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Full Length Research Paper

Growth performance and haematological characteristics of West African Dwarf (WAD) sheep fed graded levels of dietary pigeon pea seed meal

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This study was conducted to evaluate the effects of dietary pigeon pea seed meal on the growth performance and haematological characteristics of West African Dwarf (WAD) sheep. Four diets were formulated to contain pigeon pea seed meal (PSM) at 0, 10, 20 and 30% levels, representing diets A, B, C, and D, respectively. Twelve weaned rams averaging 8.57 kg body weight and aged 7-8 months were used in the study. The rams were divided into 4 groups of 3 rams housed singly in pens, and each group assigned to one of the four diets for 8 weeks in a completely randomized design experiment. Data collected included, average daily weight gain (g), daily dry matter intake (g) and feed conversation ratio (g feed /g grain) calculated. Haematological and biochemical characteristics were also evaluated. Average daily weight gain was significantly (P<0.05) better in diet A and C than diet D, but diets A, B and C were similar (P>0.05). Feed conservation ratio differed significantly (P<0.05) among the groups, with diet C recording better conversion ratio than diets A and D, respectively. The PSM diets generally promoted lower PCV and higher WBC values in sheep. Neutrophil and lymphocytes were significantly (P<0.05) affected by the PSM. While neutrophil increased with increasing level of PSM, the converse was true about lymphocytesood glucose, and urea in the animals were also significantly (P<0.05) influenced by PSM, which followed the same pattern as the nuetrophil and lymphocytes respectively. Serum gamma-glutamyl transpeptidase (SGGTP) and serum gamma-glutamyl transferase (SGGT) were significantly (P<0.05) higher in sheep fed on control diet A than in those fed on either diet C or D. Serum creatinine was significantly (P<0.05) higher in sheep fed on control diet than in those on the PSM diets. The results of this study indicated that processed pigeon pea seed could be used as a plant protein resource for sheep, but may not be included beyond 20% for optimum performance and physiological welfare of the animal.

Key words: Pigeon pea, West African Dwarf, sheep, weaner rams diet.

INTRODUCTION

The increase in world population especially in developing countries like Nigeria calls for urgent improvement in livestock production. It is believed that deficiency of animal proteins is one serious problem that needs to be solved in Nigeria and other African countries. Small size, slow rate of growth, poor productive and reproductive performance of livestock in the region, account for the poor consumption of protein of animal origin. Animal proteins content in diets of most Nigerians are very low and have reached a crisis level. Average consumption of animal protein in this country is estimated at 4.5 g/head/day as against the minimum requirement of 35 g/head/day recommended by the Food and Agricultural

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Abbreviations: PSM, Pigeon pea seed meal; **WAD,** West African Dwarf; **WBC,** white blood cell; **SGGTP,** serum gamma-glutamyl transpeptidase; **SGGT,** serum gamma-glutamyl transferase; **PCV,** packed cell volume.

Organization of the United Nation (Atsu, 2002). There is a large market potential for sheep and goats in the southern part of Nigeria; hence, there is mass importation/movement of these small ruminants from the North of the country due to inadequate number of the animal produced in the south (Okali and Lipton, 1984). Sheep are among the most important livestock species in Nigeria with an estimated population of approximately 22.09 million heads (Okali and Lipton, 1984). Most supplements are expensive and their use in ruminant nutrition competes with monogastric animals and human nutrition. There is need to address this problem of inadequacy in dietary supplements in ruminant animal nutrition especially the protein supplements. This can be achieved by searching for alternative protein feedstuff that will attract less competition from monogastric animals and humans. Nature has endowed many varieties of legumes with the capacity of synthesis of wide range variety of chemical substances that are known to exert deleterious effect when ingested by animals. The use of these legumes is encumbered by the presence of these proteolytic inhibitors and other anti-nutritional factors, many of which are heat-labile and others heat-stable. Pigeon pea seed is reported to contain hemagglutinin (Amaefule, 2002) which is known to affect the blood formation in animals by reduction of PCV (Akinmutimi, 2004). Ene-Obong (1985) has also reported the presence of tannins in pigeon pea seed. Raw pigeon pea seed are rich in protein (18.5 to 31.1%) and carbohydrate (36.0 to 66.0%) depending on the variety (Kay, 1979). It has a biological value of 60% (Oyenuga, 1968). The high protein genotypes contain significantly higher (about 25%) sulphur – containing amino acids, namely methionine and cystine (Singh et al., 1990). Pigeon pea is a good source of dietary minerals such as calcium, phosphorus, magnesium, iron, sulphur and potassium. It is a good source of water-soluble vitamin, especially thiamine, riboflavin, niacin and cholines. Although pigeon pea seed meal, as an alternative feedstuff has been used in monogastric animals feeding trials, there is still paucity of information on its use for ruminant feeding. This study was therefore designed to evaluate the growth performance and haematological characteristics of sheep fed varying levels of dietary pigeon pea seed meal.

