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Research Article

Effects of Supplementation of *Tetrapleura tetraptera* (African Porridge) Concentrate Diets on the Performance and Faecal Egg Counts of West African Dwarf Rams

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Abstract

Flavonoids and other metabolites in *Tetrapleura tetraptera* could be exploited as natural feed additive to non - nutritive chemical antibiotics to enhance growth performance and its efficacy as anthelminthic. The study was designed to determine the growth performance and faecal egg counts of West African Dwarf rams (WAD) fed diets containing varying levels of *Tetrapleura tetraptera* fruit meal. Thirty-five (35) WAD rams with an average weight of 13.20 ± 0.20 kg were used in a completely randomized designed for 140 days. Five concentrate diets containing varying levels of TTFM (0, 0.5, 1.0, 1.5 and 2.0%) were compounded while Panicum maximum was fed as basal diet. Performance characteristics determined were initial, final weight, weight gain and feed conversion ratio while faecal samples were collected at 0, 4, 8, 12, 16 and 20th weeks of the experiment. Data collected were subjected to analysis of variance (ANOVA). Results showed that the daily weight gain (DWG: 51.43 to 65.07g/day) increased linearly across the dietary treatments. Dietary TTFM had significant ($p < 0.05$) effects on the dry matter concentrate intake. The faecal egg count and cysts reduced significantly ($p < 0.05$) from 8th week of the experiment with the lowest count at 2.00% TTFM. It was therefore concluded that TTFM had potential as feed additive for enhanced daily weight gain, dry matter intake coupled with anthelminthic properties.

Keywords: *Tetrapleura tetraptera*; Diets; Faecal Egg Counts; Dwarf Rams

Introduction

The West African dwarf sheep and goats are early maturing, prolific and non-seasonal breeders [1]. However, nutrition and diseases have been identified as major factors responsible for these indigenous breeds [2]. The productivity of these breeds can be improved and hence the animal protein intake of average Nigeria increased. It becomes therefore necessary to supplement the seasonal fodder fluctation of natural pasture with concentrates.

Parasitism and gastrointestinal nematode parasitism in particular, is arguably the most serious constraint affecting small ruminant production world-wide. Economic losses are caused by decreased production, cost of prevention, cost of treatment, and the death of infected animals. It is difficult by any form of major survey or other estimation to establish precise figures on losses incurred in production from infection and disease. Even minimal accuracy of loss estimates is difficult because production diseases or disorders may result from interaction with nutritional and environmental stresses, management methods, concurrent diseases, genetic predispositions, or other factors [3]. A count of over 5000 oocytes/g of feces is considered significant. While counts below 5000/g do not ordinarily suggest a clinical infestation, they may indicate a potential source of severe infestation if environmental conditions become favorable for rapid spread [4].

Materials and Methods

The study was conducted at the small ruminant unit of the Federal College of Animal Health and Production Technology, Moor

Plantation, Ibadan. The unit is located in the southwestern part of Nigeria. The area lies within the rain forest ecological zone and fall within longitude and latitude 7^0-27^0N and 3^0-25^0E respectively and altitude of 220-300m above sea level with the average rainfall of about 1250mm. The temperature and relative humidity ranges from 30-35^{0}C and 76-84% respectively. Twenty-five (25) West African dwarf rams randomly allotted to five dietary treatments in a completely randomized design with 5 replicates chosen from each treatment between 6 and 8months of age and average weight 13.00 ± 0.02kg were used for the experiment. The fresh *T. tetraptera* fruits were purchased from a reputable market in Ibadan, Oyo State Nigeria. This was identified and authenticated at the Herbarium unit of the Forest Research Institute of Nigeria (FRIN) Ibadan, Oyo state, Nigeria. The authenticated fruits were rinsed in sterile water and air-dried for two (2) consecutive weeks at room temperature and later milled into powdery form before compounding with other feedstuffs as fruit meal at 0%, 0.5%, 1.0%, 1.5% and 2.0% inclusion levels for treatments 1, 2, 3, 4 and 5 respectively. Each animal was served with *P. maximum* grass *ad libitum* and concentrate diets at 3% body weight twice daily.

