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Effect of Dietary Incorporation of *Curcuma longa* Powder on Haematology and Serological Properties of Guinea Pigs (*Cavia porcellus*)

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Abstract

The reduced efficiency of antibiotic growth promoters in livestock, and the unavoidable residual effects on livestock products such as egg, meat and milk have pushed researchers to rush towards the use of phytobiotics in animal feed. This study was conducted at the Teaching and Research Farm of the University of Dschang to evaluate the Effect of *Curcuma longa* powder as feed additive on hemato-serological parameters in Guinea pigs. A total of 120 three weeks old Guinea pigs (60 males and 60 females), with an average weight of 150 ± 20 g were used. The animals were randomly distributed into four treatments in a completely randomized design with 30 animals per treatment (15 males and 15 females). Four experimental treatments were used by adding 0%, 0.25%, 0.5% and 1% *C. longa* in the diet corresponding to R_0, $R_{0.25\%}$, $R_{0.5\%}$ and $R_{1\%}$ respectively. At the 8th week of age, 12 Guinea pigs (6 males and 6 females) per treatment were fasted for 12 hours and sacrificed by cervical dislocation. Blood was rapidly collected from the jugular vein for the evaluation of haematological and biochemical parameters. Results revealed that the inclusion of *Curcuma longa* at 0.25% significantly ($p < 0.05$) increased the concentration of hematocrit, lymphocytes, monocytes, granulocytes and platelets. A significant decrease ($p < 0.05$) was observed in hemoglobin, red blood cells, white blood cells, serum lipids, globulin, AST, ALT, and urea. It was concluded that the use of *Curcuma longa* powder at 0.25% as feed additive positively regulates blood serum parameters of Guinea pigs.

Keywords

Cavia porcellus, *Cucurma longa*, Haematology and Serological Parameters

1. Introduction

The use of synthetic antibiotics as growth promoters has high cost implications and adverse side effects on animal health, prolonged withdrawal period and risk of accumulation in tissues which could have harmful effects on human health [1]. As a result, consumers of animal products are demanding for drug residues free meat. Presently, a lot of attention has been given to phytobiotics in animal husbandry because of their growth stimulating effects. The belief in these non-toxic products such as phytobiotics to a large extent has fueled their use in animal production by researchers. However, toxicity resulting from medicated feeding of animals with plant-based diets has been reported [2]. It is therefore imperative to verify the toxicity of these phytobiotics, following the example of *Curcuma longa* before recommending its use in animal production.

Curcuma longa, is a phytobiotics, member of the Zingiberaceae family. It is a rhizomatous perennial herb about 1.5 m high. It is mainly found in tropical and subtropical regions of the world. It is rich in essential oils and certain beneficial trace elements [3]. This plant is widely used as a spice, colouring agent and is also known for its medicinal properties [4]. Reported pharmacological activities include its hepatoprotective, antioxidant, antimicrobial and anti-inflammatory role [4]. The active ingredients responsible for these different activities are curcuminoids and their derivatives [5] [6]. Phytobiotics such as *C. longa* and Ginger have been reported to have positive effects on the growth performance and health of rabbits [7]. Such phytobiotics can also effectively regulate liver and kidney function [2]. Thus, the use of *C. longa* as feed additives can improve haematological and biochemical parameters in domestic animals [8]. These parameters are reliable indicators of the health status of animals, and may have important roles in the diagnosis, prognosis and treatment of diseases. Very little information exists on the effects of the use of *C. longa* powder as a feed additive on blood and hepatorenal parameters in Guinea pigs. Therefore, the present work carried view of studying the effects of diets enriched with *C. longa* powder as feed additive on hematological and biochemical parameters of Guinea pigs.

2. Materials and Methods

2.1. Study Area

This study was carried out at the *Cavia porcellus* Unit of the Teaching and Research Farm of the Faculty of Agronomy and Agricultural Sciences of the University of Dschang, Cameroon. Dschang is located in the West region of Cameroon at 05˚26'N and 10˚26'E. The area experiences a wet season from March to November and a hot dry season for the rest of the year. Maximum ambient temperature is around 21˚C, while an average annual rainfall of 2000 mm is prevalent.

