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Performance of West African Dwarf ² (WAD) Goats fed ³ **N-source treated(N-treated source)** and forage supplemented ⁴ **Cassava peels in Humid Cross River State,** ⁵ **Nigeria**

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8 ABSTRACT

9 An investigation to ascertain the performance of West African Dwarf (WAD) goats fed **N-source**
10 treated(N-treated source) and forage supplemented cassava peels in Cross River State, Nigeria
was carried out.

11 Cassava peels were treated and supplemented with materials rich in nitrogen: fertilizer grade urea (T₁
12 – CSP + U), broiler litter (T₂ – CSP + BL), sweet potato (T₃ – CSP + SPF) and cassava (T₄ – CSP +
13 CSF) forages in a Completely Randomized Design (CRD) for 90 days of the growth trial. Results
14 revealed that the bucks in the cassava peel forage supplemented groups (T₃ – CSP + CSF and T₄ –
15 CSP + SPF) were observed to have better performance in terms of feed intake, weight gain, feed
16 conversion ratio (FCR) and dry matter digestibility. This is due to the presence of fermentable and
17 readily degradable proteins in the sweet potato and cassava forages. It is therefore recommended
18 that basal crop by-product supplementation by small holder goat keepers should be geared towards
19 the use of forages which is seen as a cheap and alternative supplement with crop by-products.

20 1. INTRODUCTION

21 With the increase in the production levels of food crops in Nigeria, there **will be (are)** more residues and by
22 products (straws, haulms, stovers, cobs, vines, peels, brans, leaves, chaff, etc) left after crop harvest
23 [1]. Similarly, Crop by-products predominantly cassava peels are available in large quantities in the
24 rural villages of Cross River State in Nigeria [2]. Hence, it is conceived that small ruminant animals,
25 especially the West African Dwarf (WAD) goats owned by traditional resource-poor livestock keepers
26 can obtain maximum productivity levels through these lignocellulosic materials [3].

27 These materials are characterized by low levels of protein, soluble carbohydrates and minerals [4].
28 They are poor quality materials, usually high in fiber, poorly degraded in the rumen, as well as low in
29 nitrogen and minerals [5]. These characteristics will affect their utilization by ruminants through
30 creating an unfavourable rumen environment, impeding microbial adhesion, affecting particle size
31 reduction, passage rates of both particulate and liquid digester, as well as roughage degradation rate
32 and volatile fatty acid (VFA) production [5].

33 There is therefore the need to upgrade the feeding value of fibrous crop by-products that are of
34 paramount importance in the nutrition of the ruminants. This can be achieved by interfering with the
35 protective effect of lignin on the availability of substrate to the rumen bacteria or to hydrolytic enzymes
36 [6]. This process could be enhanced by using simple inexpensive treatments which could increase the
37 breakdowns of these fibrous crop by-products in the rumen.

38 Interestingly, it is understood that the quality of protein available for the ruminants to utilize poor
39 quality feed stuffs is immaterial in their nutrition. What is paramount is the utilization of compounds

40 rich in N-supplies in combination with these fibrous feed materials [5]. Increased N-supplies can
41 improve the rumen environment (e.g., pH, rumen NH₃ or rumen degradable protein) to ensure
42 increased fermentation of the basal crop by-products by rumen micro-organisms [5]. Compounds with
43 these properties are non-protein nitrogen (NPN) compounds such as urea. There is also the need to
44 utilize highly nitrogenous forages and waste from the litter of poultry that are also rich in N-supplies
45 [7]. These materials represent a potential source of crude protein for the ruminant animals and may

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serve as a rational means to recycle these waste nutrients back into animal 46 feed. If this is achieved
47 the double purpose of conserving animal protein and alleviating pollution within our environment
48 would be served.

49 There is paucity of information as regards the performance on N-source treated (fertilizer grade urea
50 and broiler litter) and forage supplemented cassava peels by West African Dwarf (WAD) goats owned
51 by small holder goat farmers in the rural villages of Cross River State, Nigeria. The information on
52 these performance parameters will help to provide alternative and cheap sources of feed stuffs that
53 could help to sustain the livestock industry as well as increase the animal protein supplies that could
54 meet the requirements of the rural populace and beyond.

55 2. MATERIALS AND METHODS

56 2.1 Experimental site

57 The experiment was conducted at the sheep and goats unit of the Teaching and Research farm of the
58 University of Calabar, Calabar, Nigeria. Calabar is located at about latitude 4°58'N and longitude
59 8°17'E with an average annual temperature of 25 - 30°C and annual rainfall of 1,830 mm [8].

