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Effects of Treatment of Cocoa Pod Husks with Aqueous Ash Extract of Bean Haulms on Growth Performance and Haemato-Biochemical Parameters of Rabbits

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Abstract

Sustainability of animal production system depends mostly on feed used. Therefore, the utilization of agricultural by product is one of the safe ways to attempt this goal. For this end, a study on the level of incorporation of cocoa pod husk on growth performance, haematological and biochemical parameters were carried out. A total of 80 young rabbits composed of 40 males and 40 females with an average weight of 824.30 ± 53.8 g and 826.09 ± 40.61g respectively. There were randomly assigned to 5 experimental rations in a complete randomized designed with 8 rabbits per treatment and each rabbit served as experimental unit. From the control ration R (0−); 0% cocoa pod husks and R (0+); 20% of untreated hulls, 3 other rations of which three (R1, R2, R3) were formulated with respectively 20%, 25%, and 30% husks treated with ash from bean haulms at concentrations of 12.5 kg/100 litters of water. The results revealed that the initial weight, feed consumption, feed conversion ratio, were not significantly affected ($p > 0.05$) by the different treatments. However, total weight gain, daily weight gains and final body weight of rabbit fed R1 ration were significantly ($p < 0.05$) higher (1973.77; 23.49; 2794.60 g respectively) as compare to other treatment irrespective of sex. Analysis of variance generally revealed a significant effect ($p < 0.05$) on fasting body weight (2447.43; 2476.22; 2687.99; 2512.52; 2425.89 g respectively for rations R0−, R0+, R1, R2 and R3), carcass weight (1270.84 g) and carcass yield (52.37%) was lower for animals feed R3 ration regardless of sex. On the other hand, no significant difference ($P > 0.05$) was observed in the relative weights of some parts, organs and those of the abdominal fat of the rabbits. Similarly, no significant difference (P > 0.05) was observed for haematological and biochemical parameters studied. Cocoa pod husks treated at 12.5% with bean haulm ash extracts can be incorporated up to 20% - 25% to improve growth performance of rabbits without any negative effect on their health.

Keywords

Carcass, Cocoa Pod Husks, Growth Performance, Bean Haulms Extracts, Haemato-Biochemical Parameters, Rabbit

1. Introduction

Rabbit farming can easily be practiced in all areas, whether rural or peri-urban [1]. It does not require much capital compared to other domestic animal farms. Rabbits have high fertility, short gestation period (28 - 32 days) and a great ability to use a variety of forages [2]. They are good converters from feed to meat and use up to 30% crude fiber compared to 3% - 10% for poultry species [3]. Despite all these advantages, rabbit farming is still underdeveloped in Cameroon because it faces many constraints, including feed. In fact, in intensive breeding, the feed cost represents 70% of production cost [4]. Therefore, any reduction in the cost of feed will significantly reduce production costs [5]. It will therefore be necessary to explore local feed resources which have the capacity to produce as much as conventional feeds and at a lower cost. Several local feed resources have caught the attention of nutritionists, including cocoa pod husks (*Theobroma cacao*). They represent 52% to 56% of ripe cocoa pod and with cocoa production in Cameroon between 2018-2019 amounting to 245,000 tonnes, we have an in-shell availability of nearly 140,000 tonnes [6]. However, after harvest, they are generally left in the fields; however, the latter are very rich in nutrients. (Crude protein 6.8% - 10% Ms; lipid 1.5% - 2% Ms; carbohydrate 32% - 46.6% Ms; crude fiber 24% - 35.4% Ms; minerals 6.4% - 8.4% Ms [7]). Several studies have shown that they can be effectively used in the feed of broilers [8], pigs and fish [9], rabbit, [10]. However, the high rigidity of their walls, as well as the presence of anti-nutritional factors (theobromine, tannins) still limit their use in animal feed. [10] showed that for incorporation levels greater than 20% they observed a decrease in total body weight and weight gain. They attributed this decline to poor nutrient digestibility and the presence of anti-nutritional factors. They also observed a drop in red blood cell count in rations containing the cockles and also attributed this drop to the presence of tannins which have the ability to form complexes with iron atoms; these are building blocks of hemoglobin. According to [11], it is possible to weaken the plant walls through treatment with ash extracts, his work revealed that the cell walls content (NDF) of rice straw treated with banana ash extracts was low compared to untreated straw. This was due to the fact that the constituents of the cell wall of the straw were attacked during the treatment; which led to the weakening of the wall through the breaking of the ester bonds between lignin-hemicellulose-cellulose; therefore, allowing better results in digestibility. Likewise, ash extracts as alkaline solutions can also allow significant elimination of anti-nutritional factors (tannins, theobromine) present in these hulls as shown by [12]. In view therefore of the chemical composition of cocoa pod husks and the low availability of sources of cellulose that can be used by rabbit farmers in large-scale farms, their incorporation into the ration as a source of cellulose after treatment with ash extracts could be great. Therefore, the objective of this work was to determine the best level of incorporation of treated cocoa pod husks in the ration of young rabbits in the growing phase.

2. Materials and Methods

2.1. Area of Study

This study was conducted at the Animal Nutrition and Production Research Unit (URPRONAN) of the University of Dschang. It is located at an altitude of 1420 m above sea level, between latitude 05˚26'N and longitude 10˚26'E. The climate of the region is equatorial of Cameroonian type with the rainy season that last from mid-March to mid-November and the dry season from mid-November to mid-March [13]. Rainfall varies between 1500 and 2000 mm per year and temperatures range from 14˚C (July-August) to 25˚C (February) with an average temperature of about 21˚C. The average annual insolation is 1873 hours and the average relative humidity is 76.8%.

2.2. Preparation of Ash Extracts and Treatment of Cocoa Pod Husk

The ash extracts were obtained according to the reference [14]. Bean haulms were harvested and burn to ashes. The ashes obtained were sieved and dissolved in water at concentrations of 12.5 kg/100 liter of water. The mixtures were homogenized and left to stand for 48 hours. The resulting solutions were filtered to obtain ash extracts.

1 kg of previously chopped cocoa pod husk (CPH) collected from Penja (Mongo division) was soaked in 5 liters of extract solutions for 12 hours. The husks were then sun-dried to constant weight, crushed and stored in large air-tied plastic bags from which samples were collected for bromatological analyzes.