2.2. Processing of *Curcuma longa* Powder

Curcuma longa was harvested in the district of Santchou (West region of Came-

roon), sun dried, then ground into powder using a hammer mill of sieve size 2 mm. The powdered spice was then stored in air-tired polythene bags prior to use in the experimental rations. Sample of the test spice was stored in a refrigerator at a temperature of 4˚C. The phytochemical analyses of *Curcuma longa* carried out as described by Talukdar *et al.* [9] revealed that alkaloids, flavonoids, terpenoids, phenols, steroids and tannins were presents.

2.3. Animal Equipment and Housing

For this trial, 120 animals (60 males and 60 females) with an average weight of 150 ± 20 g were used and housed in four pens. These pens were made of plywood, measuring 1 × 0.8 × 0.6 m, equipped with light facilities. The animals were raised on the floor with 5 cm thick dry white untreated wood shaving beddings, which was changed after every 2 days to prevent the accumulation of faeces and urine. Each compartment or lodge was equipped with a wooden trough for feed and a concrete water trough. The various boxes were fitted with a fine-mesh cover to protect the animals from mice and other predators that could enter the barn.

2.4. Animal Experimental Diet

A total of 120 Guinea pigs of three weeks old were allocated into four treatments in a completely randomized design ($R_{0\%}$, $R_{0.25\%}$, $R_{0.5\%}$ and $R_{1\%}$ of *C. longa*). Each treatment contains 30 Guinea pigs (15 males and 15 females). From a basal diet, ($R_{0\%}$) three experimental rations were formulated by adding *Curcuma longa* powder (Table 1) as follow:

- $R_{0\%}$: basal diet without additive;
- $R_{0.25\%}$: basal diet + 0.25% of *C. longa*;
- $R_{0.5\%}$: basal diet + 0.5% of *C. longa*;
- $R_{1\%}$: basal diet + 1% of *C. longa*.

Table 1. Gross composition (g/100g) of experimental basal diet fed to Guinea pigs.

Ingredients	Quantity (%)
Maize	22.00
Trypsacum laxum	26.00
Soybean meal	04.00
Cotton cake	03.00
Palm kernel cake	09.00
Fish meal	08.00
Bone meal	01.00
Wheat brand	22.00
*Premix 10%	02.00
Oyster Shell	01.00
Molasses	02.00
Total	**100.00**

Analysed composition (%)	
Digestible energy (Kcal/KgDM)	2803.05
Dry matter (%)	89.56
Crude Protein (%DM)	17.82
Crude Fibre (%DM)	16.60
Ether Extract	1.47

*Vitamin premix provided per kilogram of diet: vitamin A, 3,000,000 IU, vitamin D3: 600,000 IU; vitamin E: 4000 mg; vitamin K: 500 mg; vitamin B1: 200 mg; vitamin B2, 1000 mg; vitamin B6: 400 mg; vitamin B12: 4 mg; Mn, 80 mg; Fe: 8000 mg; Zn: 10,000 mg; Cu: 2000 mg; Methionine: 200,000 mg; Lysine: 78,000 mg; Se: 20 mg.

Feed (granulated and dried) and water were given to the animals add-libitum. The trial lasted for eight weeks.

2.5. Evaluation of Haematological and Biochemical Parameters

At the 8th week of age, twelve Guinea pigs per treatment were fasted for 12 hours, then slaughtered by cervical dislocation. During bleeding, blood was directly collected from the jugular vein for the evaluation of haematological and biochemical parameters.

Blood samples collected in anticoagulant (EDTA) test tubes were used to determine the concentration of red blood cells, white blood cells, lymphocyte, monocyte, granulocyte, hematocrit, hemoglobin, platelet and platelet, using a Genius electronic automatic hematimeter (Model KT-6180, S/N 701106101557).

