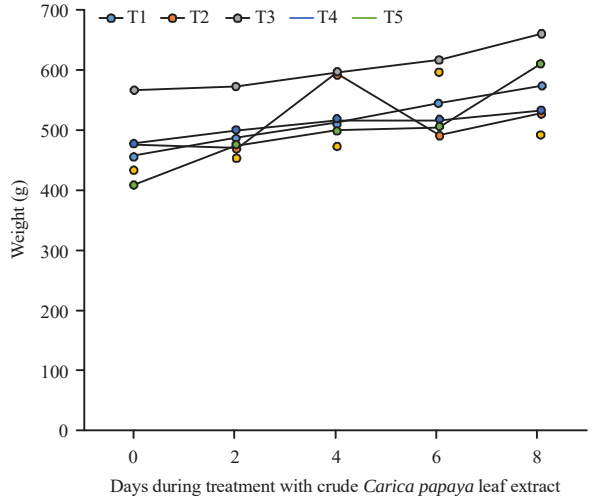

Fig. 6: Weight evolutions of *Eimeria*-infected Kabir chickens treated with different doses of aqueous *C. papaya* leaves

Growth evolution curves of chickens treated with *C. papaya* leaf extract for coccidiosis: The highest weight was observed in T5 (9.1%) while the lowest was observed in T4 (3.1%) as shown in Fig. 6.

Effects of treating *Eimeria*-infected chickens with aqueous extract of *A. vera* on haematological parameters: The following counts of blood components - WBC, RBC, HGB, HCT, MCV and PLT were done to determine the impacts of this extract on them in *Eimeria*-infected Kabir chickens. The highest value of WBC was recorded in chickens of T1 (48.7±3×10^{9} µL^{-1}) and the lowest was recorded in T5 (19.4±10.2×10^{9} µL^{-1}) and the difference was not significant (p = 0.062). The highest value of RBC was recorded in chickens of T1 (4.7±0.6×10^{12} µL^{-1}) while the lowest was recorded in T5 (1.5±0.4×10^{12} µL^{-1}) and the difference was significant (p = 0.038). The highest value of PLT was recorded in T1 group (69±0.1×10^{3} µL^{-1}) while the lowest was recorded in T3 (1±1×10^{3} µL^{-1}) and the difference was significant (p = 0.001). Haemoglobin (HGB) was significantly highest (p = 0.007) in chickens of T1 (22.6±3.4 g dL^{-1}) and lowest was in T5 (7.6±2.8 g dL^{-1}). Haematocrit (HCT) was also significantly highest (p = 0.029) in chickens of T1 (56.7±8.4%) and the lowest was in T6 group of chickens (19.6±4.8%). Mean cell volume (MCV) values were similar among treatment groups (p = 0.271) as indicated in Table 7.

Effects of treating *Eimeria*-infected chickens with aqueous extract of *C. papaya* leaf on haematological parameters: The highest mean WBC value was recorded in chickens of T4 (112.5±14.5×10^{9} µL^{-1}) and the lowest was recorded in chickens of T5 (19.4±10.2×10^{9} µL^{-1}) and the difference in WBC among the treatment groups was statistically significant (p = 0.006). The highest mean RBC value was recorded in chickens of T3 (3.6±1.2×10^{12} µL^{-1}) while the lowest was recorded in T5 (1.5±0.4×10^{12} µL^{-1}) and the difference was statistically significant (p = 0.008). Mean PLT was significantly highest (p = 0.001) in chickens of T3 (34.3±27.6×10^{3} µL^{-1}) and lowest was in T1 (1.0±0.6×10^{3} µL^{-1}). Significant differences also existed in haemoglobin and haematocrit values but not in MCV values and the details of their statistics are shown in Table 8.

Table 8: Effects of treating *Eimeria*-infected chickens with aqueous extract of *C. papaya* leaf on haematological parameters

	Blood parameters					
Experiment (mg kg^{-1} BW)	WBC×10^{9} µL^{-1}	RBC×10^{12} µL^{-1}	HGB (g dL^{-1})	HCT (%)	MCV×10^{6} µL^{-1}	PLT×10^{3} µL^{-1}
32	45.2±3.3^{b}	2.0±0.1^{ab}	9.7±0.4^{ab}	24.1±1^{a}	118.3±2.2	1.0±0.6^{a}
80	25.1±1.5^{a}	2.783±0.4^{b}	13.5±2.3^{ab}	34.1±5.5^{b}	121.7±3.7	10.3±8^{b}
144	30.6±4.8^{a}	3.6±1.2^{b}	17.5±6^{b}	45.7±16.5^{b}	125.4±4.1	34.3±27.6^{c}
Negative	27.8±3.2^{a}	2.7±0.3^{b}	13.0±1.5^{ab}	32.1±3.8^{b}	119.2±1.2	29.0±11^{c}
Neutral	19.4±10.2^{a}	1.5±0.4^{a}	7.6±2.8^{a}	19.6±4.8^{a}	133.0±6.6	4.0±.1^{a}
Statistics p-values	0.003	0.008	0.012	0.044	0.105	0.001

