NUTRIENT INTAKE AND GROWTH PERFORMANCE OF WEST AFRICAN DWARF DOES FED DIETS CONTAINING VARYING LEVELS OF AQUATIC FERN MEAL

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ABSTRACT

This study evaluated the effects of replacing cassava peel with varying levels of aquatic fern meal (Azolla spp.) on the feed intake and growth performance of West African Dwarf (WAD) goats. Five experimental diets were formulated, incorporating aquatic fern meal (AFM) at 0%, 5%, 10%, 15%, and 20% as replacements for cassava peel, thus designated as Diets A, B, C, D, and E, respectively. During the 63-day feeding trial, fifteen (15) WAD goats were randomly selected and assigned to the five dietary treatments in a completely randomized design. Parameters assessed included the chemical composition of the diets, nutrient intake, and growth performance of the goats. Statistical analysis revealed significant differences (P<0.05) in the chemical composition of the diets. Crude protein levels increased from 11.25% to 13.32% as the AFM inclusion level increased, while dry matter content decreased from 89.32% to 86.40%, and crude fiber content reduced from 10.51% to 7.19%. Nutrient intake and growth performance showed no significant differences (P>0.05) among the treatments. However, goats fed Diet C had the highest dry matter intake (475.05 g/day), while protein intake ranged from 57.10 g/day to 70.04 g/day, increasing with higher levels of AFM inclusion. The highest average weight gain (77.25 g/day) and least feed conversion ratio (6.04) were observed in goats fed Diet A. These findings suggest that the inclusion of AFM as a replacement for cassava peel may not significantly enhance nutrient intake or growth performance in WAD goats.

Keywords: Weight gain, Supplementation, Basal diet, Goat, Butrient

INTRODUCTION

One of the primary challenges affecting the growth and performance of ruminant animals during the dry season in tropical zones is the shortage and poor quality of dietary protein (Fajemisin, 2023). To address this, researchers have explored alternative protein sources that are cost-effective and readily available (Fajemisin, 2023; Alade *et al*., 2023). Aquatic fern meal (AFM), a sun-dried and processed product derived from species such as *Azolla spp*., has been highlighted by Feedipedia (2024) as a promising alternative due to its high protein content (20.60%), crude fiber (15.00%), gross energy (17.00 MJ/kg), calcium (11.00 g/kg), and phosphorus (6.10 g/kg), which might significantly enhance the nutritional value of feed, improve intake, and boost livestock growth and productivity.

West African Dwarf (WAD) goats are a dual-purpose breed renowned for their resilience and adaptability to tropical climates (Akintunde *et al*., 2024). They contribute significantly to human diets (primarily as a source of meat), employment and provide income for rural dwellers (Ibhaze *et al*., 2024). However, poor nutrition has been identified as a major factor limiting their growth and productivity (Fajemisin, 2023; Ibhaze *et al*., 2024). Incorporating aquatic fern meal into the diets of WAD goats, which remains largely unexplored, could potentially address these challenges. Therefore, this study aimed to evaluate the efficacy of AFM in improving nutrient intake, growth performance, and overall productivity of WAD goats.

MATERIALS AND METHODS

Experimental site

The study was conducted at the Teaching and Research Farm of the Federal University of Technology, Akure (FUTA), Ondo State, Nigeria.

Experimental diets

Cassava peels were sourced from cassava processing industries in Akure, sun-dried for 2–4 days to reduce hydrogen cyanide content and moisture levels. The dried peels were subsequently milled to a particle size of 2 mm to ensure uniformity. Other conventional feed ingredients, were procured from a reputable feed mill in Akure. Fresh fern leaves (*Azolla spp.*) were collected from water bodies within FUTA environment, air dried and milled. Five experimental diets were formulated, with fern meal replacing cassava peel at the following levels: 0%, 5%, 10%, 15%, and 20%, thus, designated as T1, T2, T3, T4, and T5, respectively.

Feeding and management of experimental animals

Fifteen (15) WAD goats, aged 8–10 months, were selected from the farm's existing flock and administered prophylactic treatments against endemic diseases. The goats were weighed, tagged, and randomly assigned to

five dietary treatment groups, with three goats per treatment, in a completely randomized design. The goats were fed 3.5% of their body weight.