60 2.2 Management of experimental animals

61 Sixteen (16) 16 weeks old weaner bucks of the West African Dwarf (WAD) type were dewormed and
62 treated for possible attacks of (against) ectoparasites. The goats were randomly assigned to each treatment
63 group. Four (4) replicates of 4 bucks per treatment group were housed singly in an open pen (3m x
64 4m) for the 90 days of the growth trial in a Completely Randomized Design (CRD). The animals were
65 allowed to come out on a daily basis to exercise them in an open palour (25m x 25m) within 7.30 –
66 9.00 am.

67 2.3 Feed / feed treatment and management

68 The cassava peels were treated and supplemented with materials rich in nitrogen: fertilizer grade
69 urea, broiler litter, sweet potato and cassava forages respectively. The broiler litters were obtained
70 from the broiler production house of the University of Calabar commercial farm. It was sieved
71 thoroughly to remove the wooden particles contained in them and thereafter sun dried prior to their
72 use as treatment with the sundried basal cassava peels.

73 The cassava peel was treated by adding 4kg of urea to every 100 kg of the air dried cassava peels.
74 The urea was dissolved in 100 litres of water and sprayed over the cassava with the help of a watering
75 can, while placed in a container. This was then covered with some plastic sheet and allowed for
76 twenty- one (21) days before using them to feed the animals [9]. An evidence of the reaction taking
77 place is a change in colour of the cassava usually to bright yellow and of a strong smell of ammonia
78 when the material is uncovered. The broiler litter was also treated with the cassava peels in like
79 manner as those of urea treatment above, while the fresh forages (cassava leaves and sweet potato
80 leaves + vines) were provided at supplemental rates of 20% of the basal diet (cassava peels) on dry

81 matter basis to avoid substitution effects [10]. The various treatment combinations were:

82 T₁ = Cassava peel + Fertilizer grade urea (T₁ – CSP + U)

83 T₂ = Cassava peel + Broiler litter (T₂ – CSP + BL)

84 T₃ = Cassava peel + Cassava forage (T₃ – CSP + CSF)

85 T₄ = Cassava peel + Sweet potato forage (T₄ – CSP + SPF)

86 The treated cassava peels and those supplemented were offered to the WAD goats at 3% of their
87 body weights (dry matter basis). The feed, water and commercial mineral- salt licks (TANLICK®) were
88 provided *ad libitum*. Daily feeds were offered to the animals in the morning and evening at 09:00 and
89 16:00 hour respectively.

90 2.4 Growth trial

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The growth trial involved the use of sixteen (16) 16 weeks old weaner 91 bucks with average initial
92 weight of 6.76 ± 0.03 kg of the West African Dwarf (WAD) type (goat). Four (4) bucks were randomly
93 assigned to each treatment group (T₁, T₂, T₃ and T₄, respectively). Four (4) replicates of 1 buck per
94 treatment were housed singly in an open pen (3m x 4m) for the 90 days of the growth trial in a
95 Completely Randomized Design (CRD). The animals were allowed to exercise themselves within
96 7.00am – 8.30am in a 25m x 25m open parlor and retired by 9.00am and fed with the treated and
97 supplemented cassava peels *ad libitum* in their individual pens. The animals had regular access to
98 fresh clean water and commercial mineral-salt licks (TANLICK®). Feed offered and refused were
99 recorded on a daily basis. Average weekly weight gains were computed.

100 2.5 Digestibility trial

101 The digestibility trial lasted for 12 days (7 days of adjustment and 5 days of collection). Three (3)
102 bucks were assigned per treatment (T₁, T₂, T₃ and T₄, respectively) into metabolic cages (2.5m x 1.5m
103 x 4m) in a Completely Randomized Design (CRD). Daily feed offered and refusals were recorded.
104 Representative samples of feed offered and refused were put into sample bags and kept in a
105 Gallenkamp moisture extraction oven for 48 hours at 60°C for dry matter (DM) determination. The
106 difference in feed offered and refused per animal was recorded as voluntary feed intake on dry matter
107 basis. At the end of the digestibility trial, daily samples of feed offered, feed refused and faeces, were
108 bulked for the animals per treatment and a representative sample of the 5-day collection kept for
109 chemical analysis.

110 Total daily faecal output for the animals per treatment was collected using harness faecal collection
111 bags and recorded. Samples of faeces were taken from the animals for each treatment and dried in
112 the oven for 48hours at 60°C to determine faecal dry matter. The remainder was bulked for the
113 animals per treatment over the 5- day collection and stored in the deep freezer for faecal chemical
114 analysis.