Blood collected in non-heparinized tubes (without anticoagulant) was allowed to rest for 24 hours, serum collected was stored at −20˚C for the analysis of Aspartate Aminotransferase (AST), Alamine Aminotransferase (ALAT), urea, creatinine, total cholesterol, HDL cholesterol, triglycerides, total protein, globulins and albumin using the spectrophotometry method as prescribed by the Chronolab® commercial kits. Globulin and LDL cholesterol were calculated as recommended by Abdel-Fattah *et al.* [10].

2.6. Statistical Analyses

The data collected were subjected to one-way analysis of variance (ANOVA) following the general linear model (GLM). Where significant differences existed between treatments, the means were separated by the Waller Duncan test at 5% significance level [11].

3. Results

3.1. Effects of the Level of Incorporation of *C. longa* Powder on Some Haematological Parameters of Guinea Pig

The inclusion of *C. longa* powder in the diets had variable influence on blood parameters of guinea pig (Table 2). The white blood cell, lymphocyte and monocyte concentration of animals fed on $R_{0.25\%}$ ration was comparable ($p > 0.05$) to those of $R_{0\%}$ and $R_{1\%}$ rations and significantly ($p < 0.05$) higher than those fed

on $R_{0.5\%}$ ration. Similarly, haematocrit and platelet concentration of animals receiving $R_{0.25\%}$ ration were comparable to those of $R_{0\%}$ and $R_{0.5\%}$ rations and significantly ($p < 0.05$) lower than those of $R_{1\%}$ ration. Granulocytes concentration of Guinea pigs fed on $R_{0.25\%}$ ration was comparable ($p > 0.05$) to that of $R_{0.5\%}$ ration and significantly ($p < 0.05$) higher in Guinea pigs receiving $R_{0\%}$ and $R_{1\%}$ ration. However, the inclusion of *C. longa* powder in the rations had no significant effects ($p > 0.05$) on red blood cell, hemoglobin and platelet concentration.

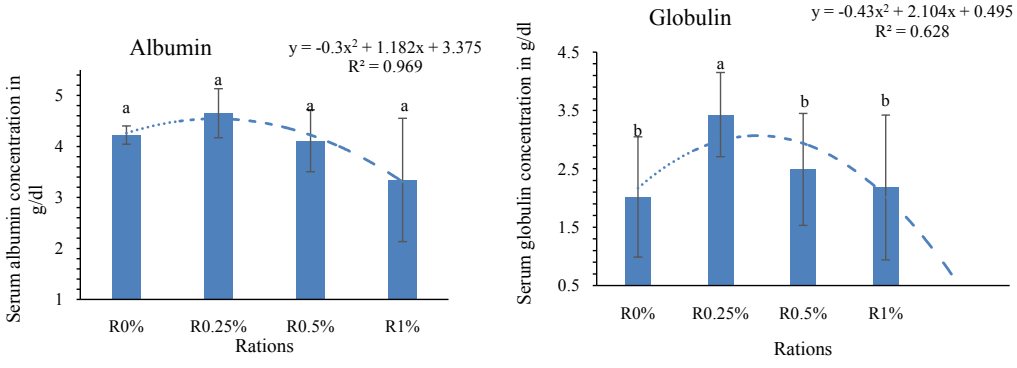
Table 2. Effects of the rate of inclusion of *C. longa* on haematological parameters of Guinea pigs.