Different superscripts a,b and ab in each column mean significant differences at p<0.05

DISCUSSION

The aqueous extract of *A. vera* significantly reduced the oocyst counts and the oocyst reduction rate increased with an increase in the concentration of *A. vera* extract. This finding is in agreement with the studies of Das *et al*.[18] and Habibi *et al*.[19]. who reported 91.2 and 93.01% oocyst reduction respectively after using *A. vera* and *A. spicata* gel for treating coccidiosis. This observation implies that *A. vera* extracts were able to kill or inhibit growth and development of oocysts. However, the belated ability of the *A. vera* extracts to completely inhibit sporulation of the coccidia oocysts could be an indication that the extracts may not be highly effective at the sporulation stage of the coccidian life cycle or that it is slow to act. It could also be an indication that the crude extracts are slower in catabolising into forms that can be absorbed by parasites when compared with the hydroalcoholic extracts.

The aqueous extract of pawpaw leaf produced similar results and greatly reduced the level of *Eimeria* oocysts in chickens in a dose-dependent manner after 8 days. The high and moderate infections initially observed in the experimental chickens were reduced to very light infections when compared with the untreated control birds. This might be an indication that the reduction in oocyst counts was due to the administration of the extracts. This efficacy rate was higher than that obtained by Al-Fifi[20] in Saudi Arabia where a 53% reduction rate was recorded with a *papaya* leaf extract complex. He opined that this might have been due to digestive enzyme activities that can digest and eliminate *Eimeria* sporozoites, thereby protecting caecal epithelium. T2 group showed the least oocyst reduction with respect to other doses and this could be an indication that the best dose for significant oocyst reduction could be an average of T1 and T3 since T2 gave the least oocyst reduction rate.

When chickens were treated with aqueous extracts of *A. vera* and *C. papaya*, significant differences were observed in growth and feed conversion rates between the six experimental groups. T3 chickens probably had higher growth and feed consumption rates because of the higher dose of *A. vera* and papaya extracts which is a food stimulant and probably increased the appetites of the birds thereby leading to higher growth rates. Chickens of T5 (Neutral group) suffered no coccidial challenge and therefore fed normally, faced little or no metabolic and immunologic challenges when compared with their counterparts in other groups. The better growth rate in the treated groups could be attributed to the enzyme papain and carotene in the pawpaw leaf extract which aids in protein digestion thus enhancing the release of free amino acids necessary to enhance growth[21]. This led to high weight gain and feed consumption ratio. This finding agrees with the report of Chandrakesan *et al*.[22] in India. However, it is not in line with the report of Kurkure *et al*.[23], who stated that coccidial challenge had no effect on body weight gain and feed conversion ratio. Nowadays, *papaya* is considered as a nutraceutical fruit and this is due to its multifarious medicinal properties. Clinical trials need to be carried out to exploit the therapeutic utility of *C. papaya* in combating various diseases[24].

It was observed that RBC values were the highest in chickens treated with the highest dose of extract (T3) compared to that of the control. Coccidians are known to perforate the caeca and intestinal walls hence, causing bleeding. It reduced RBC count of the untreated and suboptimally treated chickens. These results are similar to those reported by Bedáňová *et al*.[25] and Iyare *et al*.[26], although they mixed these extracts in the drinkers of their chickens and they were not administered directly as was done in this study. Also, WBC counts were highest in extract treated groups in a dose-dependent manner in most cases. It is possible that the higher doses of *A. vera* might have provoked the reticuloendothelial system and or the lymphoid organs to raise the level of white blood cells with specific antibodies to fight against these parasites which are foreign bodies and as a result, the level of WBC increased in the blood. Available

information indicates that haematological values of avian species are also significantly influenced by poultry diseases including fowl typhoid, mycoplasmosis, avian coccidiosis and many other diseases like Newcastle disease (NCD) and stress[27].

T3 had the highest platelet value implying that *A. vera* might have wound healing properties and healed the wounds from lesions caused by these parasites on the caecal and intestinal walls. Average HGB level of 8.5 g dL^{-1} was lower than those obtained by Pampori and Iqbal[28]. This might be due to the method they used (Haematocrit centrifuge); where red cells were not properly packed thereby giving a higher value.

After treatment with *C. papaya* leaf extract, the highest WBC value was recorded in chickens of the positive control followed by treated groups and least in T5 (Negative). The least WBC value in T5 might be due to the fact that T5 was the neutral group and faced no coccidian challenge and as a result, the immune system never provoked the production of WBC thereby leading to the low value of WBC in T5. Coccidiosis is believed to thrive well in chickens by suppressing the production of antibodies against them.

