Nigerian J. Anim, Sci. 2024, 26 (2): 290-297

Performance and Digestion of African Star Apple Meal-based Diet in West African Dwarf Goats

[1]Odeyinka, S.M., [1]Abegunde, T.O., [2]Ayandiran, S.K., [1]Adeoya, D.S. and [1]Oparemi, M.B.

[1]Department of Animal Sciences, Obafemi Awolowo University, Ile Ife. Osun State. Nigeria.
[2]Department of Animal Science, Osun State University Osogbo. Osun State. Nigeria

Corresponding author: samuel.ayandiran@uniosun.edu.ng

Target audience: Local small ruminant farmers

Abstract

This study was conducted to determine the growth performance of West African Dwarf (WAD) goats fed African Star Apple based diets. A total of sixteen (16) WAD goats of both sexes were randomly allotted into four experimental treatments in a complete randomized design. Four experimental mash diets were compounded with the inclusion of Chrysophullum albidum replacing wheat offal at 0, 10, 20 and 30% (T1, T2, T3 and T4, respectively) graded levels. These diets were fed to the goats at 3% of their body weight as a supplement to the basal diet of Panicum maximum. The experiment lasted for 16 weeks. The proximate composition of the experimental diets indicated that dry matter was higher in T1 than in other diets. Diets containing inclusion levels of Chrysophyllum albidum (T2, T3 and T4) were higher in crude protein, crude fibre, ether extract and ash contents than the T1 diet. However, goats fed diets T1 and T2 had significantly higher total weight and average daily gain than T3 and T4. The feed conversion was best in goats fed the T2 diet, followed by T1, T3 and T4. Goats fed diet T2 had significantly higher crude protein, crude fibre and ether extract digestibility coefficients compared to goats fed other diets. It could be concluded that the inclusion of Chrysophullum albidum in the diets of WAD goats at 10% led to optimum performance characteristics and digestibility coefficients.

Keywords: Feed intake, weight gain, digestibility, unconventional, goats

Description of Problems

Goats are endowed with special attributes such as heat tolerance, disease resistance, short generation interval, and high reproduction rate [1]. Goats are considered superior to other ruminant species in their utilization of poor-quality and high-fibre feeds [2]. They are mostly kept for meat, milk and skin production. Other purposes of keeping goats include household income, festival celebrations and special occasions [3]. Various factors contributed to the low productivity such as health constraints, management as well as, shortages in feed quality and quantity [4]. The major constraint to ruminant livestock production in the tropics is the availability of cheap and quality feedstuffs especially in the dry season, as

reported by [5]. [6] observed that in the tropics, ruminants are raised mainly on grasses, which are poor in nutrients and digestibility during the dry season which leads to a loss in total weight gain in the dry season [7]. [8] stated that poor productivity and high mortality of stock, which characterize the livestock production industry, are largely explained by not feeding the right quantity and quality of feeds to the various livestock species.

However, the high cost of conventional feed resources necessitated the search for cheap alternative feedstuffs such as *Chrysophullum albidum* fruits. African star apple (*C. albidum*) is a dominant canopy tree of lowland and mixed rainforests, sometimes, riverine [9]. It is also reported that it is an excellent source of vitamins, irons, and flavours to diets 10]. [11] reported that the pulp contains a valuable amount of crude fibre, fat, mineral matter and caloric value. Carbohydrates and crude protein in the fruit are higher in the seeds. Early reports [12] found the crude protein, carbohydrate, crude fat, crude 36 fibre, and total ash contents in seeds as 8.75, 83.38, 3.45, 2.42 and 2.00%, respectively, warranting the seeds as a good novel feedstuff in animal feed. The potentials of the seeds of *C. albidum* have not been fully utilised and during its season they are found as litter around communities constituting environmental pollution [13]. Therefore, this study examined the performance characteristics and digestion in WAD goats fed graded levels of *C. albidum*-based diet.

Material and Methods

Experimental site

The experiment was carried out at the Sheep and Goat Unit of the Teaching and Research Farm, Obafemi Awolowo University, Ile Ife, Osun State, Nigeria. The experiment lasted for twelve (16) weeks.