MATERIALS AND METHODS

Location

This study was carried out in the sheep/goat unit of the teaching and research farm of Michael Okpara University of Agriculture, Umudike. Umudike is in Abia State of Nigeria, located on Latitude 05°28' North and longitude 07°31' East, and lies at an altitude of 122 meters above sea level. It lies within the tropical rainforest zone characterized by average annual rainfall of 2, 177 mm in 148 - 155 rain days. Average ambient temperature is 25.5°C with minimum and maximum temperatures of 22 to 29°C, respectively. Relative humidity ranged from 76 – 87% (NRCRI, 2004).

Procurement and processing of experimental material

The pigeon pea seed used in this study were purchased from open market in Enugu, the capital of Enugu state, Nigeria. The pigeon pea seeds were cleaned up by winnowing and the clean seeds boiled for 30 min at about 100°C as earlier reported by Kaankula et al. (2000). The seeds were then dried on concrete floor for 3 days before grinding in a grinding machine to cracked sizes of 2-4 parts/seed.

Chemical analysis

Samples of the processed pigeon pea seeds, forage (*Panicum maximum*) and diets were analyzed for proximate constituents according to the method of AOAC (2000). Metabolizable energy values were calculated using the prediction equation (MAF, 1977):

$$\text{ME (MJKg}^{-1}\text{ DM)} = 0.0226\text{CP} + 0.0407\text{EE} + 0.0177\text{NFE}$$

Where: CP = crude protein, EE = ether extract, CF = crude fibre, NFE = nitrogen free extract.

Experimental diets

The processed pigeon pea seed was used to formulate four diets at 0, 10, 20 and 30% levels, designated by A, B, C and D, respectively (Table 1).

Experimental animals and design

Twelve young WAD rams, aged 7-8 months and weighing between 6.0 and 8.5 kg were purchased from the local university environment for the study. The rams were quarantined for 21 days, during which they were dewormed and then treated in acaricide baths against external parasites. Thereafter, they were housed individually in pens. Each group of three animals were randomly assigned to one of the four experimental diets. The concentrate diets were offered to the animals based on 3% body weight, while the forage and water were offered *ad libitum.* Body weight of the animals were recorded at the beginning of the experiment and weekly thereafter using a hanging scale of 100 kg capacity. Feed intake were measured by recording the quantities of feed (concentrates and forage) offered and quantities refused. Feed conversion ratio was measured by computing the ratio of the dry matter intake to the weight gain of animal. The study lasted for 8 weeks.

Blood sampling and analytical methods

Blood samples were drawn from each animal through the jugular vein using a 12 ml gauge (6 cm) needle to draw 10 ml of blood on the 8th week of the study. The blood samples were divided into two; first lot (5 ml) was emptied into heparinized packs containing about 40 mg of anti-coagulant components. The second lot (5 ml) was collected over anti–coagulant free bottles, and were used to determine blood biochemical components. Packed cell volume

Table 1. The composition and proximate constituents of experimental diets, pigeon pea seed meal and forage.

	Diet					
Ingredient (%)	**A**	**B**	**C**	**D**	**PSM**	**Forage**
Cassava peel	52.50	52.50	53.00	45.50		
Pigeon pea	0.00	10.00	20.00	30.00		
Maize offal	35.50	25.50	16.00	12.50		
Palm kernel cake	10.50	10.50	10.50	10.50		
Bone meal	1.00	1.00	1.00	1.00		
Common salt	0.50	0.50	0.50	0.50		
Total	100.00	100.00	100.00	100.00		
Chemical composition						
Dry matter (%)	87.00	87.10	86.70	86.60	93.16	85.30
Crude protein	6.80	7.20	8.37	9.54	20.50	9.79
Crude fibre	9.27	9.93	11.96	10.13	6.52	8.70
Ether extract	1.31	2.18	1.30	2.17	2.42	1.20
Ash	6.53	7.40	5.64	6.50	4.24	8.10
N – Free extract	63.09	60.39	59.43	58.26	59.48	57.43
ME (MJ/KG DM)	1.50	1.51	1.52	1.53	1.74	1.46

PSM = Pigeon pea seed meal; Forage = (*Panicum maximum*)