2.3. Experimental Diet and Management

We used 80 local breed animals (40 males and 40 females) in this trial. The animals were housed in wired cages made of metal measuring 97 × 46 × 26 cm placed in a well ventilated room. They were randomly distributed into 5 experimental rations in a complete randomized designed with 8 rabbits per treatment and each rabbit served as experimental unit. From the control ration R (0−) without cocoa pod husks and R (0+) ration with untreated hulls, 3 other rations of which three (R1, R2, R3) were formulated with husks treated with ash from bean haulms at concentrations of 12.5 kg/100 liters of water (**Table 1**). Feed and water were served ad libitum throughout the test period. At the start and end of the study, the building, cages, feeders and drinkers were thoroughly washed and disinfected. The animals were given anti-coccidian (amproline), anti-stress before and after each manipulation.

3. Data Collection

3.1. Growth Parameter

The feed and animals were weighed at the start of the test and then every 7 days until the end of the trial. Weekly feed consumption was calculated as the difference between the amount of feed distributed during the week and the refusals collected at the end of the same week.

$$QC = Qs - RQ$$

Table 1. Percentage composition of rations.

	Rations				
Ingredients (%)	R0−	R0+	R1	R2	R3
Red corn	28	28	29	29	29
Wheat Bran	16	05	03	03	03
Rice bran	16	15	14	08	03
Cocoa pod husk	00	20	20	25	30
Trypsacum L	12	00	00	00	00
Cotton cake	06	9.5	9.5	9.5	9.5
Soybean meal	6.5	08	09	9.5	09
Palm kernel cake	12	11	11	11	11
Fishmeal	0.5	0.5	0.5	0.5	0.5
Shell	0.5	0.5	0.5	0.5	0.5
Palm oil	02	02	03	3.5	04
Premix 0.5%	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100
	Calculated chemical composition				
Crude protein (%)	16.27	16.32	16.08	16.00	16.07
*Metabolized energy (Kcal/Kg)	2446.02	2401.58	2405.74	2409.31	2406.34
Crude fiber (%)	13.34	13.56	13.51	13.86	13.72
Price (FCFA/kg)	222.00	211.75	211.25	197.50	183.25

*Composition of the premix: Vit A: 3,000,000 IU, Vit D: 500,000 IU, Vit E: 6000 mg, Vit K: 600 mg, Vit B1: 600 mg, Vit B2: 800 mg, Vit 3: 1800 mg, Vit B6: 400 mg, Vit12: 6 mg, Folicacid: 250 mg, Nacine: 600 mg, Cl: 86,500 mg, Fe: 12,000 mg, Cu: 1200 mg, Mn: 12,000 mg, Zn: 10,000 mg, I: 100 mg, Se: 40 mg, Mg: 3397 mg, Na: 283 mg, Ca: 215.166 mg, Methoine: 130,000 mg, Lysine: 50,000 mg. ME: metabolizable energy.

with:

QC = quantity consumed (g),

Qs = quantity served (g),

Qr = feed refusal (g).

The weekly weight gain will be obtained by making the difference between two consecutive weekly weights.

$$BWG = Wn - (Wn - 1)$$

with:

BWG = Body Weight Gain (g),

Wn = weight at the week considered (g),

$Wn - 1$ = weight in the previous week (g).

Feed conversion ratio (FCR) reflects the amount of feed consumed to produce 1 kg of live weight. It was be calculated as follows:

$$FCR = \frac{\text{Total } FI(g)}{\text{Total } WG(g)}$$

with:

FI = Feed Intake

WG = Weight gain

At the end of the trial, 14 animals (7 males and 7 females) per treatment were randomly selected, fasted for 12 hours, weight and sacrificed for evaluation of carcass characteristics. The animals were completely bled, and eviscerated as recommended by [15]. The carcass yields, relative weight carcass, parts (heads, legs, skin) and organs in relation to the live weight were evaluated respectively according to the following formulas:

$$\text{Carcass Yield}(Y\%) = \frac{\text{Weight of carcass}(\text{g})}{\text{Live weight}(\text{g})} \times 100$$

$$\text{Relative Percentage weight of organs}(\%) = \frac{\text{Weight of organs}(g)}{\text{Live weight of animal}(g)} \times 100$$

3.2. Hematological and Biochemical Parameters

The blood of animals sacrificed for the analysis of carcass was collected using test tubes containing anticoagulant (EDTA) for the assay of the hematological parameters and test tubes, without anticoagulant for the assay of the parameters serological.

4. Statistical Analysis

Data collected on growth and haemato-biochemical parameters were subjected to 2 way-analysis of variance (level of incorporation and sex) following the general linear model of statistical package for social science (SPSS.21.0) software. where significant differences existed between treatments, the mean where separated by the Waller Duncan's test at 5% significance level.

5. Results

5.1. Effects of Graded Levels of Treated Cocoa Pod Husks on Growth Performance of Rabbits

Effects of graded levels of treated cocoa pod husks (CPH) on the growth performance of the rabbits are shown in Table 2. It appears that the initial weight, feed intake, feed conversion ratio were not significantly affected ($p > 0.05$) by the different treatments. However, significant differences ($p < 0.05$) were observed in terms of total weight gain, average daily gain, final weight with higher values for animals subjected to R1 treatment regardless of sex.

Table 2. Effects of graded level of treated cocoa pod husks on growth performance of the rabbit.