Inclusion levels of TTFM (%)					
	0	0.5	1.0	1.5	2.0
Ingredients					
Corn bran	30.00	30.00	30.00	30.00	30.00
Palm kernel cake	25.00	25.00	25.00	25.00	25.00
Rice bran	20.00	20.00	20.00	20.00	20.00
Wheat offal	15.00	15.00	15.00	15.00	15.00
Groundnut cake	5.00	5.00	5.00	5.00	5.00
TTFM	-	+	++	+++	++++
Dicalcium phosphate	3.00	3.00	3.00	3.00	3.00
*Premix	1.00	1.00	1.00	1.00	1.00
Salt	1.00	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00	100.00

Table 1: Gross compositions of concentrate diets containing varying levels of *Tetrapleura tetraptera* fruit meal for WAD rams.

TTFM: *T. Tetraptera* Fruit Meal

+ (0.5kg TTFM), ++ (1.00kg TTFM), +++ (1.50kg TTFM), ++++ (2.00kg)

*contains Vitamin A (I.U.) 10,000.000; Vitamin D_2 (I.U.) 2,000,000; Vitamin E (I.U) 20,000; Vitamin K (mg) 2,250; Riboflavin (mg) 5000; Pyridoxine (mg) 275; Biotin (mg) 50; Pantothenic acid (mg) 7500; Vitamin B_1 (mg) 175; Vitamin B_{12} (mg) 15.0; Niacin (mg) 27,500; Folic acid (mg) 7500. Choline Chloride (mg) 400; Antioxidant (mg) 125; Fe (g) 20.0; Zn (g) 50.0; Mn (g) 80.0; Cu (g) 5.0g; I (g) 12.0; Co (mg) 200; Se (mg) 200.

Performance parameters

The experimental rams were weighed before the commencement of the experiment and once in a week for 20 weeks. Each animal was fed with wilted *P. maximum* grass *ad libitum* (500g in the morning and 200g at afternoon) and concentrate diets at 3% body weight twice daily (2% in the morning and 1% at afternoon). Left over grasses and concentrate diets were weighed every morning to determine the total feed consumed.

Parameters studied included Average daily weight gain, average daily feed intake, feed conversion ratio.

Parasite egg count

The faecal samples collection was done 7 days before the commencement of the experiment according to a modified Wisconsin salt floatation techniques as described by [5]. About 3g of faecal samples will be ground and mixed with 42ml floatation fluid (a saturated solution). After filtering a sub sample will be transferred to both compartments of McMaster counting chamber and allowed to stand for 5 minutes. The eggs rose to the top, so that all in focus against upper slide. The number of eggs within each ruled area multiplied by 50, representing the number of eggs per gram in the original sample.

Statistical analysis

Data obtained were subjected to analysis of variance using [6] in a Completely Randomized Design. One-way analysis of variance (ANOVA) was used to determine the means and standard error. Treatment means were compared using Duncan's new multiple range test in the package.

Growth performance of West African Dwarf rams fed diets containing varying levels of *Tetrapleura tetraptera* fruit meal

The performance characteristics of West African Dwarf (WAD) rams as influenced by different inclusion levels of *T. tetrapleura* fruit meal (TTFM) are presented in table 3. There were no significant difference ($p > 0.05$) in the initial and final weight measured. The initial weight obtained was similar which ranged from 13.23 to 13.58kg. Although, there were no significant difference ($p > 0.05$) observed but rams fed with 2% inclusion level of TTFM had higher final weight values (22.50kg) compared with other treatments. Inclusion of TTFM to the diets of West African dwarf rams had positive influence ($p < 0.05$) on the daily weight gain, daily grass intake and daily concentrate intake but no significant difference observed ($p > 0.05$) in the total feed intake parameter. The highest daily