Extract-treated chickens showed higher RBC values than those of the control groups; this can be attributed to high nutritional contents of *A. vera* and papaya leaves which is very rich in vitamin A and carotene thereby enhancing the production of RBC in the marrow. The least RBC value was observed in the chickens of T4 ($0.8\pm0.3\times10^{12}$ uL^{-1}), infected but not treated. This probably might have been due to the fact that since T4 consisted of chickens that were infected but not treated, unlimited multiplication of the *Eimeria* parasites might have led to serious loss of blood (RBC) as these parasites perforate the caeca of the chickens. High platelet level might be due to the fact that *papaya* leaves are very rich in vitamin A which is very effective in wound healing and increase the production of platelets, similar results were reported by Oduola *et al*.[29] and Ogbuokiri *et al*.[30].

CONCLUSION

Carica papaya and *Aloe vera* aqueous extracts have good anticoccidial properties and very effective in the treatment of coccidiosis. Both extracts have influence on haematological parameters of chickens and affect growth of chickens in various ways depending on the concentrations. *C. papaya* and *A. vera* leaves extracts significantly reduced the oocyst counts and improved the RBC and WBC values in the chickens. Thus, these extracts could be used as organic alternative of synthetic chemicals to combat coccidiosis and improve chicken health.

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REFERENCES

1. Kostadinović, L., J. Lević, S. Popović, I. Čabarkapa, N. Puvača, O. Đuragić and Š. Kormanjoš, 2015. Dietary inclusion of *Artemisia absinthium* for management of growth performance, antioxidative status and quality of chicken meat. Europ. Poult. Sci., Vol. 79, 10.1399/eps.2015.75
2. Khan, M.J.A., H.K. Sohail, N. Salma, S.G. Syeda and S. Jamila *et al*., 2014. Effect of dietary supplementation of *Aloe vera* leaves on growth performance and immunity of Fayoumi chicks. Pak. J. Nutr., 13: 191-195.
3. Kaboudi, K., S. Umar and M.T. Munir, 2016. Prevalence of Coccidiosis in Free-Range Chicken in Sidi Thabet, Tunisia. Scientifica, 10.1155/2016/7075195.
4. Akhtar, M., A.F. Tariq, M.M. Awais, Z. Iqbal, F. Muhammad, M. Shahid and E. Hiszczynska-Sawicka, 2012. Studies on wheat bran Arabinoxylan for its immunostimulatory and protective effects against avian coccidiosis. Carbohydr. Polym., 90: 333-339.
5. Khaliq, K., M. Akhtar, M.M. Awais and M.I. Anwar, 2017. Tavuklarda koksidiyoza karşı *Aloe vera* polisakkaritlerinin İmmunoterapötik etkinliğinin saptanması. [Evaluation of immunotherapeutic effects of *Aloe vera* polysaccharides against coccidiosis in chicken]. Kafkas Univ. Vet. Fak. Dergisi, 23: 895-901. (in Turkish).
6. Desalegn, A.Y. and M.R. Ahmed, 2020. Anticoccidial Activity of *Aloe debrana* and *Aloe pulcherrima* Leaf Gel against *Eimeria* Oocysts. J. Parasitol. Res., 10.1155/2020/8524973
7. Akhtar, M.F., M. Hanif and N.M. Ranjha, 2015. Methods of synthesis of hydrogels. A review. Saudi Pharm. J., 24: 554-559.
8. Akram, M.Z., M. Salman, H. Jalal, U. Asghar, Z. Ali, M.H. Javed and M. Khan, 2019. Evaluation of dietary supplementation of *Aloe vera* as an alternative to antibiotic growth promoters in broiler production. Turk. J. Vet. Res., 3: 21-26.
9. Rodrigues, L.I.O., A.C.L. de Oliveira, S. Tabrez, S. Shakil and M.I. Khan *et al*., 2018. Mutagenic, antioxidant and wound healing properties of *Aloe vera*. J. Ethnopharmacol., 227: 191-197.