		Treatment					
Parameters	Sex	R0−	R0+	R1	R2	R3	P
IW (g)	♂	844.79 ± 67.00^{aA}	837.56 ± 54.00^{aA}	792.22 ± 46.00^{aA}	827.18 ± 58.00^{aA}	819.79 ± 44.00^{aA}	0.79
	♀	827.47 ± 29.13^{aA}	804.43 ± 51.19^{aA}	849.42 ± 32.78^{aA}	816.77 ± 45.86^{aA}	832.36 ± 44.09^{aA}	0.73
	♂♀	836.13 ± 48.06^{a}	820.99 ± 52.59^{a}	820.82 ± 39.39^{a}	821.98 ± 51.93^{a}	826.08 ± 44.04^{a}	0.99
	P	0.36	0.94	0.66	0.75	0.99	
FLW (g)	♂	2521.30 ± 64.21^{bA}	2576.23 ± 49.11^{bA}	2736.47 ± 43.86^{aA}	2578.18 ± 54.34^{bA}	2499.00 ± 42.57^{bA}	0.00
	♀	2575.64 ± 36.43^{bcA}	2591.41 ± 46.18^{bcA}	2862.15 ± 36.18^{aA}	2692.54 ± 100.24^{bA}	2552.56 ± 51.40^{cA}	0.00
	♂♀	2548.47 ± 50.32^{b}	2583.82 ± 47.64^{b}	2794.60 ± 40.02^{a}	2611.80 ± 77.29^{b}	2525.78 ± 46.98^{b}	0.00
	P	0.45	0.91	0.53	0.67	0.66	
TWG (g)	♂	1676.50 ± 6.00^{cA}	1738.67 ± 12.00^{bA}	1944.24 ± 9.16^{aA}	1751.00 ± 10.53^{bA}	1679.20 ± 3.00^{cA}	0.00
	♀	1748.17 ± 12.06^{cA}	1786.97 ± 12.34^{bcA}	1996.36 ± 12.91^{aA}	1875.78 ± 94.94^{bA}	1720.19 ± 13.69^{cA}	0.00
	♂♀	1712.33 ± 9.03^{d}	1762.82 ± 12.17^{c}	1973.77 ± 11.03^{a}	1789.82 ± 52.73^{b}	1699.70 ± 8.34^{d}	0.00
	P	0.40	0.96	0.45	0.69	0.15	
ADG (g)	♂	19.95 ± 0.07^{cA}	20.69 ± 0.14^{bA}	23.14 ± 0.10^{aA}	20.84 ± 0.12^{bA}	19.99 ± 0.03^{cA}	0.00
	♀	20.81 ± 0.14^{cA}	21.27 ± 0.14^{bcA}	23.76 ± 0,.	22.33 ± 1.13^{bA}	20.47 ± 0.16^{cA}	0.00
	♂♀	20.38 ± 0.10^{d}	20.98 ± 0.14^{c}	23.49 ± 0.12^{a}	21.30 ± 0.12^{b}	20.23 ± 0.09^{d}	0.00
	P	0.40	0.96	0.45	0.69	0.15	
ADC (g)	♂	109.93 ± 4.93^{aA}	114.71 ± 7.00^{aB}	113.33 ± 7.00^{aA}	110.70 ± 10.69^{aA}	113.26 ± 4.93^{aA}	0.91
	♀	111.27 ± 8.60^{aA}	116.27 ± 1.07^{aA}	116.80 ± 5.60^{aA}	111.01 ± 7.04^{aA}	113.68 ± 6.70^{aA}	0.73
	♂♀	110.60 ± 6.76^{a}	115.49 ± 4.03^{a}	113.69 ± 6.30^{a}	111.27 ± 8.86^{a}	113.47 ± 5.81^{a}	0.88
	P	0.23	0.03	0.71	0.53	0.456	
FCR (g)	♂	5.50 ± 0.26^{aA}	5.54 ± 0.37^{aA}	4.89 ± 0.32^{aA}	5.31 ± 0.54^{aA}	5.66 ± 0.25^{aA}	0.17
	♀	5.34 ± 0.37^{aA}	5.46 ± 0.01^{aB}	4.9154 ± 0.26^{aA}	4.98 ± 0.44^{aA}	5.55 ± 0.28^{aA}	0.15
	♂♀	5.42 ± 0.31^{a}	5.50 ± 0.19^{a}	4.84 ± 0.29^{a}	5.22 ± 0.49^{a}	5.60 ± 0.26^{a}	0.08
	P	0.39	0.02	0.76	0.42	0.784	

a, b, c, d, e: means on the same row with the same superscripts do not differ significantly ($P > 0.05$). A, B: the means with the same superscripts in the same column for the same component are not significantly different ($p > 0.05$). R0− = Ration without cocoa hulls, R0+ = Ration with 20% untreated cocoa pod husks, R1 = Ration with 20% treated cocoa husks, R2 = Ration with 25% treated cocoa husks, R3 = Ration with 30% processed cocoa husks. IW = Initial weight, FLW = Final live weight, TWG = Total weight gain, ADG = Average daily gain, ADC = Average daily consumption, FCR = Feed conversion ratio.

- **Effects of the level of incorporation of treated cocoa pod husks on carcass yield of rabbits**

Table 3 shows the effects of the level of incorporation of treated CPH on carcass yield of rabbits. Analysis of variance shows that body weight, dressed weight and carcass yield were significantly lower ($p < 0.05$) with rabbit fed R3 treatment as compared to the rest of the ration regardless of sex.

- **Effects of the level of incorporation of treated cocoa pod husks on the relative weight of some parts, organs and abdominal fat in rabbits**

Table 4 shows the effects of the level of incorporation of treated CPH on the relative weights of parts, organs and abdominal fat in rabbits. Analysis of variance revealed no significant effect ($P > 0.05$) on these parameters regardless of sex.

5.2. Effects of the Level of Incorporation of Treated Cocoa Pod Husks on Hematological Parameters of Rabbits

Table 5 shows the effects of the level of incorporation of treated CPH on hematological parameters of rabbit. Analysis of variance revealed that CPH incorporation had no significant effect ($P > 0.05$) on blood hematological parameters.

5.3. Effects of the Level of Incorporation of Processed Cocoa Pod Husks Leaves on Biochemical Parameters of Rabbit

Table 6 shows the effects of the level of incorporation of treated CPH on blood

Table 3. Effects of the level of incorporation of treated cocoa pod husks on carcass yield of rabbits.

		Treatment					
Carcass characteristics	Sex	R0−	R0+	R1	R2	R3	p
Slaughter weight (g)	♂	2417.10 ± 76.60^{bA}	2469.97 ± 51.35^{bA}	2633.68 ± 45.56^{aA}	2475.38 ± 51.42^{bA}	2407.57 ± 47.64^{bA}	0.00
	♀	2477.77 ± 38.95^{bcA}	2482.46 ± 51.25^{bcA}	2742.31 ± 32.22^{aA}	2549.66 ± 39.79^{bA}	2444.21 ± 57.45^{cA}	0.00
	♂♀	2447.43 ± 57.77^{b}	2476.22 ± 51.30^{b}	2687.99 ± 38.89^{a}	2512.52 ± 45.60^{b}	2425.89 ± 52.54^{b}	0.00
	P	0.27	0.84	0.69	0.67	0.62	
Dressed weight (g)	♂	1358.58 ± 83.17^{aA}	1338.47 ± 42.60^{aA}	1400.02 ± 39.02^{aA}	1360.05 ± 36.15^{aA}	1229.90 ± 27.12^{bA}	0.01
	♀	1345.50 ± 38.98^{bcA}	1349.93 ± 51.20^{bcA}	1503.26 ± 69.04^{aA}	1417.08 ± 39.85^{bA}	1311.78 ± 57.63^{cA}	0.00
	♂♀	1352.04 ± 61.07^{b}	1344.20 ± 46.90^{bc}	1451.64 ± 54.03^{a}	1388.56 ± 38^{ab}	1270.84 ± 42.37^{c}	0.00
	P	0.18	0.59	0.31	0.81	0.18	
Carcass yield (%)	♂	56.17 ± 1.70^{aA}	54.18 ± 0.59^{abA}	53.16 ± 1.72^{bA}	54.93 ± 0.31^{abA}	51.10 ± 1.73^{cA}	0.01
	♀	54.29 ± 0.72^{aA}	54.36 ± 0.92^{aA}	54.83 ± 2.89^{aA}	55.57 ± 0.69^{aA}	53.65 ± 1.10^{aA}	0.63
	♂♀	55.23 ± 1.21^{a}	54.27 ± 0.75^{a}	54.00 ± 2.30^{ab}	55.25 ± 0.50^{a}	52.37 ± 1.41^{b}	0.01
	P	0.12	0.32	0.47	0.21	0.36	