Parameters	Inclusion levels of TTFM (%)				
	0	0.5	1.0	1.5	2.0
Dry matter	81.50	81.40	81.10	80.90	81.55
Crude protein	15.20	15.28	15.34	15.38	15.43
Ether extract	8.40	8.70	8.95	8.96	9.02
Ash	11.00	10.95	10.75	11.02	10.93
Crude fibre	15.89	15.91	16.05	16.10	16.23
Nitrogen free extract	49.51	49.16	48.71	48.54	48.39
Neutral detergent fibre	48.64	52.62	54.69	58.19	60.38
Acid detergent fibre	34.64	36.84	38.93	43.64	47.19
Acid detergent lignin	9.87	11.64	14.62	16.32	17.11
Hemicelluloses	14.00	15.78	15.76	14.55	13.19
Cellulose	24.77	25.20	24.31	27.32	30.08
Tannin	0.32	0.38	0.45	0.56	0.74
Saponin	0.71	0.73	0.78	0.84	0.95
Flavonoid	2.32	2.44	2.67	2.82	3.54
Alkaloid	1.87	1.86	1.90	2.01	2.23
Hydrogen cyanide	0.12	0.15	0.22	0.25	0.26
Sterol	0.76	0.96	1.11	1.36	1.45
Macrominerals (%)					
Calcium	0.84	0.92	1.24	1.68	2.31
Phosphorus	1.12	1.32	1.65	1.97	2.22
Magnesium	2.47	2.54	2.95	3.54	4.01
Potassium	0.74	0.56	0.98	0.79	0.98
Sodium	0.24	0.28	0.28	0.31	0.34
Microminerals(mg/kg)					
Manganese	234.12	242.23	251.23	264.33	267.67
Iron	184.60	177.80	173.30	195.45	205.54
Copper	11.34	8.79	10.33	11.65	10.98
Zinc	55.32	44.76	45.65	51.21	48.87

Table 2: Chemical compositions of experimental diet containing varying levels of *Tetrapleura tetraptera* fruit meal.

weight gain (65.07g/day) was obtained at 2.0% TTFM inclusion level while the lowest daily weight gain value (51.43g/day) was observed at 0% TTFM. However, the daily grass intake observed in this experiment ranged from 323.38 to 370.47g/day and daily concentrate intake ranged from 247.05 to 301.17g/day which were significantly affected ($p < 0.05$) by inclusion levels of TTFM. Though no significant difference, the best feed conversion ratio (FCR) with 9.60 was observed with the rams fed diets containing 2% inclusion level of TTFM. The metabolic weight gain ranged from 4.39 to 5.24. The highest metabolic weight was recorded with (2% TTFM) with 5.24g/day.

Faecal egg counts of West African Dwarf rams fed diets containing *Tetrapleura tetraptera* fruit meal

Tables 4 and 5 show the faecal egg count (FEC) and faecal oocyst count of West African Dwarf rams fed diets containing varying levels of *T. tetraptera*. The faecal egg counts at the beginning of the experiment ranged from 4.10- 4.18%. The faecal egg worm counts increased progressively from week 4 till the end of the experiment. Significant difference ($p < 0.05$) was observed at 8th week of the experiment with highest value (5.34) recorded at the T1 with 0% inclusion level of TTFM. The least value (2.52) was recorded for faecal egg count at week 8. The lowest value (1.35) was obtained

Parameters	Inclusion levels of TTFM (%)						
	0	0.5	1.0	1.5	2.0	SEM	P-value
Initial weight (kg)	13.24	13.23	13.44	13.58	13.39	0.25	0.99
Final weight (kg)	20.44	20.95	21.27	21.89	22.50	0.49	0.74
Weight gain (kg)	7.20	7.72	7.82	8.31	9.11	0.31	0.58
Metabolic weight ($W^{0.75}$)	4.39	4.63	4.68	4.89	5.24	0.11	0.42
Daily weight gain ((g/day)	51.43^{c}	55.14^{bc}	55.93^{abc}	59.36^{ab}	65.07^{a}	0.08	0.03
Dry matter grass intake (g/day)	370.47^{a}	363.32^{a}	357.14^{a}	335.60^{b}	323.38^{b}	4.25	0.00
Dry matter concentrate intake (g/day)	247.05^{b}	254.22^{b}	261.43^{b}	273.33^{ab}	301.17^{a}	5.72	0.02
Total dry matter intake(g/day)	617.52	617.55	618.57	608.93	624.55	5.29	0.93
Feed conversion ratio	12.01	11.20	11.06	10.26	9.60	0.41	0.26

Table 3: Performance characteristics of rams fed diet containing *Tetrapleura tetraptera* fruit meal.

[a,b,c:] Means with different superscripts along the same row are significantly different ($p > 0.05$).