Haematological parameters	Rate of incorporation (%)				p
	$R_{0\%}$	$R_{0.25\%}$	$R_{0.5\%}$	$R_{1\%}$	
WBC ($\times 10^3/\mu l$)	9.89 ± 1.13^{ab}	11.27 ± 2.10^{a}	9.07 ± 1.08^{b}	9.68 ± 1.47^{ab}	0.047
LYM ($\times 10^3/\mu l$)	5.12 ± 0.76^{ab}	5.85 ± 1.71^{a}	4.32 ± 0.77^{b}	4.62 ± 0.74^{ab}	0.047
MONO ($\times 10^3/\mu l$)	1.52 ± 0.43^{a}	1.68 ± 0.41^{a}	1.00 ± 0.21^{b}	1.58 ± 0.42^{a}	0.024
GRAN ($\times 10^3/\mu l$)	3.40 ± 0.29^{bc}	4.17 ± 0.65^{a}	3.73 ± 0.22^{ab}	3.11 ± 0.50^{c}	0.004
RBC (μl)	5.48 ± 0.67	5.60 ± 0.66	5.50 ± 0.43	5.68 ± 0.59	0.932
HGB (g/dl)	15.18 ± 0.63	14.83 ± 0.73	15.48 ± 1.05	15.96 ± 1.74	0.382
HCT (%)	50.10 ± 2.94^{ab}	48.57 ± 3.10^{b}	50.52 ± 3.10^{ab}	53.57 ± 3.79^{a}	0.041
PLT ($\times 10^3/\mu l$)	259.33 ± 17.68^{b}	257.17 ± 42.64^{b}	270.17 ± 22.32^{b}	318.67 ± 30.75^{a}	0.006
PCT (%)	0.35 ± 0.07	0.33 ± 0.10	0.28 ± 0.08	0.38 ± 0.07	0.326

a, b, c: Means on the same row with the same superscripts do not differ significantly ($p > 0.05$). WBC: White blood cells; Lym: Lymphocyte; Mono; Monocyte; Gran: Granulocyte; RBC: Red blood cells; HCT: Hematocrit; Hgb: Hemoglobin; PLT: Platelets; PCT: Platelet cell; $R_{0\%}$: without *C. longa*; $R_{0.25\%} = R_{0\%} + 0.25\%$ *C. longa*; $R_{0.5\%} = R_{0\%} + 0.5\%$ *C. longa*; $R_{1\%} = R_{0\%} + 1\%$ *C. longa*.

3.2. Effects of Different Levels of Incorporation of *C. longa* Powder on Serum Protein Concentration

The inclusion of different levels of *C. longa* powder in the diet significantly ($p < 0.05$) decreased serum concentration of albumin, globulin and total protein (**Figure 1**). The relationship between albumin, globulin, total protein and the level of incorporation of *C. longa* powder in the diet shows that the concentration of serum albumin, globulin and total protein decreased with increasing level of



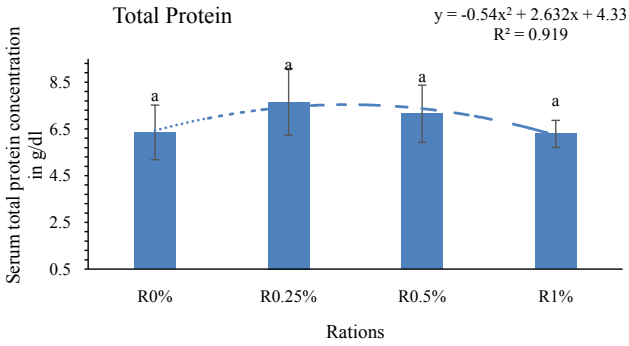


Figure 1. Effects of the level of incorporation of *C. longa* powder on serum protein concentration. a: Means on the same row with the same superscripts do not differ significantly ($p > 0.05$); $R_{0\%}$: without *C. longa*; $R_{0.25\%} = R_{0\%} + 0.25\%$ *C. longa*; $R_{0.5\%} = R_{0\%} + 0.5\%$ *C. longa*; $R_{1\%} = R_{0\%} + 1\%$ *C. longa*.

C. longa powder. The regression value derived ($R^2 = 0.96$ and $R^2 = 0.91$) suggest that the variation of albumin, and total protein are 96% and 91% respectively dependent on the rate of inclusion of *C. longa* in feed.