a, b, c, d: means on the same row with the same superscripts do not differ significantly ($P > 0.05$). A, B: the means with the same superscripts in the same column for the same component are not significantly different ($p > 0.05$). R0− = Ration without cocoa hulls, R0+ = Ration with 20% untreated cocoa pod husks, R1 = Ration with 20% treated cocoa husks, R2 = Ration with 25% treated cocoa husks, R3 = Ration with 30% processed cocoa husks.

Table 4. Effects of the level of incorporation of treated cocoa pod husks on the relative weights of some parts, organs and abdominal fat of rabbit.

		Treatment					
Relative weight of some organs (%)	**Sex**	**T0−**	**T0+**	**T1**	**T2**	**T3**	**P**
lungs	♂	0.39 ± 0.05^{aA}	0.45 ± 0.11^{aA}	0.37 ± 0.05^{aA}	0.32 ± 0.03^{aA}	0.48 ± 0.17^{aA}	0.37
	♀	0.49 ± 0.16^{aA}	0.44 ± 0.11^{aA}	0.53 ± 0.16^{aA}	0.58 ± 0.24^{aA}	0.57 ± 0.12^{aA}	0.83
	♂♀	0.44 ± 0.10^{a}	0.451 ± 0.05^{a}	0.45 ± 0.10^{a}	0.45 ± 0.13^{a}	0.52 ± 0.14^{a}	0.79
	P	0.09	0.92	0.29	0.05	0.50	
head	♂	7.26 ± 0.02^{aA}	7.18 ± 0.02^{aB}	7.20 ± 0.03^{aA}	7.20 ± 0.03^{aA}	7.20 ± 0.01^{aA}	0.98
	♀	7.27 ± 0.87^{aA}	7.85 ± 1.30^{aA}	7.59 ± 1.49^{aA}	8.09 ± 0.30^{aA}	8.85 ± 1.58^{aA}	0.58
	♂♀	7.26 ± 0.44^{a}	7.51 ± 0.66^{a}	7.40 ± 0.76^{a}	7.64 ± 0.16^{a}	8.03 ± 0.79^{a}	0.56
	P	0.50	0.02	0.05	0.05	0.06	
livers	♂	2.09 ± 0.10^{aA}	2.23 ± 0.27^{aA}	2.18 ± 0.24^{aA}	2.03 ± 0.19^{aA}	2.42 ± 0.10^{aA}	0.22
	♀	2.12 ± 0.58^{aA}	2.07 ± 0.68^{aA}	2.12 ± 0.29^{aA}	2.20 ± 0.56^{aA}	2.10 ± 0.33^{aA}	0.99
	♂♀	2.10 ± 0.34^{a}	2.15 ± 0.47^{a}	2.15 ± 0.26^{a}	2.12 ± 0.37^{a}	2.26 ± 0.21^{a}	0.93
	P	0.05	0.10	0.67	0.27	0.09	
kidneys	♂	0.49 ± 0.06^{aA}	0.57 ± 0.04^{aA}	0.52 ± 0.10^{aA}	0.51 ± 0.03^{aB}	0.69 ± 0.11^{aA}	0.07
	♀	0.56 ± 0.17^{aA}	0.60 ± 0.07^{aA}	0.48 ± 0.03^{aA}	0.65 ± 0.25^{aA}	0.57 ± 0.14^{aA}	0.76
	♂♀	0.53 ± 0.11^{a}	0.59 ± 0.05^{a}	0.50 ± 0.06^{a}	0.58 ± 0.14^{a}	0.63 ± 0.12^{a}	0.47
	P	0.09	0.34	0.24	0.04	0.65	
hearts	♂	0.19 ± 0.01^{aA}	0.21 ± 0.02^{aA}	0.20 ± 0.01^{aB}	0.21 ± 0.02^{aA}	0.20 ± 0.01^{aA}	0.55
	♀	0.24 ± 0.04^{aA}	0.24 ± 0.04^{aA}	0.21 ± 0.06^{aA}	0.24 ± 0.07^{aA}	0.24 ± 0.03^{aA}	0.96
	♂♀	0.22 ± 0.02^{a}	0.23 ± 0.03^{a}	0.21 ± 0.03^{a}	0.23 ± 0.04^{a}	0.22 ± 0.02^{a}	0.85
	P	0.13	0.43	0.04	0.09	0.08	
leg	♂	2.08 ± 0.12^{aA}	2.18 ± 0.10^{aA}	2.10 ± 0.30^{aA}	2.04 ± 0.47^{aA}	2.38 ± 0.31^{aA}	0.65
	♀	2.27 ± 0.40^{aA}	2.54 ± 0.68^{aA}	1.88 ± 0.19^{aA}	2.24 ± 0.30^{aA}	2.56 ± 0.45^{aA}	0.37
	♂♀	2.17 ± 0.26^{a}	2.36 ± 0.39^{a}	1.99 ± 0.24^{a}	2.14 ± 0.38^{a}	2.47 ± 0.38^{a}	0.19
	P	0.05	0.05	0.59	0.30	0.39	
skin	♂	7.09 ± 1.03^{aA}	9.80 ± 2.64^{aA}	8.39 ± 2.06^{aA}	8.65 ± 1.61^{aA}	9.12 ± 1.96^{aA}	0.74
	♀	8.47 ± 1.35^{aA}	7.60 ± 0.87^{aA}	9.13 ± 3.57^{aA}	10.35 ± 0.82^{aA}	9.39 ± 2.97^{aA}	0.64
	♂♀	7.78 ± 1.19^{a}	8.70 ± 1.75^{a}	8.76 ± 2.81^{a}	9.50 ± 1.21^{a}	9.26 ± 2.46^{a}	0.86
	P	0.62	0.21	0.24	0.17	0.49	
Abdominale fat	♂	0.85 ± 0.18^{aA}	1.04 ± 0.66^{aB}	1.16 ± 0.11^{aB}	0.77 ± 0.58^{aA}	1.15 ± 0.83^{aA}	0.88
	♀	2.06 ± 0.25^{aA}	2.13 ± 0.13^{aA}	2.74 ± 2.15^{aA}	2.20 ± 0.88^{aA}	2.41 ± 0.33^{aA}	0.93
	♂♀	1.46 ± 0.21^{a}	1.59 ± 0.39^{a}	1.95 ± 1.13^{a}	1.48 ± 0.73^{a}	1.78 ± 0.58^{a}	0.83
	P	0.60	0.03	0.01	0.35	0.28	
Testis	♂	0.12 ± 0.02^{a}	0.12 ± 0.02^{a}	0.11 ± 0.03^{a}	0.12 ± 0.03^{a}	0.12 ± 0.01^{a}	0.98