Evaluation of feed intake and performance

The feeding trial lasted 63 days, during which the goats were fed their respective diets in the morning, and clean water was provided *ad libitum*. Goats were weighed weekly in the morning before feeding to monitor weight changes. Data were taken on feed intake, daily weight gain and feed conversion ratio.

Laboratory Analysis of experimental diets

Feed samples were analyzed for proximate composition using AOAC (2016) while the fibre fractions were determined using Van Soest *et al* (1991) methods.

Statistical analysis

Data collected were subjected to one-way analysis of variance (ANOVA) to test for the effect of aquatic fern meal using SPSS software (Version 26). Duncan's Multiple Range Test (DMRT) of the same software was used to separate the means.

RESULTS AND DISCUSSION

Table 1 presents the nutrient composition of diets containing graded levels of AFM. All parameters were significantly ($P<0.05$) different, with dry matter (DM) and crude fiber (CF) decreasing as AFM inclusion increased. DM content (86.49–89.32%) falls within acceptable ranges, able to reduce microbial growth and spoilage, while supporting optimal nutrient intake (Omotoso *et al*., 2023). Conversely, crude protein (CP) content increased significantly (11.25–13.32%), surpassing the threshold (8%) needed to enhance rumen microbial activity, digestion, and nutrient utilization (Omotoso *et al*., 2023). This suggests that AFM could serve as an effective protein supplement during forage scarcity.

Ether extract (EE) was highest (3.25%) in Diet C, indicating an energy-dense feed essential for maintaining energy balance and supporting growth (Jiwuba *et al*., 2021). The lowest ash content (5.22%) in Diet C complements its nutrient profile. All fibre fraction decreased with hemicellulose peaked at 12.45% in Diet B but was lowest (8.33%) in Diet E. Reduced fiber bulkiness may improve digestibility and voluntary intake but excessive reductions could compromise rumen health (Bayne and Edmondson, 2021; Ibhaze *et al*., 2024). These results underscore aquatic fern meal's potential to enhance nutrient density, balance fiber and protein, and support productivity in West African Dwarf goats.

Table 1: Nutrients composition (%) of diets containing varying levels of aquatic fern meal

	A	B	C	D	E	SEM	P-Value
Dry Matter	89.32 [a]	88.02 [b]	87.87 [c]	87.22 [d]	86.49 [e]	0.25	0.02
Crude Protein	11.25 [c]	12.19 [b]	12.27 [b]	13.25 [a]	13.32 [a]	0.21	0.01
Crude Fibre	10.51 [a]	8.47 [b]	8.09 [c]	7.30 [d]	7.19 [e]	0.32	0.04
Ether Extract	2.17 [e]	2.76 [c]	3.25 [a]	2.38 [d]	3.04 [b]	0.11	0.03
Ash	5.52 [c]	5.43 [d]	5.22 [e]	6.19 [a]	5.73 [b]	0.09	0.03
Nitrogen free extract	59.87 [a]	59.17 [b]	59.03 [b]	58.10 [c]	57.21 [d]	0.25	0.01
Neutral detergent fibre	45.59 [a]	44.72 [b]	43.66 [c]	39.85 [d]	37.51 [e]	0.82	0.02
Acid detergent fibre	35.89 [a]	32.27 [b]	32.19 [c]	30.59 [d]	29.18 [e]	0.60	0.02
Acid detergent lignin	3.91 [a]	3.41 [b]	3.36 [c]	2.98 [d]	2.91 [e]	0.10	0.02
Hemicellulose	9.70 [c]	12.45 [a]	11.48 [b]	9.27 [d]	8.33 [e]	0.40	0.02
Cellulose	31.98 [a]	28.86 [b]	28.83 [b]	27.61 [c]	26.27 [d]	0.51	0.01

[abcde] mean with different superscript along the same row are significantly ($P<0.05$) different
SEM: Standard Error of Mean

Table 2 highlights the nutrient intake of WAD goats fed diets with varying levels of AFM. No significant ($P>0.05$) differences were observed across treatments, though goats on diets C and E recorded the highest dry matter intake (475.05 g/day) and crude protein intake (70.04 g/day), respectively. The high crude protein intake may be due to the high protein content of aquatic fern, thus, enhancing feed palatability and voluntary intake (Omotoso *et al*., 2023).