3.3. Effects of the Level of Incorporation of *C. longa* Powder on Serum Lipid Concentration

Serum concentrations of total cholesterol, HDL, LDL and triglycerides decreased significantly ($p < 0.05$) with the inclusion of *C. longa* powder in the rations (Figure 2). The relationships between HDL, LDL, triglycerides and graded level

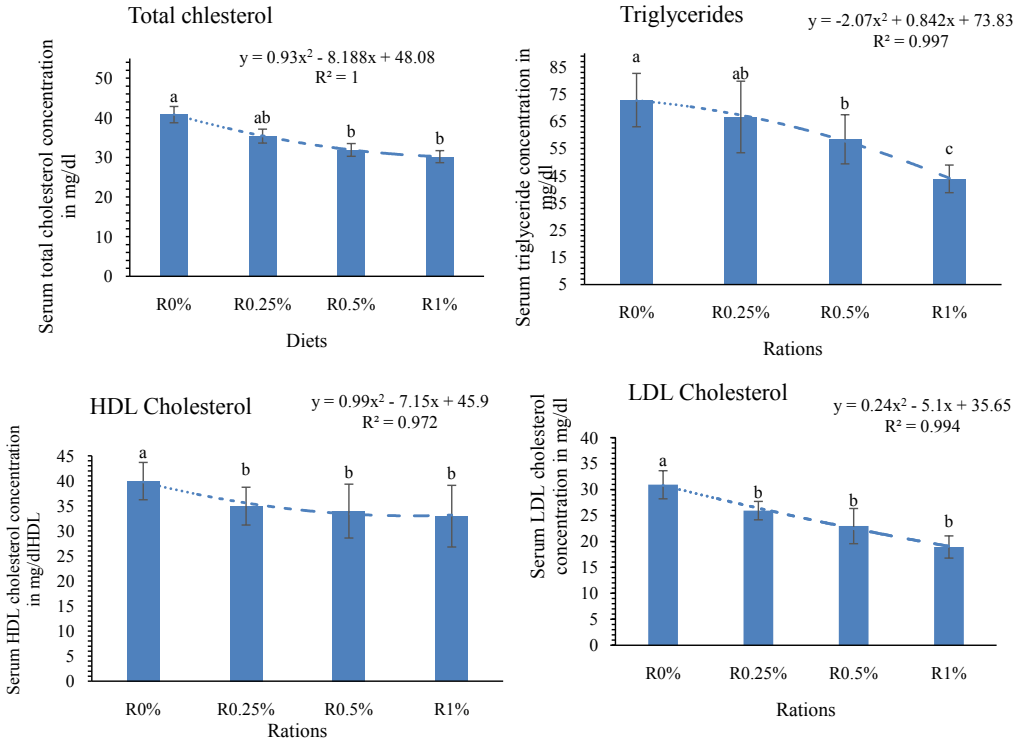


Figure 2. Effects of the level of incorporation of *C. longa* powder on serum lipid concentration. a, b: graphs with the same letters are not significantly different at the 5% threshold. $R_{0\%}$: without *C. longa*; $R_{0.25\%} = R_{0\%} + 0.25\%$ *C. longa*; $R_{0.5\%} = R_{0\%} + 0.5\%$ *C. longa*; $R_{1\%} = R_{0\%} + 1\%$ *C. longa*.

of *C. longa* induced a high regression coefficient (R^2 = 0.97 for HDL, R^2 = 0.99 for LDL and R^2 = 0.99 for triglycerides) indicating a strong relation between lipids concentration and the rate of inclusion *C. longa* in feed.

3.4. Effects of the Rate of Incorporation of *C. longa* Powder on Serum Transaminase Concentration

Serum concentration of creatine decreased significantly ($p < 0.05$) with the inclusion of *C. longa* powder when compared to animal fed on $R_{0.05\%}$ in high rate in the diets (Figure 3). Serum urea, AST and ALT levels increased significantly ($p < 0.05$) with the inclusion of *C. longa* powder in the rations (Figure 3). This relationship shows that the concentration of serum urea, AST and ALT decreases with increasing level of *C. longa* powder. The regression value derived (R^2 = 0.95 for urea, R^2 = 0.85 for AST and R^2 = 0.89 for ALT) suggest that the variation of urea, AST and ALT are 95%, 85% and 89% respectively dependent on the rate of inclusion of *C. longa* in feed. However, the coefficient of determination of creatine (R^2 = 0.45) was weakly related to the level of incorporation of *C. longa* in the ration.