a, b, c: means on the same row with the same superscripts do not differ significantly (P > 0.05). A, B: the means with the same superscripts in the same column for the same component are not significantly different (p > 0.05). R0− = Ration without cocoa hulls, R0+ = Ration with 20% untreated cocoa pod husks, R1 = Ration with 20% treated cocoa husks, R2 = Ration with 25% treated cocoa husks, R3 = Ration with 30% processed cocoa husks.

Table 5. Effects of the level of incorporation of treated cocoa pod husks on hematological parameters of the rabbit.

		Treatment					
Hematological parameters	**Sexe**	**R0−**	**R0+**	**R1**	**R2**	**R3**	**P**
WBC (10^9/l)	♂	7.30 ± 0.69^{aA}	6.73 ± 1.61^{aA}	6.80 ± 1.67^{aA}	7.13 ± 1.50^{aA}	5.93 ± 2.07^{aA}	0.84
	♀	6.00 ± 0.65^{aA}	6.40 ± 0.52^{aA}	6.46 ± 1.35^{aA}	6.30 ± 0.51^{aA}	6.90 ± 1.01^{aA}	0.79
	♂♀	6.65 ± 0.67^{a}	6.56 ± 1.06^{a}	6.63 ± 1.51^{a}	6.71 ± 1.00^{a}	6.41 ± 1.54^{a}	0.99
	P	0.78	0.06	0.70	0.24	0.18	
Ly (10^9/l)	♂	2.66 ± 0.51^{aA}	3.13 ± 0.85^{aA}	4.86 ± 3.23^{aA}	3.30 ± 1.31^{aA}	2.96 ± 0.37^{aA}	0.53
	♀	3.06 ± 0.30^{aA}	3.36 ± 0.41^{aA}	3.36 ± 0.15^{aB}	3.00 ± 0.36^{aA}	3.33 ± 0.45^{aA}	0.57
	♂♀	2.86 ± 0.40^{a}	3.25 ± 0.63^{a}	4.11 ± 1.69^{a}	3.15 ± 0.83^{a}	3.15 ± 0.41^{a}	0.45
	P	0.36	0.18	0.02	0.15	0.89	
MO (10^9/l)	♂	0.43 ± 0.23^{aA}	0.56 ± 0.20^{aA}	0.53 ± 0.28^{a}	0.56 ± 0.05^{aA}	0.53 ± 0.32^{aA}	0.95
	♀	0.50 ± 0.10^{aA}	0.50 ± 0.10^{aA}	0.60 ± 0.10^{aA}	0.60 ± 0.10^{aA}	0.50 ± 0.10^{aA}	0.49
	♂♀	0.46 ± 0.16^{a}	0.53 ± 0.15^{a}	0.56 ± 0.19^{a}	0.58 ± 0.075^{a}	0.51 ± 0.21^{a}	0.79
	P	0.11	0.20	0.07	0.56	0.07	
GRA (10^9/l)	♂	2.86 ± 0.40^{aA}	3.03 ± 0.61^{aA}	3.43 ± 0.90^{aA}	3.26 ± 0.15^{aA}	3.23 ± 1.04^{aA}	0.87
	♀	2.90 ± 0.62^{aA}	2.80 ± 0.17^{aA}	2.70 ± 0.26^{aA}	2.70 ± 0.62^{aA}	2.86 ± 0.35^{aA}	0.96
	♂♀	2.88 ± 0.51^{a}	2.91 ± 0.39^{a}	3.06 ± 0.58^{a}	2.98 ± 0.38^{a}	3.05 ± 0.69^{a}	0.97
	P	0.38	0.13	0.16	0.07	0.11	
RBC × (10^{12}/l)	♂	5.98 ± 0.49^{aA}	5.62 ± 0.12^{aA}	5.60 ± 0.42^{aA}	6.11 ± 0.51^{aA}	5.76 ± 0.59^{aA}	0.60
	♀	6.19 ± 0.29^{aA}	6.08 ± 0.44^{aA}	6.20 ± 0.49^{aA}	6.28 ± 0.38^{aA}	6.57 ± 0.77^{aA}	0.79
	♂♀	6.08 ± 0.39^{a}	5.85 ± 0.28^{a}	5.90 ± 0.45^{a}	6.19 ± 0.44^{a}	6.16 ± 0.68^{a}	0.72
	P	0.31	0.05	0.62	0.46	0.52	
HB (g/dl)	♂	12.60 ± 0.85^{aA}	12.53 ± 0.30^{aA}	12.36 ± 1.18^{aA}	12.73 ± 0.50^{aA}	12.80 ± 0.70^{aA}	0.96
	♀	13.26 ± 0.37^{aA}	13.00 ± 0.69^{aA}	12.80 ± 0.60^{aA}	13.36 ± 0.30^{aA}	12.70 ± 0.88^{aA}	0.63
	♂♀	12.93 ± 0.61^{a}	12.76 ± 0.49^{a}	12.58 ± 0.89^{a}	13.05 ± 0.4^{a}	12.75 ± 0.79^{a}	0.76
	P	0.30	0.11	0.16	0.46	0.62	
HCT %	♂	36.10 ± 1.93^{aA}	35.30 ± 0.70^{aA}	34.70 ± 3.03^{aA}	36.03 ± 1.55^{aA}	35.83 ± 2.02^{aA}	0.89
	♀	37.46 ± 1.72^{aA}	36.43 ± 2.68^{aA}	35.63 ± 2.06^{aA}	37.43 ± 0.73^{aA}	36.03 ± 2.37^{aA}	0.73
	♂♀	36.78 ± 1.8^{a}	35.86 ± 1.69^{a}	35.16 ± 2.54^{a}	36.73 ± 1.14^{a}	35.93 ± 2.19^{a}	0.58
	P	0.87	0.06	0.35	0.41	0.78	
PLT (10^9 /l)	♂	219.67 ± 25.42^{aA}	209.67 ± 37.64^{aA}	217.00 ± 30.51^{aA}	223.00 ± 54.56^{aA}	258.67 ± 54.72^{aA}	0.66
	♀	209.33 ± 14.04^{aA}	208.33 ± 17.21^{aA}	186.00 ± 12.12^{aA}	215.33 ± 15.30^{aA}	202.00 ± 15.13^{aA}	0.22
	♂♀	214.50 ± 19.73^{a}	209.00 ± 27.42^{a}	201.50 ± 21.31^{a}	219.16 ± 34.93^{a}	230.33 ± 34.92^{a}	0.66
	P	0.33	0.12	0.10	0.05	0.06	
MCV (fl)	♂	60.43 ± 2.73^{aA}	62.83 ± 1.22^{aA}	61.90 ± 2.52^{aA}	59.10 ± 2.74^{aA}	62.46 ± 4.45^{aA}	0.52
	♀	60.53 ± 0.15^{aA}	59.83 ± 0.65^{abA}	57.46 ± 1.23^{bA}	59.06 ± 1.89^{abA}	56.96 ± 1.98^{cA}	0.04
	♂♀	60.48 ± 1.44^{a}	61.33 ± 0.93^{a}	59.68 ± 1.87^{a}	59.08 ± 2.31^{a}	59.71 ± 3.2^{a}	0.53
	P	0.06	0.30	0.15	0.53	0.18	