115 2.6 Chemical Analysis

116 The samples of oven-dried feed offered and feed refused were further dried at 105°C for about 6
117 hours to climatic residual moisture before being ground through 1mm screen for chemical analysis.
118 About 1g samples were weighed into crucibles and placed in a muffle furnace at 500°C for 24 hours to
119 determine ash content, while organic matter concentration was computed by difference [11]. The
120 crude protein (CP) concentration (total nitrogen x 6.25) was determined according to the Micro121
kjeldahl method, while crude fat (CF) was determined by extraction [11]. Similarly, neutral detergent
122 fibres (NDF), acid detergent fibre (ADF) were determined according to prescribed standard

123 procedures [12]. Metabolizable energy (ME) was estimated according to the model suggested by [13]
124 as $ME (MJ/kg DM) = 135 - 0.15 \cdot ADF\% + 0.14 \cdot CP\% - 0.15 \cdot Ash\%$.

125 2.7 Statistical Analysis

126 Analysis of variance (ANOVA) using general linear model (GLM) procedures [14] for Completely
127 Randomized Design (CRD) was used to determine the treatment effects in the growth and digestibility
128 trials. Treatment means, was separated using the Duncan Multiple Range Test [15].

129 3. RESULTS AND DISCUSSION

130 3.1 Proximate composition of basal cassava peel and nitrogen supply

131 The proximate composition of the basal cassava peel and nitrogen supply sources used as treatment
132 and supplements for the study are presented in Table 1. Similarly, the proximate composition of the
133 diets: urea and broiler litter treated cassava peels (T_1 – CSP + U and T_2 – CSP + BL respectively) and
134 cassava and sweet potato forage supplemented cassava peels (T_3 – CSP + CSF and T_4 – CSP +
135 SPF respectively) are presented in Table 2. The dry matter (DM) contents of the feedstuffs were not
136 significantly ($P > 0.05$) different. However, the crude protein contents of the feedstuffs were
137 significantly ($P < 0.05$) different. The CP content ranged between 16.02 and 30.05% among the
138 treatment groups with T_3 (CSP + CSF) and T_1 (CSP + U) having the lowest and highest values
139 respectively. A trend in the increase of the CP contents of the diets were observed because of the
140 complementary or contributive effects of the CP contents of the materials used for treating the

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cassava peel and/or used as a supplement (Table 1). Thus the increase 141 in the CP contents of T_1
142 (CSP + U) and T_2 (CSP + BL) for instance, may be attributed to the higher CP contents of urea
143 (28.84%) and broiler litter (26.50%) respectively. The use of these materials in this study is worthwhile
144 since the use of conventional proteins may be a costly and wasteful venture amidst cheaper
145 alternatives. For instance, the cost of nitrogen in the form of white fish meal is generally more than
146 fifty times that of nitrogen from urea, and small amounts of urea can be added to diets for ruminants
147 to supply at least a part of their nitrogen needs (need) [16]. In addition, it was observed that broiler litter
148 consists of a mixture of a fibrous food with poultry excrement and it is possible that the ammonia
149 which is produced as the excrement decays may actually increase the nutritive value of the fibrous
150 part of the diet [16]. Therefore, these feedstuffs based on chemical analysis have been recommended
151 to meet the minimum level of CP (12%) utilized for digestibility trials [17].

152 There was a significant ($P < 0.05$) difference in the ether extract (EE) contents of the feedstuffs. The
153 EE contents of the feedstuffs were in the increasing order of 6.04, 10.05, 13.00 and 14.00%, for T_1
154 (CSP + U), T_2 (CSP + BL), T_4 (CSP + SPF) and T_3 (CSP + CSF). The EE contents in T_3 (CSP + CSF)
155 and T_4 (CSP + SPF) were higher as compared to T_1 (CSP + U) and T_2 (CSP + BL). The higher EE
156 contents of the feedstuffs (T_3 - CSP + CSF and T_4 - CSP + SPF) may be attributed to the relative
157 content of oil contained in the forages of cassava and sweet potato [18].

158 The crude fibre (CF) contents of the feedstuffs were not significantly ($P > 0.05$) different. The CF
159 contents of the feedstuffs were in the increasing order of 15.05, 17.00, 19.55 and 20.06%, for T_1 (CSP
160 + U), T_2 (CSP + BL), T_3 (CSP + CSF) and T_4 (CSP + SPF). Although significant difference did not
161 occur among the feedstuffs in CF contents, T_4 (CSP + SPF), T_3 (CSP + CSF) and T_2 (CSP + BL)
162 recorded higher CF contents. These higher values may be attributed to the lignin contents contributed
163 by the leaves/vines of the cassava and sweet potato as well as those of wood chips which are a

164 component of the broiler litter [19].