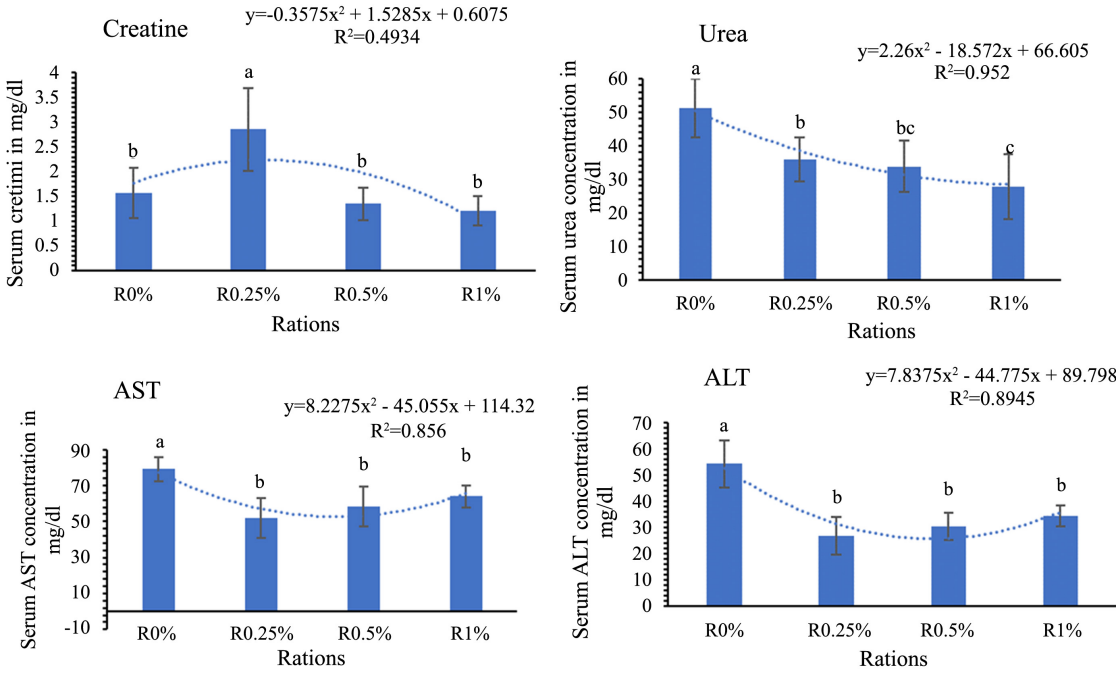


Figure 3. Effect of the level of incorporation of *C. longa* powder on serum transaminase concentration. a, b: graphs with the same letters are not significantly different at the 5% threshold. ; $R_{0\%}$: without *C. longa*; $R_{0.25\%}$ = $R_{0\%}$ + 0.25% *C. longa*; $R_{0.5\%}$ = $R_{0\%}$ + 0.5% *C. longa*; $R_{1\%}$ = $R_{0\%}$ + 1% *C. longa*.

4. Discussion

Blood parameters are considered as the main pathological, nutritional and physiological indices for assessing the state of an organism [12] [13]. Any change in the constituent elements of blood relative to the normal values is an important index for the interpretation of the physiological or metabolic state of the animal,

especially the quality of feed [14]. A decreased in red blood cells is usually associated with poor quality feed. Hemoglobin determines the animal's ability to withstand certain level of respiratory stress and hematocrit is the proportion of blood containing red blood cells [15]. When their values are high, this characterizes polycystemia and when they are weak, it indicates anemia [16]. The incorporation of 0.25% of *C. longa* powder significantly increased white blood cell, hematocrit, lymphocyte, monocyte, granulocyte and platelet concentration. This study corroborates with the work of Sey *et al.* [17] who showed that phytobiotics are also used as blood and immunity purifiers because they stimulate white blood cells and eventually increased interferon levels. However, our results contradict those of Sara *et al.* [18] who found that phytobiotics did not have a significant effect on these blood parameters. The test spice had, no significant effect on red blood cell, hemoglobin and platelet concentration. This corroborates the finding of Galib *et al.* [19] who revealed that *C. longa* powder had no effect on these parameters because of its antioxidant activity.