Processing of Chrysophyllum albidum

Chrysophullum albidum fruits were sourced within and outside the University campus. The *C. albidum* fruits were separated from the chaff and dried for one week before they were milled and mixed with other ingredients such as Rice bran, wheat offal, maize, palm kernel cake, and premix.

Experimental diets

Four experimental mash diets were compounded with the inclusion of *C. albidum* replacing wheat offal at 0, 10, 20 and 30% graded levels (Table 1). These diets were fed to the goats at 3% of their body weight as a supplement to the basal diet of *Panicum maximum.*

A total of sixteen (16) West African dwarf goats were purchased in local goats market in Ile Ife and Ede with an average weight of 5.25 kg. The West African goats were housed in disinfected and well-ventilated pens. They were given feed and water for thirty-one (31) days before the beginning of experiments to adapt them to the diets of *C. albidum*. Thereafter, animals were randomly allotted to four treatments in a complete randomized design [each treatment comprised of four (4) West African dwarf goats].

Table 1 Gross composition of the experimental diets

Ingredients (%)	T1	T2	T3	T4
Maize	15.00	15.00	15.00	15.00
Wheat offal	58.00	48.00	38.00	28.00
Chrysophyllum albidum	0.00	10.00	20.00	30.00
PKC	13.00	13.00	13.00	13.00
Rice Bran	10.00	10.00	10.00	10.00
Salt	2.00	2.00	2.00	2.00
Premix	2.00	2.00	2.00	2.00

TI; Concentrate diet with 0% inclusion of *Chrysophyllum albidum,* T2; Concentrate diet with 10% inclusion of *Chrysophyllum albidum,* T3; Concentrate diet with 20% inclusion of *Chrysophyllum albidum,* T4; Concentrate diet with 30% inclusion of *Chrysophyllum albidum Experimental animal and management*

Data collection

The animals were weighed before the commencement of the experiment and subsequently weekly during the experimental period and the daily weight gain was calculated from initial weight less the final weight. Daily Feed intake was estimated by subtracting the leftover feed from the feed offer for each day of the experiment.

Digestion trial

Three animals were randomly selected and acclimatized in the metabolism cage for a week with facilities for a separate collection of faeces and urine. Ten per cent (10%) of faecal samples were taken per day and dried in the oven at 70□C for 24 hours then bulked, thoroughly mixed, ground and sub-sampled for chemical analysis

$$\text{Apparent Digestibility} = \frac{\text{Nutrients in Feeds} - \text{Nutrients voided in faeces}}{\text{Nutrients in Feeds}} \times 100$$

Samples of experimental diets and faeces voided were taken to the Poultry Meat Laboratory, Obafemi Awolowo University, Ile Ife, Osun State, Nigeria for proximate analysis according to the procedure of [14].

Statistical analysis

All data obtained from the Study were subjected to a one-way analysis of variance (ANOVA) of [15] and significant means were separated using Duncan's multiple range test option of the same package.

Results and Discussion

The proximate analysis of the experimental diets indicated that dry matter was higher in T1 than other diets (Table 2). Diets containing inclusion levels of *Chrysophyllum albidum* (T2, T3 and T4) were higher in crude protein, crude fibre, ether extract and ash contents than the T1 diet. However, diet T1 had the highest carbohydrate fraction compared to T2, T3 and T4 diets. [16] reported a higher crude protein content of 19.80–21.59% in *C. albidum* and a study by [17] also showed the

crude protein content of *C. albidum* was reported to be between 8.00 to 9.44%. This was slightly lower than the values obtained in this study. The crude fibre content of the diets obtained in this study was higher than the findings of previous studies on the same fruit species [18]. A study by [19] reported the ether extract content of the *C. albidum* to be 5.9%. The values obtained in the current study fall within the range of values reported in these previous works. The high ether extract content in *C. albidum* may be attributed to the presence of oils and fats in the plant. The *C. albidum* has been reported to contain essential fatty acids such as linoleic acid, oleic acid, and palmitic acid. The content of NFE decreased as the level of incorporation of *C. albidum* in the diet increased. A study conducted on the chemical composition of *C. albidum* reported a lower content of carbohydrates (43.9%) than what was observed in this study [20].