Goats fed diet C exhibited the highest crude fiber intake (43.71 g/day). High crude fibre intake is essential for promoting proper rumen function, stimulating rumination, and maintaining a healthy rumen environment, ultimately enhancing growth performance (Omotoso *et al*., 2023). Conversely, goats fed diet E had the lowest intake for all fibre fractions including neutral detergent fiber (197.30 g/day), acid detergent fiber (153.49 g/day), and cellulose (138.20 g/day). Adequate fiber intake is critical for preventing digestive disorders and improving overall digestive health in ruminants (Bayne and Edmondson, 2021). These findings suggest that dietary inclusion of aquatic fern meal supports nutrient intake while maintaining fiber levels crucial for optimal rumen

function. Factors such as feed palatability, age, and management practices also influence voluntary intake in goats.

Table 2: Nutrient intake (g/day) of West African Dwarf goats fed diets containing varying levels of aquatic fern meal

	A	B	C	D	E	SEM	P-Value
Dry matter	452.91	449.87	475.05	448.59	454.94	22.90	0.10
Crude protein	57.10	62.31	66.23	68.14	70.04	3.31	0.80
Crude fibre	53.29	43.30	43.71	37.55	37.82	2.81	0.43
Ether extract	11.01	14.08	17.60	12.25	15.99	0.95	0.15
Ash	27.98	27.74	28.24	31.85	30.13	1.48	0.92
Nitrogen free extract	303.53	302.44	319.27	298.81	300.95	15.37	0.10
Neutral detergent fibre	231.17	228.56	236.05	204.96	197.30	11.92	0.84
Acid detergent fibre	181.98	164.93	174.02	157.31	153.49	9.07	0.89
Acid detergent lignin	19.82	17.45	18.17	15.33	15.29	1.03	0.65
Hemicellulose	49.19	63.63	62.03	47.65	43.82	3.35	0.22
Cellulose	162.16	147.48	155.85	141.98	138.20	8.06	0.91

[abcde] mean with different superscript along the same row are significantly (P<0.05) different
SEM: Standard Error of Mean

Table 3 shows the growth performance of WAD goats fed diets containing varying levels of aquatic fern meal. All parameters showed no significant (P>0.05) differences across treatments. Studies on *Azolla* meal supplementation in livestock have yielded mixed results. Goats on diet A exhibited the best performance, with the highest FI (14.60 kg), TWG (4.87 kg), AWG (77.25 g/day), and least FCR (6.04). This indicates that diet A was the most efficient in promoting growth. Higher inclusion levels of aquatic fern meal may have resulted in diminished performance, possibly due to the presence of anti-nutritional factors in *Azolla spp.* that inhibit digestive enzymes and nutrient absorption (Yin *et al*., 2000).
Ahmed *et al*. (2016) reported reduced performance in pigs and Corriedale sheep fed diets with increasing levels of *Azolla filiculoides*, attributing the decline to anti-nutritional compounds. Conversely, Kumar *et al*. (2017) found no adverse effects of *Azolla* supplementation on weight changes in buffalo bulls and male kids. Weight gain in small ruminants depends on dry matter intake, protein intake, and nutrient digestibility (Jiwuba *et al*., 2021). Lower FCR reflects a more efficient diet, as less feed is required for a unit of weight gain. Thus, the findings suggest that aquatic fern meal supplementation many not help improve or supports higher weight gain.

Table 3: Growth performance of West African Dwarf goats fed diets containing varying levels of aquatic fern meal

	A	B	C	D	E	SEM	P-Value
Dry matter intake	452.91	449.07	475.91	444.80	458.82	22.98	0.99
Initial weight gain	9.73	8.63	9.23	9.20	8.47	0.49	0.95
Final weight gain	14.60	13.00	12.07	13.13	12.37	0.81	0.92
Total weight gain	4.87	4.37	2.83	3.93	3.90	0.47	0.79
Average daily gain	77.25	69.31	44.97	62.43	61.90	7.51	0.79
Feed conversion ratio	6.04	6.84	15.30	10.14	8.50	1.63	0.44

[abcde] mean with different superscript along the same row are significantly (P<0.05) different
SEM: Standard Error of Mean

CONCLUSION AND RECOMMENDATIONS

Inclusion of aquatic fern meal in goat diets may not significantly improve feed intake and weight gain, as the values obtained in this study were not statistically different. However, further processing methods may be necessary, as antinutrients in the AFM could be a contributing factor to the lack of improvement in feed intake and growth performance of the goats obtained in this study.

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