(PCV), which is the ratio of volume of cells to the volume of plasma, was determined by the capillary haematocrit centrifuge as described by Coles (1986). White Blood Cell (WBC) was determined by Wintrobe method (Coles, 1986). Differential counts of WBC (neutrophils, eusinophils and lymphocytes) were determined by Giemsa's stain method (Coles, 1986). Biochemical components, total and conjugated bilirubin, serum gamma-glutamyl transpeptidase (SGGTP) and serum gamma- glutamyl transferase (SGG7) were determined according to Coles (1986). Urea was determined by the urease-Berthelot method (Coles, 1986). Blood glucose was determined by Folin and Wu method (Allen, 1990; Ullman et al., 1992). Creatinine was determined according to the method described by Henry (1974).

Statistical analysis

All data generated were subjected to analysis of variance (Steel and Torrie, 1980), and significant differences between treatment means were separated using Duncan's multiple range test (SAS, 1999).

RESULTS

The composition and proximate constituents of the experimental diets, the pigeon pea seed meal and the forage (*panicum maximum)* used in this study are presented in Table 1. The performance of West African Dwarf (WAD) sheep fed graded levels of dietary pigeon pea seed meal are presented in Table 2. The sheep fed diet A consumed significantly (P<0.05) more concentrates per day (168.46 g) than those fed on the PSM diets, B (105.46 g), C (111.85 g) and D (106.65 g).

Among the PSM diets, ration B was consumed less than C and D even when these contained higher levels of PSM. Diet C was consumed most among the PSM diets but not significantly (P>0.05) more than diet B or D. The average daily weight gain varied significantly (P<0.05) and followed the same pattern as the average total body weight gain. The feed conversion ratio of animals fed diet C (20% PSM) was far better (P<0.05) than of those on diets A and D. However diet B group did not differ significantly (P> 0.05) from the groups fed diets A, C and D. The haematological and biochemical blood components obtained in this study are presented in Table 3. The PSM diets generally promoted lower PCV values in sheep as the level of dietary PSM increased. There was a significant (P<0.05) decrease in PCV in animals fed diet D. The PSM diets promoted higher WBC. The WBC differential, neutrophil and lymphocytes significantly (P<0.05) differed among the groups with neutrophil increasing while lymphocytes decreased as the level of dietary PSM was increased. Eosinophil was not significantly (P>0.05) affected by the PSM, the total and conjugated bilirubins were also not affected, and blood urea and glucose varied significantly (P<0.05). While blood urea decreased with increase in the level of PSM, glucose increased progressively. SGGTP and SGGT were significantly (P<0.05) higher in sheep fed on control diet A than in those fed on either diet C or D. Serum creatinine (mg/100 ml) was significantly (P<0.05) higher in sheep fed on control diet (1.67) than those on the PSM diets.

Table 2. Performance of WAD sheep fed graded levels of dietary pigeon pea seed meal.

Parameter	A	B	C	D	SEM
Initial BW (kg)	9.15	7.98	8.68	9.05	0.76
Final BW (kg)	11.20^{a}	9.70^{c}	10.77^{ab}	10.40^{b}	0.16
Body wt. Gain (kg)	2.05^{a}	1.72^{ab}	2.08^{a}	1.35^{b}	0.17
Body wt. Gain (g/day)	36.61^{a}	30.65^{ab}	37.20^{a}	24.11^{b}	3.06
Concentrate DMI (g/day	168.46^{a}	105.84^{b}	111.85^{b}	106.65^{b}	1.25
Forage DMI (g/day)	122.17^{ab}	121.36^{ab}	124.66^{a}	119.09^{b}	1.25
Total DMI (g/day/Wkg$^{0.75}$)	56.72^{a}	48.15^{b}	46.76^{b}	46.61^{b}	2.41
Feed conversion ratio	13.34^{a}	8.67^{ab}	6.37^{b}	12.83^{a}	1.68

$^{a, b}$ Means within the same row with different superscript are significantly (P<0.05); SEM , standard error of the means; wt., weight.

Table 3. Haematological and serum biochemical characteristics of WAD sheep fed graded levels of dietary pigeon pea seed meal.