Continued

MCH (pg)	♂	21.06 ± 0.40^{aA}	22.33 ± 0.94^{aA}	22.06 ± 1.17^{aA}	20.90 ± 1.11^{aA}	22.33 ± 1.72^{aA}	0.40
	♀	21.43 ± 0.40^{aA}	21.36 ± 0.40^{aA}	20.63 ± 0.66^{aA}	21.36 ± 1.46^{aA}	19.43 ± 1.10^{aA}	0.09
	♂♀	21.25 ± 0.40^{a}	21.85 ± 0.67^{a}	21.35 ± 0.91^{a}	21.13 ± 1.28^{a}	20.88 ± 1.41^{a}	0.75
	P	1.00	0.15	0.25	0.65	0.37	
MCHC (%)	♂	34.90 ± 0.81^{aA}	35.63 ± 0.92^{aA}	35.53 ± 0.41^{aA}	35.36 ± 0.25^{aA}	35.70 ± 0.17^{aA}	0.52
	♀	35.43 ± 0.60^{aA}	35.70 ± 0.80^{aA}	35.93 ± 0.40^{aA}	35.70 ± 0.87^{aA}	35.33 ± 0.35^{aA}	0.79
	♂♀	35.16 ± 0.70^{a}	35.61 ± 0.86^{a}	35.78 ± 0.40^{a}	35.53 ± 0.56^{a}	35.51 ± 0.26^{a}	0.73
	P	0.55	0.61	0.88	0.06	0.37	

a, b, c: means on the same row with the same superscripts do not differ significantly ($P > 0.05$). A, B: the means with the same superscripts in the same column for the same component are not significantly different ($p > 0.05$). R0− = Ration without cocoa hulls, R0+ = Ration with 20% untreated cocoa pod husks, R1 = Ration with 20% treated cocoa husks, R2 = Ration with 25% treated cocoa husks, R3 = Ration with 30% processed cocoa husks. WBC: White blood cells; LY: Lymphocytes; MO; Monocytes; MCHC: mean corpuscular hemoglobin concentration, GRA: Granulocytes; RBC: Red blood cells; HB: Hemoglobin; HCT: Hematocrit; PLT: blood platelets; MCV: mean corpuscular volume; MCH: mean corpuscular hemoglobin.

Table 6. Effects of the level of incorporation of treated cocoa pod husks on biochemical parameters of rabbit.

		Traitement					
Biochemical parameters	**Sexe**	**R0−**	**R0+**	**R1**	**R2**	**R3**	**P**
Urea (mg/dl)	♂	33.65 ± 3.70^{aA}	48.04 ± 14.55^{aA}	53.61 ± 9.81^{aA}	50.64 ± 13.17^{aA}	35.79 ± 12.88^{aA}	0.19
	♀	49.07 ± 6.21^{aA}	63.31 ± 19.49^{aA}	51.54 ± 16.22^{aA}	51.18 ± 14.81^{aA}	47.58 ± 8.94^{aA}	0.67
	♂♀	41.36 ± 4.95^{a}	55.67 ± 17.02^{a}	52.57 ± 13.01^{a}	50.91 ± 13.99^{a}	41.69 ± 10.91^{a}	0.16
	P	0.48	0.55	0.32	0.87	0.58	
Creatinine (mg/dl)	♂	1.31 ± 0.14^{aA}	1.59 ± 0.13^{aA}	1.26 ± 0.23^{aA}	1.15 ± 0.19^{aA}	0.95 ± 0.62^{aA}	0.25
	♀	0.81 ± 0.29^{cA}	1.12 ± 0.61^{bB}	1.94 ± 0.53^{aA}	1.72 ± 0.28^{abA}	1.28 ± 0.15^{bA}	0.04
	♂♀	1.06 ± 0.21^{a}	1.35 ± 0.37^{a}	1.60 ± 0.38^{a}	1.43 ± 0.23^{a}	1.12 ± 0.38^{a}	0.16
	P	0.21	0.03	0.11	0.36	0.05	
ASAT (μ/l/L)	♂	92.33 ± 25.69^{aA}	60.66 ± 5.50^{aA}	76.00 ± 17.32^{aA}	87.66 ± 25.69^{aA}	66.00 ± 12.48^{aA}	0.26
	♀	101.00 ± 10.53^{aA}	83.33 ± 11.15^{aA}	66.33 ± 3.51^{aB}	62.66 ± 15.04^{aA}	70.33 ± 25.14^{aA}	0.05
	♂♀	96.66 ± 18.11^{a}	72.00 ± 8.32^{a}	71.16 ± 10.41^{a}	75.16 ± 20.36^{a}	68.16 ± 18.81^{a}	0.08
	P	0.10	0.18	0.03	0.22	0.18	
ALAT (μ/l/L)	♂	106.00 ± 10.29^{aB}	73.30 ± 29.31^{aA}	84.33 ± 16.16^{aA}	83.66 ± 10.96^{aA}	75.33 ± 10.50^{aA}	0.85
	♀	110.33 ± 18.00^{aA}	65.66 ± 28.93^{aA}	90.00 ± 3.46^{aA}	72.66 ± 17.00^{aA}	72.33 ± 20.40^{aA}	0.09
	♂♀	108.16 ± 14.14^{a}	69.48 ± 29.12^{a}	87.16 ± 9.81^{a}	78.16 ± 13.98^{a}	73.83 ± 15.45^{a}	0.31
	P	0.04	0.91	0.12	0.60	0.28	
TC (mmol/L)	♂	1.00 ± 0.22^{aA}	0.920 ± 0.08^{aA}	0.91 ± 0.07^{aA}	0.99 ± 0.10^{aA}	0.88 ± 0.03^{aA}	0.68
	♀	0.92 ± 0.04^{aB}	0.91 ± 0.04^{aA}	1.01 ± 0.18^{aA}	0.87 ± 0.09^{aA}	1.00 ± 0.12^{aA}	0.52
	♂♀	0.96 ± 0.13^{a}	0.91 ± 0.06^{a}	0.96 ± 0.12^{a}	0.93 ± 0.09^{a}	0.94 ± 0.07^{a}	0.90
	P	0.04	0.28	0.08	0.89	0.08	