Table 2 Proximate composition of the experimental diets

Parameters	T1	T2	T3	T4
Dry matter	90.09	88.82	88.80	88.94
Crude Protein	11.80	13.57	13.27	12.12
Crude Fibre	9.06	11.32	13.24	14.41
Ether Extract	2.93	4.34	3.56	6.16
Ash	4.87	6.89	8.16	8.02
NFE	71.34	63.80	61.77	60.30

TI; Concentrate diet with 0% inclusion of *Chrysophyllum albidum,* T2; Concentrate diet with 10% inclusion of *Chrysophyllum albidum,* T3; Concentrate diet with 20% inclusion of *Chrysophyllum albidum,* T4; Concentrate diet with 30% inclusion of *Chrysophyllum albidum,* NFE; Nitrogen free extract.

There were no significant differences ($p>0.05$) in the means of average daily feed consumption, average initial weight and average final weight (Table 3). However, goats fed diets T1 and T2 had higher ($p<0.05$) total weight and average daily gain than T3 and T4. The feed conversion was least ($p<0.05$) in goats fed the T2 diet compared to other treatments. The total weight gain in this study was lower than 3.42 – 4.45 [21] for WAD goats fed wheat offal-carried pineapple waste. The ADG observed in this study were higher than that reported by [22] when they included African Star Apple seed meal in the diets of WAD goats after consuming the highest level (10%) of African Star Apple. Furthermore, the FCR in this study was higher than 5.67 – 8.32 reported by [23] for WAD goats fed bread waste and *Moringa oleifera* based diet

There were significant differences ($p<0.05$) in the means of all apparent nutrient digestibility across the treatments except in the dry matter and ash (Table 4). Goats fed T2 had higher ($p<0.05$) crude protein, crude fibre and ether extract digestibility coefficients compared to goats fed other diets. However, the carbohydrate fraction digestibility was higher ($p<0.05$) in goats fed diet T1 followed by T2 and T4, then T3. The values obtained were similar to values

Table 3 Growth Performance of the WAD goats fed African star apple

Parameter	T1	T2	T3	T4	SEM	P value
ADFC(g/day)						
Concentrate	139.46	143.62	132.39	132.65	4.16	0.7693
Panicum	479.82	486.48	448.40	450.30	14.21	0.7379
Total ADFI	619.27	630.10	580.79	582.95	18.37	0.7600
AILW (kg)	5.23	5.25	5.20	5.20	0.18	0.9997
AFLW (kg)	7.37	7.53	6.58	6.62	0.21	0.2726
TWG (kg)	2.15^{a}	2.28^{a}	1.38^{b}	1.43^{b}	0.13	0.0020
ADG (g)	25.60^{a}	27.08^{a}	16.37^{b}	16.96^{b}	1.51	0.0020
FCR	10.01^{b}	9.67^{a}	14.80^{c}	14.14^{d}	0.85	0.0361

$^{a, b, c, d}$: Means within each row with different superscripts are significantly different ($p<0.05$)
ADFC: Average daily feed consumption, ADFI: Average daily feed intake, AILW: Average initial live weight, ADG: Average daily gain, AFLW: Average final live weight, TWG: Total weight gain

reported by [24]. The amount of fibre fractions in the diet has been reported to influence digestibility in animals [25]. [26] reported that the extent of degradation by rumen microflora has important implications for both intake and digestibility. The observed CP digestibility of animals in this study was higher than 64.65–72.08 reported by [27] for WAD goats fed grass-legume pellet.