Haematology	Parameter				
	A	B	C	D	SEM
PCV (%)	32.33^{a}	31.67^{ab}	29.00^{b}	28.33^{b}	1.15
WBC (1mm^{3})	10,700.00^{c}	11,733.00^{b}	12,200.00^{b}	13,206.67^{a}	275.22
Neutrophil (%)	46.33^{b}	47.67^{ab}	48.33^{ab}	49.67^{a}	0.69
Lymphocytes (%)	31.00^{a}	30.00^{ab}	29.00^{bc}	28.00^{c}	0.65
Eosinophil (%)	8.30	8.33	8.33	8.33	0.02
Biochemical					
Total bilirubin (mg/100 ml)	0.45	0.46	0.47	0.48	0.04
Conjugated bilirubin (mg/100 ml)	0.15	0.14	0.14	0.14	0.01
Urea (mg/100 ml)	14.07^{a}	12.27^{ab}	11.27^{b}	10.50^{b}	0.77
Glucose (mg/100 ml)	57.00^{c}	58.33^{bc}	61.33^{ab}	64.33^{a}	1.06
SGGTP (μ/L)	36.34^{a}	35.67^{ab}	35.34^{b}	35.17^{b}	0.26
SGGT (μ/L)	11.33^{a}	10.33^{ab}	10.00^{b}	9.33^{b}	0.61
Creatinine (mg/100 ml)	1.67^{a}	1.40^{b}	1.37^{b}	1.40^{b}	0.07

$^{a, b, c}$ Means on the same row with different superscript differ significantly (p<0.05); SGGTP = serum gamma glutamyl ranspeptidase; SGGT = serum gamma glutamyl transferase.

DISCUSSION

Feed intake in the PSM diets might have been depressed by the odour of the PSM and fibre content of diets as earlier observed by Bamgbose et al. (2004). The higher intake by the group on diet C seems to suggest that relative intake was controlled by some other factors apart from dietary crude protein, crude fibre, and odour/palatability. Obioha (1977) observed that even though dietary nutrients and palatability are necessary factors which influence intake in animals, satiety signals are set by a combination of such complex factors as gut fill, body fat and changes in the body chemical constituents. This might be the reason for the lower, though not significant (P>0.05) intake of diet B compared to diet C and D by sheep in this study. The higher weight gain was observed by the group fed on diets C (20% PSM), though not significantly (P>0.05) higher than those fed on diets A and B, which might be due to better nutrient (protein–energy) harmony in diet C. Ahamefule et al. (2005) had earlier reported that 20% dietary pigeon pea seed meal supported higher body weight gain for goats than diets containing 0, 10 and 30% pigeon pea seed meal. Better nutrient (protein-energy) harmony in diet C as earlier adduced might be responsible for better feed conversion ratio as this would have enhanced nutrient utilization in the animals.

Increase in WBC is normally due to immune response by animal as a result of the presence of an antigen (foreign body) in the body. The rising level of WBC with increasing levels of dietary PSM supports the earlier observed decrease in the levels of PCV in the study. This agrees with the report by Ahamefule et al. (2005) which states that pigeon pea seed meal in the diets of WAD goats promoted lower PCV and higher WBC. The presence of traces of anti-nutritional factors in the PSM diets might have triggered off immune response by WBC which tended to rise as level of PSM increased in diets. The fact that bilirubin (total and conjugated) were not influenced in this study seems to suggest that the protein in the diets was adequate and of good quality, which supported basic metabolic and physiological activities in the animals. The significantly ($P<0.05$) lower blood urea in the diets C and D group indicated superior protein quality than in diet A. This had earlier been reported by Eggun (1970), that high level of blood urea indicated poor protein quality, this suggests therefore that the pigeon pea seed meal diets were of superior protein quality than the control diet. The increasing level of blood glucose seems to indicate that there was a progressive increase in the level of readily fermentable carbohydrate from diet A to D. Increase in SGGTP and SGGT value would signify necrosis or myocardial infarctions which are all indicators of poor protein quality of test diets (Fasina et al., 1999). The lower levels of SGGTP and SGGT in sheep fed on the PSM diets tended to buttress earlier observation that the PSM diets were of superior protein quality than the control diet. Although the creatinine level was higher in animals fed on diet A, the creatinine values were within the normal range (1.2 - 1.9 mg/100 ml) for sheep (Schalm et al., 1975; Singh et al., 1990). This observation suggests that there were no muscle waste and that the sheep did not survive at the expense of their body reserves (Ologhobo, 1992). This is an indication that the dietary protein was well utilized by the animals in each treatment group as earlier reported elsewhere (Eggun, 1970; Ross et al., 1978).

Conclusion

The results on growth performance of sheep in this study indicated that pigeon pea seed meal may not be included beyond 20% dietary level for fattening of sheep. The slightly higher WBC than the normal range for sheep also observed in diet D (30% PSM) group goes further to buttress the results on growth performance. Therefore for optimum growth performance and physiological welfare of the animal, 20% dietary level of pigeon pea seed meal is recommended for sheep.

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