Continued

HDL (mmol/L)	♂	0.32 ± 0.09^{aA}	0.37 ± 0.02^{aA}	0.43 ± 0.12^{aB}	0.53 ± 0.21^{aA}	0.48 ± 0.07^{aA}	0.29
	♀	0.47 ± 0.06^{aA}	0.45 ± 0.02^{aA}	0.45 ± 0.02^{aA}	0.43 ± 0.14^{aA}	0.53 ± 0.24^{aA}	0.89
	♂♀	0.39 ± 0.07^{a}	0.41 ± 0.02^{a}	0.44 ± 0.07^{a}	0.48 ± 0.17^{a}	0.51 ± 0.15^{a}	0.36
	P	0.46	0.94	0.03	0.31	0.17	
LDL (mmol/L)	♂	0.52 ± 0.28^{aA}	0.36 ± 0.01^{aA}	0.35 ± 0.13^{aA}	0.28 ± 0.19^{aA}	0.29 ± 0.00^{aB}	0.44
	♀	0.23 ± 0.14^{aA}	0.30 ± 0.06^{aA}	0.42 ± 0.10^{aA}	0.28 ± 0.14^{aA}	0.31 ± 0.23^{aA}	0.63
	♂♀	0.38 ± 0.21^{a}	0.33 ± 0.03^{a}	0.39 ± 0.11^{a}	0.28 ± 0.16^{a}	0.30 ± 0.11^{a}	0.49
	P	0.25	0.05	0.73	0.54	0.01	
TRIG (mmol/l)	♂	0.89 ± 0.06^{aA}	1.01 ± 0.16^{aA}	0.89 ± 0.07^{aA}	1.05 ± 0.12^{aA}	0.92 ± 0.04^{aA}	0.30
	♀	1.04 ± 0.22^{aA}	0.96 ± 0.02^{aB}	1.02 ± 0.14^{aA}	1.04 ± 0.18^{aA}	0.95 ± 0.05^{aA}	0.89
	♂♀	0.96 ± 0.14^{a}	0.98 ± 0.09^{a}	0.96 ± 0.10^{a}	1.04 ± 0.15^{a}	0.94 ± 0.04^{a}	0.66
	P	0.12	0.03	0.22	0.39	0.59	
T PROT (g/dl)	♂	5.41 ± 1.61^{aA}	4.93 ± 0.67^{aA}	5.15 ± 0.45^{aA}	5.78 ± 1.64^{aA}	4.61 ± 0.50^{aA}	0.74
	♀	5.28 ± 0.89^{aA}	4.63 ± 0.40^{aA}	5.14 ± 1.81^{aB}	3.81 ± 0.05^{aB}	5.79 ± 1.45^{aA}	0.32
	♂♀	5.34 ± 1.25^{a}	4.78 ± 0.53^{a}	5.14 ± 1.13^{a}	4.79 ± 0.84^{a}	5.20 ± 0.97^{a}	0.89
	P	0.31	0.50	0.04	0.01	0.07	
ALB (g/dl)	♂	2.80 ± 0.04^{aA}	2.87 ± 0.27^{aA}	3.08 ± 1.11^{aA}	3.29 ± 0.16^{aA}	3.26 ± 0.70^{aA}	0.37
	♀	3.57 ± 1.09^{aA}	3.19 ± 0.13^{abA}	2.47 ± 1.60^{cA}	2.87 ± 0.45^{abA}	2.81 ± 1.42^{bB}	0.02
	♂♀	3.18 ± 0.56^{a}	3.03 ± 0.20^{a}	2.77 ± 1.35^{a}	3.08 ± 0.30^{a}	3.03 ± 1.06^{a}	0.44
	P	0.05	0.89	0.05	0.14	0.02	
GLB (g/dl)	♂	2.60 ± 1.57^{aA}	2.05 ± 0.44^{aA}	2.07 ± 0.44^{aA}	2.49 ± 1.77^{aA}	1.35 ± 0.89^{aA}	0.71
	♀	1.71 ± 0.21^{aA}	1.44 ± 0.28^{aA}	2.66 ± 0.42^{aA}	0.93 ± 0.50^{aB}	2.98 ± 0.06^{aA}	0.20
	♂♀	2.16 ± 0.89^{a}	1.75 ± 0.36^{a}	2.37 ± 0.43^{a}	1.71 ± 1.13^{a}	2.16 ± 0.95^{a}	0.88
	P	0.50	0.15	0.06	0.04	0.28	

a, b, c: means on the same row with the same superscripts do not differ significantly (P > 0.05). A, B: the means with the same superscripts in the same column for the same component are not significantly different (p > 0.05). R0− = Ration without cocoa hulls, R0+ = Ration with 20% untreated cocoa pod husks, R1 = Ration with 20% treated cocoa husks, R2 = Ration with 25% treated cocoa husks, R3 = Ration with 30% processed cocoa husks. TC: total cholesterol, ALB: albumin, GLB: globulin, T PROT: total protein, TRIG: triglyceride, ASAT: Aspartate Aminotransferase, ALAT: Alanine Aminotransferase, DL: high density lipoproteins, LDL: low density lipoproteins.

biochemical parameters of rabbit. It appears that the incorporation of treated CPH in rabbit ration had no significant effect (P > 0.05) on biochemical parameters.