TTFM: *Tetraplura Tetraptera* Fruit Meal

Parameters	Inclusion levels of TTFM							
	Week	**0**	**0.5**	**1.0**	**1.5**	**2.0**	**SEM**	**P-value**
Faecal egg counts ($x10^2$egg/g)	0	4.10	4.24	4.29	4.45	4.11	0.24	0.96
	4	4.44	4.09	3.55	3.94	4.02	0.26	0.57
	8	5.34^{a}	3.34^{b}	2.73^{b}	2.66^{b}	2.52^{b}	0.28	0.00
	12	5.66^{a}	2.97^{b}	2.06^{b}	2.03^{b}	1.96^{b}	0.34	0.00
	16	6.22^{a}	3.19^{b}	1.93^{b}	1.74^{b}	1.78^{b}	0.40	0.01
	20	6.93^{a}	2.90^{b}	1.59^{bc}	1.65^{bc}	1.35^{c}	0.45	0.02

Table 4: Faecal egg counts (FEC)of West African dwarf Ramsfed diets containing *Tetrapleura tetraptera* Fruit Meal.

[a,b:] Means with different superscripts along the same row are significantly different ($p > 0.05$).

TTFM: *T. tetraptera* fruit meal; SEM: Standard Error of Means

Parameters	Inclusion levels of TTFM							
	Week	**0**	**0.5**	**1.0**	**1.5**	**2.0**	**SEM**	**P-value**
Faecal oocyst count ($x10^2$egg/g)	0	15.65	15.04	16.23	14.37	13.97	0.57	0.12
	4	16.62	14.92	15.51	13.31	12.86	0.63	0.34
	8	17.85^{a}	12.53^{b}	7.67^{bc}	6.26^{c}	6.57^{c}	1.15	0.05
	12	18.02^{a}	11.03^{b}	5.34^{c}	4.01^{c}	2.80^{c}	1.48	0.02
	16	18.38^{a}	6.22^{b}	2.66^{b}	1.45^{b}	0.80^{b}	1.77	0.00
	20	18.78^{a}	3.41^{b}	0.99^{b}	0.17^{b}	0.33^{b}	1.85	0.04

Table 5: The faecal oocyst count of West African dwarf Rams fed diets containing *Tetrapleura tetraptera* fruit meal.

[a,b:] Means with different superscripts along the same row are significantly different ($p > 0.05$)

TTFM: *Tetrapleura Tetraptera* Fruit Meal; SEM: Standard Error of Means

at week 20 of the experiment which was significantly influenced by inclusion levels of TTFM. The value of egg worm count increased from 4.10 to 6.93 for the beginning and the end of the experiment. The highest value of 5.40% was observed for animals fed with 0% TTFM. There was close range of 0.48-0.68 for faecal oocyst counts obtained at 1.5 and 2.0% TTFM which were significantly affected ($p < 0.05$) by inclusion levels of TTFM across the treatments. The levels of helminths were not significantly affected ($p > 0.050$ at the onset of the experiment till 12th week. Dietary inclusion of TTFM influenced the values of helminths obtained in this study. The highest value (18.78%) was recorded with 0% TTFM while the least value of 0.17 was observed with animals offered 1.5% TTFM which was significantly affected ($p < 0.05$) by inclusion levels of *T. tetraptera*.

Results and Discussion

The daily concentrate intake (g/day) for rams in this present study were in consistent with the findings of [7] who reported a range of 150- 350g/day when investigating the feed intake, digestibility of fat tailed hair sheep fed hay supplemented with two levels of concentrates. The increase in the daily concentrate intake might due to the positive effects of bioactive constituents of TTFM on the diets palatability. In contrast with negative effects of tannin as one of the major bioactive constituent of TTFM explained by [8] in reducing feed palatability, slowing down of digestion and development of conditioned aversions in reducing voluntary feed intake. The increase in the daily concentrate intake observed in this present study might be attributed to level of tannin in the concentrate diets which has not exceeded the threshold level of 5% reported by [9]. That may lead to rejection of browses, feeds by small ruminants and wild browsers [10]. Reported reduction in intake of dry matter and crude protein when sheep were fed with browse diets containing tannins [11]. Reported that stimulation of digestive secretions e.g., saliva, bile and mucus and enhanced enzyme activity are their core mode of nutritional action. The potential of TTFM due to its pungency to increase dry matter intake by changing the intake pattern has been demonstrated by [12]. Similar reports of plant extract pungency also demonstrated by [13,14]. That dry matter intake (DMI) was increased by a blend of cinnamaldehyde and eugenol in the diets of primiparous cows and growing ewes respectively.