Table 4 Apparent nutrient digestibility of WAD goats fed the experimental diets

Parameters (g/kg)	T1	T2	T3	T4	SEM	P value
Dry matter	89.46	89.10	88.96	88.66	0.18	0.5233
Crude Protein	95.08^{b}	96.99^{a}	84.80^{c}	75.81^{d}	2.58	<.0001
Crude Fibre	80.88^{ab}	87.20^{a}	73.45^{bc}	72.15^{c}	1.91	0.0116
Ether Extract	83.61^{a}	86.42^{a}	73.51^{b}	58.12^{c}	3.55	0.0004
Ash	69.01	68.85	65.46	64.85	2.15	0.8911
Carbohydrate fraction	90.42^{a}	85.19^{ab}	80.85^{b}	84.12^{ab}	1.46	0.1131

^{a,b,c,d}*: Means in the same row having different superscripts are significantly different (P<0.05)*TI; Concentrate diet w ith 0% inclusion of *Chrysophyllum albidum,* T2; Concentrate diet with 10% inclusion of *Chrysophyllum albidum,* T3; Concentrate diet with 20% inclusion of *Chrysophyllum albidum,* T4; Concentrate diet with 30% inclusion of*Chrysophyllum albidum,* NFE; Nitrogen free extract.

Conclusion and Application

It could therefore be concluded that the inclusion of *Chrysophullum albidum* in the diets of WAD goats could serve as an alternative feed source.However, inclusion at 10% led to higher performance characteristics and digestibility coefficients.

References

1. Oguoma, N.N.O. (2003). Financing small operations along gender lines in Imo State, Nigeria. Journal of Agriculture and Social Research (JASR) 3(1), 13-28.
2. Oyeyemi, M.O. and Akusu, M.O. (2005). Retrospective study on some diseases causing mortality in West African Dwarf Lambs. Nigeria Journal of Animal Science, 12: 123-128.
3. Odeyinka, S.M. and Okunade, G.K. (2005). Goat Production in Oyo State. A case study of Ogbomosho town. *Nigeria Journal of Animal Production,* 32(1): 108 – 115.
4. Tsedeke, K.K. (2007). Production and marketing systems of sheep and goats in Alaba, Southern Ethiopia. M.sc. Thesis*,* Awassa College of Agriculture, University of Hawassa, Awassa, Ethiopia. April, 2008.
5. Odeyinka, S.M., Oyedele, O.J. and Olubunmi, P.A. (2003). The performance of West African Dwarf Goats and soybean milk residue, cowpea seed waste and corn starch residue. *Livestock Research for Rural Development* (15) 12
6. Babayemi, O.J. (2007). In-vitro fermentation characteristics and acceptability by West Africa Dwarf goats of some dry season forages. African Journal of Biotechnology, 6(10): 1260-1265.
7. Iyayi, E.A., Okoruwa, V.O., Babayemi, O.J., Busari, A.A. and Peters, O.F. (2003). Livestock production pattern of agro-pastoralists in peri-urban centres of southwest Nigeria. *Nigeria Journal of Animal Production. 30(1): 87-92.*
8. Odeyinka, S.M., Ojelade, A.O., Abamba, E.O., Oyedele, O.J., Olosunde, A.O. and Ayandiran, S.K. (2014). Utilization of Gliricidia sepium, *Moringa oleifera* and cowpea *(Vigna unguiculata)* crop residue by West African Dwarf goats. *Proceedings of 39th Conference of Nigerian Society for Animal Production.* 16 – 19 March 2014, Babcock University, Ilishan-Remo Ogun State
9. Madubuike, F.N. and Ogbonnaya, O. (2003). The potential use of White Star Apple seed (*Chrysophyllum albidum*) and Physic nut (*Jatropha curcas*) as feed ingredients for Rats. *Journal of Faculty of Agriculture and Veterinary Medicine* 1:97-105.
10. Adisa, S.A. (2000). Vitamin C, protein and mineral contents of African apple (*Chrysophyllum albidum*). *Proceedings of the 18th Annual Conference of NIST* (eds) Garba SA, Ijagbone IF, Iyamu AO, Kilani AS, Ufaruna N, Pg 141 – 146.
11. Ukana, D.A., Aniekan, E.A., and

Godwin, N.E. (2012). Evaluation of proximate compositions and mineral elements in the star apple peel, pulp and seed. *Journal of Basic and Applied Scientific Research. 2(5): 4839 – 4843.*