6. Discussion

6.1. Effects of the Level of Incorporation of Treated Cocoa Pod Husks on Growth Performance of Rabbits

The results obtained in the present study showed that feed intake, was not affected (p > 0.05) by the treatments. These results are similar to those reported by

[16] who revealed that feed intake in New Zealand rabbit breed containing untreated cocoa pod husks at 0%, 20% and 25% was similar. The absence of significant difference observed for the feed conversion ratio between the different treatments correlate with the results obtained by [17] who obtained no significant difference (P > 0.05) in rabbits fed with rations containing treated cocoa pod husks (fermentation, hot water) or not and at different levels of incorporation (0%; 12.5%; 25% and 37.5%). However, we observed significantly higher weight gains ($p < 0.05$) with rabbits fed R1 rations compared with those of the control group (R0+) and with those of R2 and R3 treatments; These differences could be due to the treatment carried out on the cocoa pod husks and level of incorporation of 20% which makes cocoa pod husks more digestible, therefore leads to better weight gain. Moreover, the low final body weights observed in subjects fed R3 rations could be due to the higher level of cocoa pod husks incorporation in this ration compared to the others. The average daily weight gains values obtained in this study approximate the values (17.7; 20.8; 20.4) obtained by [16] for respective intake levels of 0%, 20% and 25% and (22.83; 23.03; 23.92) obtained by [18] studied the effects of CPH treated with corn cob extracts (188 g per 1l of extract) then fermented and supplemented with multi-enzymes (0.5%) as energy source on growth performance at respective incorporation levels of 0%, 12.5% and 15%. These values were however greater than (16.63; 10.95; 13.84 and 8.85) obtained by [17], (13.04; 8.26; 3.79; 7.91; 5,93) obtained by [19] who studied the effects of cocoa pod husks treated respectively by sun drying and fermentation on the growth performance of the rabbit (Chinchilla × New Zealand × Californian and cross bred respectively). They are also greater than (10.95; 12.97; 13.10; 16.70; 15.71) obtained by [20] who studied the effects of 5 sources of fiber (wheat bran, rice bran, palm kernel cake, corn, dried spent grain) on growth performance in New Zealand × Chinchilla rabbits. These differences could be due either to the animal breed used, the plant species, the type of treatment carried out on the cocoa pod husks or their level of incorporation in the ration. The best growth performance in this study was obtained at 25% incoorportation levels. These results agree with those obtained by [21] who reported that the incorporation of 25% of cocoa hulls in the feed did not significantly affect the growth performance of pigs compared to the control ration. On the other hand, they are far from those of [22] and [23] who reported that feeding poultry with more than 10% cocoa pod husk, respectively, could have a detrimental effect on their growth. These results could be due to the high fiber content of cocoa pod husk, which most likely reduce their digestibility and increase intestinal viscosity in these monogastric animals [24].

6.2. Effects of the Level of Incorporation of Treated Cocoa Pod Husks on Carcass Characteristics of Rabbits

Analysis of variance revealed significant ($p < 0.05$) effect on carcass characteristics of rabbits. Fasted bodyweight, body weight and carcass yield were significantly ($p < 0.05$) lower in animals given R3 treatment compared to the other groups of animals. These differences observed could be due to the final body weight which was lower in animals fed R3 rations compared to the other group of animals; The results of the carcass yield obtained in this study are close to those obtained (51.88; 53.63; 53.14) by [18]. However, the average carcass yield values obtained in the present study are lower than those of [25] who obtained a carcass yield of 67.60% to 68.40% in rabbits whose fur was removed by wire mesh and the head left intact. The difference observed between the carcass yield in this study was could be due to the fact that the weight of the skin and the head was have increased the carcass yield in the latter. These results are also lower than those (60.06; 60.34; 63.48; 63.89; 57.94) obtained by [20] and could be due either to the different sources of fiber used or to the animal species. Analysis of variance revealed no significant effect ($P > 0.05$) on the relative weight of parts, organs and abdominal fat in different groups of animals. This result is similar with those obtained by [18] and [20] who obtained no significant difference ($P > 0.05$) on the relative weight of organs in rabbits.

6.3. Effects of the Level of Incorporation of Treated Cocoa Pod Husks on the Hematological Parameters of Rabbits

Analysis of variance revealed that the incorporation of treated CPH into the ration had no significant effect ($p > 0.05$) on almost all of the hematological parameters studied. This result could be due to the treatment with haulm extract carried out on cocoa pod husks which could have reduce their theobromine and tannin concentration which are respectively toxic and anti-nutritional substances. These results are similar to those obtained by [26] who studied the effects of cocoa pods treated by fermentating in urea at a concentration of 0.1% for 14 days on hematological parameters and two breed of rabbit (Chinchilla and New Zealand) at different levels of incorporation (0%; 12.5% and 25%) and whose results generally showed that there was no significant difference ($P > 0.05$) on these parameters regardless of the species or the level of incorporation. On the other hand, these results are opposed to those obtained by [27] who obtained a significant drop in hemoglobin level (11.65; 11.69; 11.92; 11.22) with rabbits fed the rations containing 30% cocoa pod husks treated with corn cob extract compared to the other rations. This observed difference could be due to the different sources of ash extracts used for the treatment of cocoa pod husks in each of the studies or to the animal species.

6.4. Effects of the Level of Incorporation of Treated Cocoa Pod Husks on the Biochemical Parameters of Rabbits

Analysis of variance revealed that the incorporation of treated cocoa pod husks into the ration had no significant effect ($p > 0.05$) on biochemical parameters. This result could be explained by the relatively low concentration of ash extract used for the treatment of cocoa pod husks; In fact, ash extracts are rich in calcium oxide (CaO) and potassium hydroxide (KOH); which implies that in high concentrations they can be sources of toxicity for animals. The results of this study are in agreement with those of [26] who showed that, there was no significant difference (P > 0.05) on the blood biochemical parameters of rabbits, fed with treated cocoa pod husks regardless of the species or the level of incorporation (0%; 12.5% and 25%). These results contradict those of [27] who obtained significant differences (p < 0.05) on biochemical parameters of rabbits. Total protein of rabbits fed with the control diet was significantly lower (P < 0.05) than those fed with the rest of the diets containing varying levels of cocoa pod husks; The cholesterol level of rabbits was significantly reduced (P < 0.05) with an increase in dietary cocoa pod husks and high density lipoproteins were significantly increased (P < 0.05) at 20% and 30% cocoa pod husks; while low density lipoprotein significantly decreased (P < 0.05) at 20% and 30% cocoa pod husks uptake. These differences observed between these studies and that of these authors could be due to the source of ash extract, the concentration, or the animal species.

7. Conclusion

At the end of this study on the effects of treatment of cocoa pod husks with aqueous ash extract of bean haulms on growth performance and haemato-biochemical parameters of rabbits it was conclude that, cocoa pod husks treated at 12.5% with bean haulm ash extracts can be incorporated in the rabbit diet up to 25% to improve growth performance without any negative effect on their health.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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