The total daily dry matter intake values of experimental animals fed diets containing TTFM obtained in this study was in agreement with the range of 601.87 to 628.56g/day for total feed intake obtained by [15] on the evaluation of *Piliostigma reticulum* pod meal on sokoto bucks. It is also in line with the finding of [16] who reported a range of 610- 678g/day for Washera rams fed on natural pasture hay as basal diet. However, there was a shortfall as compared to the values obtained by [17] who reported average total dry matter intake of 528.21 and 534.68g/day for West African dwarf lambs fed diets containing varying levels of broiler litters respectively. All the observed values of feed intake were within the recommended daily feed intake of ruminants (3-4%DM body weight) according to [18]. This finding corroborates with earlier reports by researchers [19] who reported a range of 3.28 to 3.78% for rams fed mixtures of roughages and concentrates of the body weight and [20] reported a range of 3.25 to 3.67% for lambs fed diets containing *Foenicum vulgare*as additive. 21 concluded on the average daily matter intake of the two genetic groups (Malpura and cross-bred lambs) were 754 and 755g/day amounting to 3.5% of their body weight [22]. Reported that dry matter intake is an important factor in the utilization of feed by ruminants and is a critical determinant of energy utilization and performance in small ruminants [23,24]. Also indicated that feed intake is an important factor in the utilization of feed by livestock. The result obtained for total daily feed intake in this present study agreed with the report of [25] who observed that feed intake by small ruminants depend on the palatability and fibre content of the diets. Concentrate diets do not cause rumen fill because diets with less roughage like concentrate may increase the animal dry matter intake as explained by [26,27]. However, in the current study, rams fed diets containing 2% TTFM consumed more concentrate DM. Higher proportions of concentrates in the diets elevates DM intake in 2.0% TTFM as a result of the increased rate of passage in addition to providing higher energy intake [28]. Observed that increasing the amount of concentrates in the diets improved daily weight gain in rams. The differences in the daily weight gain observed in this study as a result in increasing in the inclusion levels of TTFM is an attribute of higher crude protein and metabolizable energy intake that allows more microbial population growth and therefore promoting digestion, making nutrients available to increase weight gain in rams. This finding was in agreement with [29] who reported higher daily weight for sheep supplemented with 350g/day concentrate than those supplemented with 1.5% body weight [30]. Also reported higher daily weight gain in goats supplemented with concentrates 1.5% BW compared with those consumed 1.0% body weight. The forage consumption in the control diet higher significantly compared with other treatments is in line with the finding of [31] who evaluated energy levels and forage types in lamb diets and observed that gastro intestinal tracts (GIT) was heavier in the animals which consumed diets with the higher forage level than in those which received higher energy levels [32]. Also studied four concentrates levels in lamb diets and observed heavier GIT in the animals fed diets containing 700g of forage per kilogram of DM.

Nutrition has been identified as one of the major factors responsible for poor performance of the indigeneous breeds [33]. Addition of TTFM increased weight gain per day significantly when compared to the control diets with lowest crude protein. This increase might also be attributed to the improved micro environment of the rumen through the increased volatile fatty acids due to TTFM addition [34]. Reported that one of the effective components of digested TTFM is acetate which is regarded as the main sources of ruminant nutrition which resulted in the optimum environment. These conditions may increase digestion coefficient as found in the Holstein calves [35] who fed calves with medicinal plants (Coriander) and found that digestion coefficient of neutral detergent fibre (NDF) and acid detergent fibre (ADF) were increased significantly. The increased in weight gain could due to the bioactive component saponins which is one of the main components of the TTFM [36]. Reported that the saponin conjugated to the cholesterol of protozoa membranes, so inhibit its activity in the rumen therefore increase the diet use efficiency in the animals [37,38]. Found out that addition of two levels of medicinal plants (0.0 and 7.5g of dried Nigel seed) of high saponin constituent to Karrady ewes ration increased the body weight of ewes compared to the control ewes. Similar trend was also found out by [39] who reported that bioactive compounds in plant extracts improved growth performance of ruminants. Higher body weight gain and daily weight gain of rams fed diets containing 2% inclusion level of TTFM in this study might due to greater dry matter intake and the effects of essential oil constituents in the TTFM. The increase in the daily weight gain in this present study was in line with the findings of [40] who found out significant higher body weight gain compared to negative control diet [41]. Reported moderate levels of tannins significantly reduced the degradability of rumen-soluble protein, increased methionine absorption and a large number of amino acids from small intestine and subsequently resulted in the optimal use of amino acids for growth. However, the extent to which tannins affect the dry matter and other nutrient intakes in sheep and other ruminants is variable [42]. Increased proportions of concentrate in the diet of lambs improve their weight gain rates [43-45]. Higher proportions of concentrate in the diet elevate DM intake because of the increased passage and subsequently improved daily weight gain [30]. The high-quality protein concentrates fed to rams in this study improved daily weight gain and this confirmed the finding of [46] who reported a rapid growth of ruminant fed high quality protein concentrates. This also in line with [14] who reported improved dry matter intake and growth performance for growing ewes as a result of addition of medicinal plant combinations cinnamaldehyde, eugenol and capsicum to their diets.