12. Ajewole, K. and Adeyeye, A. (1991); Seed oil of white star apple *(Chrysophyllum albidum)* physiochemical characteristics and fatty acid composition, *Journal of Science, Food and Agriculture,* 54, 313-315.
13. Adewusi, H.G. and Bada, S.O. (1997). Preliminary information on the Ecology of *Chrysophyllum albidum* in West and Central Africa. *Proceeding of a national workshop on the potential of the star apple in Nigeria.* (pp. 16-25). Ibadan, Nigeria.
14. Association of Official Analytical Chemists (2008). Official Method of Analysis of the AOAC (W. Horwitz Editor) Eighteenth Edition. Washington D.C, AOAC.
15. SAS (2008). User's guide, statistics, version 9.3 Edit. SAS Institute Inc., Cary, NC, USA.
16. Annongu, A.A., Joseph, K.L., Adeyina, A.O., Sola-ojo, F.E., Edoh, J.H. and Ajide, S.O. (2017). Utilization of African star apple (*Chrysophyllum albidum*) kernel meal in broiler diets. *Journal of Agricultural Sciences* Vol. 62, No. 2.
17. Aletor, V.A.., Ogunwolu, S.O. and Agbede, J.O. (2002). Chemical composition and the feeding value of star apple (*Chrysophyllum albidum*) fruits and leaves. *Food Chemistry*, 78(4), 457-462.
18. Ajide, S.O. (2018). Feeding potentials of star apple (*Chrysophyllum albidum*) kernel in broiler chickens. A thesis submitted to the Department of Animal Production Faculty of Agriculture in partial fulfilment of the requirement for the award of the degree of Doctor of Philosophy (PhD) in Animal Production, University of Ilorin, Ilorin Nigeria.
19. Agbabiaka, L.A., Abolade, O.S., Adebayo, A.B. and Olayemi, F.F. (2013); Nutritional and medicinal importance of *Chrysophyllum albidum*. *Food and Public Health Journal*, 3(5), 223-230.
20. Ajiboye, B.O. and Fagbohun, E.D. (2010). Nutritional and phytochemical screening of *Chrysophyllum albidum*. *African Journal of Biotechnology, 9(42), 7110-7113.*
21. Ayandiran, S. K., Odeyinka, S. M. and Makinde, O. A. (2012). Utilization of wheat offal- carried pineapple waste meal in the diet of West African Dwarf goats. *Bulletin of Animal Health and Production in Africa*. 60 (4): 501-510
22. Ogungbesan, A.M., Ibeawuchi, J.A. and Orisadeyi, S.A. (2020). Performance characteristics and blood chemistry of West African Dwarf goats fed diets supplemented with African Star Apple seed meal.

Journal of Applied Animal Research, 48(1), 436-441.

23. Ayandiran S.K., Odeyinka SM and Odedire JA. (2019). Growth performance and nutrient digestibility of West African Dwarf (WAD) goats fed bread waste and *Moringa oleifera* leaf. *International Journal of Animal Science.* 3(2): 1047
24. Adeniji, A.A., Ojebiyi, O.O. and Alagbe, J.O. (2012). Effects of graded levels of dried African star apple leaves on the growth performance of West Africa Dwarf goats. *Agricultural Journal, 7(4), 259-265.*
25. Oyaniran, D.K., Ojo, V.O.A., Aderinboye, R.Y., Bakare, B.A. and Olanite, J.A. (2018). Effect of pelleting on nutritive of forage legumes. Livestock Research for Rural Development 30(4): 1-8.
26. Peterson, J.A., Belyea, L.A., Bowman, J.P., Kerley, M.S. and Williams, J.E. (1994). Forage quality, evaluation and utilization. In: Fahey, G. C. (ed). *American Society of Agronomists*. Madison, Wisconsin, USA. 59-107 32.
27. Oyewole, S.T. and Aderinola, O.A. (2019). Growth performance and bio-economic indices of varying mixtures of grass-legume pellets fed to West African Dwarf (WAD) goats. *Journal of Biology, Agriculture and Healthcare*, 9(24), 2019.