10. Darabighane, B. and S.N. Nahashon, 2014. A review on effects of *Aloe vera* as a feed additive in broiler chicken diets. Ann. Anim. Sci., 14: 491-500.
11. Nghonjuyi, N.W., C.K. Tiambo, H.K. Kimbi, C.A.N. Manka'a, R.S. Juliano and F. Lisita, 2015. Efficacy of ethanolic extract of *Carica papaya* leaves as a substitute of sulphanomide for the control of coccidiosis in KABIR chickens in Cameroon. J. Anim. Health Prod., 3: 21-27.
12. Akhtar, M., A. Hai, M.M. Awais, Z. Iqbal, F. Muhammad, Ahsan ul Haq and M.I. Anwar, 2012. Immunostimulatory and protective effects of *Aloe vera* against coccidiosis in industrial broiler chickens. Vet. Parasitol., 186: 170-177.
13. Darabighane, B., A. Zarei and A.Z. Shahneh, 2012. The effects of different levels of *Aloe vera* gel on ileum microflora population and immune response in broilers: A comparison to antibiotic effects. J. Applied Anim. Res., 40: 31-36.
14. Khan, M.I.R., M. Asgher and N.A. Khan, 2014. Alleviation of salt-induced photosynthesis and growth inhibition by salicylic acid involves glycinebetaine and ethylene in mungbean (*Vigna radiata* L.). Plant Physiol. Biochem., 80: 67-74.
15. Udo, E.J. and A.M. Abba, 2018. Comparative Study of *In-Vitro* Anti-Coccidial Efficacy of *Allium sativum* and *Carica papaya*. J. Zool. Res., 2: 10-14.
16. Darabighane, B. and S.N. Nahashon, 2014. A review on effects of *Aloe vera* as a feed additive in broiler chicken diets. Ann. Anim. Sci., 14: 491-500.
17. Unigwe, C.R., U.P. Okorafor, U.M. Ogbu and O.C. Nwufoh, 2014. The nutritive profile of sun-dried paw-paw (*Carica papaya*) leaf meal and its effect on the growth performance of broiler chickens. Int. J. Pure Applied Sci. Technol., 20: 72-78.
18. Das, P., S.P. Sinhababu and T. Dam, 2006. Screening of antihelminthic effects of Indian plant extracts: A preliminary report. J. Altern. Complementary Med., 12: 299-301.
19. Habibi, H., S. Firouzi, H. Nili, M. Razavi, S.L. Asadi and S. Daneshi, 2014. Anticoccidial effects of herbal extracts on *Eimeria tenella* infection in broiler chickens: *in vitro* and *in vivo* study. J. Parasitic Dis., 40: 401-407.
20. Al-Fifi, Z.I.A., 2007. Effect of leaves extract of *Carica papaya*, *Vernonia amigdalina* and *Azadiratcha indica* on the coccidiosis in free-range chickens. Asian J. Anim. Sci., 1: 26-32.
21. Onyimonyi, A.E. and O. Ernest, 2009. An assessment of pawpaw leaf meal as protein ingredient for finishing broiler. Int. J. Poult. Sci., 8: 995-998.
22. Chandrakesan, P., K. Muralidharan, V.D. Kumar, G. Ponnudurai, T.J. Harikrishnan and K.S.V.N. Rani, 2009. Efficacy of a herbal complex against caecal coccidiosis in broiler chickens. Veterinarski Arhiv, 79: 199-203.
23. Kurkure N.V., S.W. Kolte, A.G. Bhandarkar and D.R. Kalorey, 2006. Efficacy of herbal preparation against coccidiosis in broilers. J. Vet. Parasitol., 20: 155-157.
24. Mani, V., M. Parle, K. Ramasamy, A. Majeed and A. Bakar, 2011. Reversal of memory deficits by *Coriandrum sativum* leaves in mice. J. Sci. Food Agric., 91: 186-192.
25. Bedáňová, I., E. Voslářová, V. Večerek, V. Pištěková and P. Chloupek, 2007. Haematological profile of broiler chickens under acute stress due to shackling. Acta Vet. Brno, 76: 129-135.
26. Iyare, E.E. and N.N. Obaji, 2014. Effects of aqueous leaf extract of *Azadirachta indica* on some haematological parameters and blood glucose level in female rats. Niger. J. Exp. Clin. Biosci., 2: 54-58.
27. Kokosharov, T. and T. Todorova, 1987. Changes in the iron content, erythrocytes and hemoglobin in the blood of poultry with acute experimental fowl typhoid. Veterinarno-meditsinski nauki, 24: 70-74.
28. Pampori, Z.A. and S. Iqbal, 2007. Haematology, serum chemistry and electrocardiographic evaluation in Native chicken of Kashmir. Int. J. Poult. Sci., 6: 578-582.
29. Oduola, T., T.O. Idowu, I.S. Bello, F.A. Adeniyi and E.O. Ogunyemi 2012. Haematological response to intake of unripe *Carica papaya* fruit extract and the isolation and characterization of *caricapinoside*: A new antisickling agent from the extract. Asian J. Pharm. Clin. Res., 5: 77-81.
30. Ogbuokiri, U., A. Iheanacho, A. Osuji, O. Charles and B. Ekenyem, 4. Effect of pawpaw leaf (*Carica papaya*, Linn.) meal on some performance attributes of starter broiler chicks. J. Anim. Sci. Adv., 2014: 826-832.