Feed conversion ratio (FCR) wasbetter in the diet containing 2.0% TTFM could be attributed to the greater daily weight gain. Improved FCR could be attributed to several factors such as type of diet, age, weight and breed could influence the feed utilization efficiency [47]. It has been shown from previous studies that adding 2% herbal flavours to the diets of fattening cattle improved the FCR. The result in this present study is in line with the findings of [48]. who found out that adding *Foeniculum vulgare* seed powder to the starter diet of dairy calves improved their FCR [10]. Suggested that chemicals present in the flavouring herbs can improve FCR by modulating the bacteria fermentation and decreasing methane production in the rumen. The FCR obtained in this study for the best inclusion level 2% of TTFM higher than the range of 6.02 to 6.27 obtained by [20] who fed growing rams with diets containing different levels of *Foeniculum vulgare* seed powder as feed additive. It was higher than the values (7.68 and 6.81) recommended for the growing rams with average daily gain (ADG) of 173g/day and 197g/day by [49] and [50] respectively. The feed conversion ratio found in the study was higher than the range between 3.48 and 7.35 reported by [51]. who fed West African Dwarf growing rams with *P. maximum* supplemented with differently processed pigeon pea leaves. The difference might be attributed to different levels of nutritional composition of diets and effectiveness of feed utilization.

The range of faecal egg counts (FEC) was described as light from 50-799, moderate from 800-1200 and massive above 1200 by [52]. The light ranges observed in this present study was in line with the range of of 50-600egg/g reported by [53] who supplemented concentrate diets with *Carica papaya* to the diets fed to village managed West African dwarf goats. The reduction in the faecal egg counts in animals fed concentrates containing *T. tetraptera* fruit meal could be attributed to the high levels of energy and crude protein in the diets fed to the animals. This is in line with earlier finding by [54] who reported that high energy, high protein results in reduction in gastro-intestinal parasite infection. In a related study in West African dwarf sheep, high energy and high crude protein reduced the level of gastro-intestinal nematodes [55]. This could suggest that worms in environments with no nutritional restriction can develop to their full physiological and reproductive potential; on the other hand, low protein diets may provide restricted nutrition for worms too. As a consequence, they might not be able to fulfil their requirements for physiological and reproductive functions and hence express their full pathogenic potential [56]. It has also been reported by [57] that animals receiving supplementary feeding may achieve an improved resilience and resistant

against worm infections. Reduction in faecal egg counts observed in TTFM concentrates supplements could be attributed to the presence of some secondary metabolites most especially tannins in the fruits of *T. tetraptera.* Higher concentrations of tannin in plant species have been found to help to control certain internal parasites of animals [58,59]. Also discovered a reduction in faecal egg counts (nematode population) in a comparative study on albendazole substituted with *Carica papaya* seeds in the control of gastro-intestinal nematodes. Similar finding was discovered by [60] with reduction in faecal egg count of West African Dwarf goats after administering *C. papaya* seed in-feed and in-water in controlling helmintic [61]. Found out that inclusion of TTFM extract up to 0.4% maximum reduced the faecal microbial load and faecal helminths in male dutch rabbits [62].

Conclusion

The reduction in faecal egg count in TTFM concentrate supplements showed a remarkable relationship in weight gain with reduction in FEC support earlier findings of the relationship between weight gain and FEC.

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