165 The ash contents of the feedstuffs were not significantly different ($P > 0.05$). The ash contents of the
166 feedstuffs were in the increasing order of 16.00, 16.05, 18.01 and 20.04%, for T₁ (CSP + U), T₂ (CSP
167 + BL), T₄ (CSP + SPF) and T₃ (CSP + CSF). Although significant differences did not occur among the
168 feedstuffs in ash contents, T₃ (CSP + CSF) and T₄ (CSP + SPF) recorded higher ash contents. These
169 feedstuffs are higher in ash contents because of the contributive effects of the leaves of cassava and
170 sweet potato that have been reported to be a valuable source of ash [18].

171 The Nitrogen free extract (NFE) contents of the feedstuffs were significantly different ($P < 0.05$). The
172 NFE content ranged between 30.39 – 32.86% for T₃ (CSP + CSF) and T₁ (CSP + U). The acid
173 detergent fibre (ADF) and the neutral detergent fibre (NDF) were significantly different ($P < 0.05$). The
174 ADF contents in the feedstuff were in the increasing order of 16.00, 26.00, 30.39 and 34.00% in T₁
175 (CSP + U), T₂ (CSP + BL), T₃ (CSP + CSF) and T₄ (CSP + SPF) respectively. Similarly, the NDF
176 contents in the feedstuffs were in the increasing order of 30.06, 40.00, 50.05 and 56.00% in T₁ (CSP
177 + U), T₂ (CSP + BL), T₃ (CSP + CSF) and T₄ (CSP + SPF) respectively.

178 The calculated metabolizable energy (ME) of the feedstuffs was significantly different ($P < 0.05$). The
179 ME content of the feedstuffs varied from as low as 7.94 MJ/kgDM to as high as 12.00 MJ/kgDM in T₃
180 (CSP + CSF) and T₁ (CSP + U) respectively. The feedstuffs that possess the higher CF content
181 recorded the lowest values of ME [19]. However, the ME of the feedstuffs was within the
182 recommended levels (6 - 13MJ/kgDM) for maintenance and production for goats [20].

183 3.2 Feed intake

184 Table 3 shows the result of the performance of WAD bucks fed cassava peels treated with urea (T₁-
185 CSP + U) and broiler litter (T₂ - CSP + BL) and cassava peels supplemented with cassava forage (T₃
186 – CSP + CSF) and sweet potato forage (T₄ – CSP + SPF). Results from the study revealed that there
187 were significant ($P < 0.05$) differences in the dry matter feed intake among the WAD bucks in the
188 utilization of the different diets. However, the intake of T₃ (CSP + CSF) and (T₄ – CSP + SPF) by the
189 bucks were not significantly ($P > 0.05$) different. The dry matter intake of the feedstuffs varied from as
190 high as 276.07 g/day to as low as 104.27 g/day for T₃ (CSP + CSF) and T₁ (CSP + U) respectively in
191 the WAD bucks. The bucks in the cassava peel forage supplemented groups (T₃ – CSP + CSF and T₄
192 – CSP + SPF) were observed to have a higher feed intake as compared to their cassava peel urea
193 (T₁- CSP + U) and broiler litter (T₂ - CSP + BL) treatment groups. The increase in feed intake may be
194 attributed to the catalytic effects of the forages used as supplements [6]. In addition, the forages may
195 have fermentable proteins and readily degradable walls as are peculiar 195 with legume forages which
196 would increase the substrates available to cellulolytic microbes with a consequent increase in the
197 population of these microorganisms [21]. Therefore, conditions that enhance the activities of these
198 rumen microorganisms are liable to increase food intake [20].

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204 3.3 Weight gains

205 The results of the performance of the WAD bucks fed cassava peels treated with urea (T₁- CSP + U)
206 and broiler litter (T₂ - CSP + BL) and cassava peels supplemented with cassava forage (T₃ – CSP +
207 CSF) and sweet potato forage (T₄ – CSP + SPF) are presented in Table 3. The initial weights of the