A decrease in serum lipid concentration was recorded in animals fed with rations containing 0.25%, 0.5% and 1% *C. longa* powder respectively. This could be due to the fact that curcumin decreased the absorption of cholesterol, thus increasing the activity of the enzyme cholesterol-7α-hydroxylase [20]. Curcumin acts by inhibiting the absorption of serum lipids in the intestine, increasing the conversion of serum lipids into bile acids in the liver. These results are consistent with those of Abdel El-Latif *et al.* [7] who reported that the addition of *C. longa* powder in the diet of rabbit at 0.25% and 0.05% reduced plasma concentrations of cholesterol, triglycerides and LDL cholesterol. In addition, the finding of Galib *et al.* [19] shows that rabbits fed 0.75%; 1% and 2% ginger powder and *C. longa* powder showed a significant decreased in triglycerides concentration.

The significant increase in serum proteins (albumin, globulin and total proteins) with animals fed on diet containing 0.25% *C. longa* powder observed during this study could be due to the presence of curcumin, which act by decreasing hepatic lesions and increasing nutrient absorption [21]. The results of this study corroborate with those of Ankit *et al.* [22] who reported that, supplementation of feed with garlic powders by 0.25% and 0.5% increased total protein level in broilers, and to those of Abdel-Ghaney *et al.* [23] who also reported that, supplementation of feed with thyme powders significantly increased total protein, globulin and albumin levels in broilers on the other hand.

Serum transaminase concentrations decreased with the incorporation of *C. longa* powder in the rations. The significant decreased in AST and ALT obtained with rations containing *C. longa* powder were due to the hepato-protective effect of this phytobiotic [24]. The results of this study corroborate those of Ajith *et al.* [25]; Kryshtafovych *et al.* [26] who reported that the addition of garlic powder as additive in feed at 0.25%, 0.5% and 0.75% and thyme at 5, 10 and 15 g/kg decreased the activity of ALT and AST in broilers. According to these authors, polyphenols present in garlic and thyme extract could be responsible for the protective activity of the liver by limiting the reabsorption of ALT and AST. The

decrease in the values obtained for creatinine concentration in animals fed rations containing 0.5% and 1% *C. longa* powder could be linked to the activity of phenolic compounds present in this phytobiotics that facilitated the excretion of creatinine, a product resulting from protein metabolism. Ajith *et al.* [25], reported that the polyphenols and flavonoids present in the extract of *Zingiber officinale* could be responsible for the protective activity of nephrons by limiting the reabsorption of creatinine and facilitating its excretion by the kidneys hence the decrease observed. These results are in line with those of Abdel El-Latif *et al.* [7], who observed a decrease in serum creatinine concentration in quails supplemented with thyme essential oil at 150, 300 and 450 mg/kg.

Urea concentration decreased in animals receiving *C. longa* powder compared to the control group. This significant reduction in serum urea concentration could be attributed to ammonia production, the caecum of guinea pig or to the microbial activity that is similar to that of the rumen in ruminants Abdel El-Latif *et al.* [7]. Serum urea concentration is an index that reflects the state of protein metabolism, renal function and body nutrition Kryshtafovych *et al.* [26]. The results of this study corroborate the results of Okalii [27], who reported that, the supplementation of feed with garlic and thyme powders by 3% separately and 1.5% in combination significantly decreased urea concentration in all groups of supplemented goats.

5. Conclusion

This study revealed that, the administration of *C. longa* powder up to 0.25% in feed has no detrimental effects on haematological and biochemical parameters of Guinea pigs. However, the incorporation of *Curcuma longa* powder in the diet at 0.25% improves the health conditions of Guinea pigs.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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