208 WAD bucks allotted to the different feed treatment groups were not significantly ($P > 0.05$) different. 209 Similarly, the final total weight and the weight gains were also not significantly ($P > 0.05$) different. 210 However, the final weight in order of superiority for the WAD bucks were 7.63kg, 7.58kg, 7.29kg and 211 7.25kg for T₃ (CSP + CSF), T₄ (CSP + SPF), T₂ (CSP + BL) and T₁ (CSP + U) respectively. The 212 average total weight gain and the average daily weight gain of WAD bucks for the treatment groups 213 were significantly ($P < 0.05$) different. The average total weight gain values in the WAD bucks varied 214 from as high as 870.00g to as low as 490.00g for T₃ (CSP + CSF) and T₁ (CSP + U) respectively. The 215 average daily weight gain values for the WAD bucks varied from as high as 9.67g/day to as low as 216 5.44g/day for T₃ (CSP + CSF) and T₁ (CSP + U) respectively. The marked variation in weight gain by 217 WAD bucks fed the different feedstuffs may be attributed to the various levels of metabolizable energy 218 in the crop by-products [22]. Although the metabolizable energy of T₃ (CSP + CSF) was lower than 219 those of T₁ (CSP + U) they were within the range 6 – 13 MJ/kg DM necessary for optimal productivity 220 [20]. The superior weight gains exhibited by WAD goats fed T₃ (CSP + CSF) may also be attributed to 221 the level of voluntary intake of the diets. This is in agreement with the reports by [23] that if the 222 voluntary intake of feed by the animals is too low, rate of production will be depressed. This factor has 223 thus, been described as one of the factors for productivity in small ruminants [24].

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232 3.4 Feed conversion ratio (FCR)

233 The results in Table 3 revealed that there were significant ($P < 0.05$) differences in the FCR among 234 the WAD bucks fed cassava peels treated with urea (T₁- CSP + U) and broiler litter (T₂- CSP + BL) 235 and cassava peels supplemented with cassava forage (T₃- CSP + CSF) and sweet potato forage (T₄ 236 – CSP + SPF). The FCR of the WAD bucks were in the increased from 18.18 to 19.17 through 28.55 237 and 29.01 for T₂ (CSP + BL), T₁ (CSP + U), T₃ (CSP + CSF) and T₄ (CSP + SPF) respectively. The 238 WAD bucks fed the cassava peels supplemented with forages (T₃- CSP + CSF and T₄- CSP + SPF) 239 utilized feed for body weight gain poorly ($P < 0.05$) when compared with the cassava peel treated with 240 urea (T₁- CSP + U) and broiler litter (T₂- CSP + BL). Thus, the cassava peels supplemented with 241 forage groups recorded a higher body weight gain. However, the efficiency at which the WAD bucks 242 converted feeds for body weight gains in this present study was contrary to the average value (11.96) 243 obtained by [25]. The disparity in FCRs may be attributed to the difference in the initial body weights 244 of the animals utilized.

245 3.5 Dry matter digestibility

246 The results in Table 3 revealed that there were significant differences ($P < 0.05$) in the dry matter 247 digestibility among the WAD bucks fed cassava peels treated with urea (T₁- CSP + U) and broiler 248 litter (T₂- CSP + BL) and cassava peels supplemented with cassava forage (T₃- CSP + CSF) and 249 sweet potato forage (T₄- CSP + SPF). The dry matter digestibility of the feedstuffs were in the 250 increasing values of 64.93%, 63.20%, 53.13% and 51.53% for T₃ (CSP + CSF), T₄ (CSP + SPF), T₁ 251 (CSP + U) and T₂ (CSP + BL) respectively. Although animals fed T₃ (CSP + CSF) possessed the 252 highest digestibility value (64.93%), they were not statistically different from those of T₄ (CSP + SPF 253 – 63.20%). The high digestibility value recorded by WAD goats fed T₃ (CSP + CSF) could be related 254 to the high feed intake values recorded for the feedstuff by the WAD bucks. A regular trend in the

255 relationship between feed intake and feed digestibility was observed in this study. The digestibility of
256 feed among the WAD bucks fed the different diets increased with increasing levels of feed intake.
257 This is in agreement with the reports of [16], who established a positive relationship between the
258 digestibility of foods and their intake.

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260 4. CONCLUSION AND RECOMMENDATION

261 The bucks in the cassava peel forage supplemented groups (261 T₃ – CSP + CSF and T₄ – CSP
262 + SPF) were observed to have better performance in terms of feed intake, weight gain, feed
263 conversion ratio (FCR) and dry matter digestibility. This is attributed to the catalytic effects of the
264 forages used as supplements due to the presence of fermentable and readily degradable proteins
265 which would increase the substrates available to cellulolytic microbes with a consequent increase in
266 the population of these microorganisms that are liable to increase food intake, feed utilization,
267 digestibility and subsequent weight gain. It is therefore recommended that basal crop by-product
268 supplementation by small holder goat keepers should be geared towards the use of forages which is
269 seen as a cheap and alternative supplement with crop by-products.

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