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Effect of feeding crop residues of different cereals and legumes on weight gain of Yankassa rams

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Crop residues from maize (*Zea mays* L.), sorghum (*Sorghum bicolor* L. Moench), millet (*Pennisetum glaucum*), cowpea (*Vigna unguiculata* L. Walp) and groundnut (*Arachis hypogaea* L.) are important livestock feed in the West African savannas particularly during the long dry season. The residues from cereal crops are relatively in abundance, but of low nutritive value compared to the leguminous crop residues, which are normally in short supply. This experiment was conducted to determine the most efficient combinations of feeding crop residues of major cereals and legumes with and without bran supplement to 'Yankassa' rams in confinement over a 70-day period and their effect on weight gains. Feeding the residues of cereals alone resulted in a mean weight loss of 14% for sorghum, 16% for maize and 11% for millet, while feeding the residues of cowpea or groundnut alone resulted in the weight gain of about 13 and 12%, respectively. Supplementing the cereals residues with about 300 g of legume residues per ram per day resulted in slight gain in weight. Addition of 300 g wheat bran and 300 g legume residues to the cereals in the daily diets of each ram resulted in about 19% mean weight gain. Thus, bran showed a small but significant additive effect on weight gain. From the 1.5 kg cereals or legumes residues offered per ram per day, the rams ate about 50% of cereals and 82% of the legumes. Thus, the cereals residues are not only less nutritious, but also less consumable compared to the legumes.

Key word: Cowpea, crop residues, groundnut, livestock feeding, maize, millet, sorghum.

INTRODUCTION

The rapid increase in population and more demand for food is pushing agriculture to marginal lands in West Africa (Singh et al., 2004). This coupled with little or no use of fertilizers has led to continuous decline in soil fertility and low food and feed productivity in the region resulting into widespread malnutrition and hunger (Ajeigbe et al., 2001). Crop and livestock integration helps in maintaining soil fertility by the use of manure and increases farm efficiency by providing traction and transport and also it increase the farm income and human nutrition through milk and meat (Smith et al., 1997)

The major constraint to crop-livestock integration in West Africa is the limited availability of livestock feed with high nutrient quality (Latham, 1999). In this region, farmers mostly feed their livestock with sorghum, millet and maize stovers as basal diet, while cowpea and groundnut haulms are fed as protein supplement (Russo, 1990). Other agricultural by-products such as brans, oilcakes, etc, which are generated when crops are processed (de Leeuw, 1997) are also fed to livestock as energy and mineral supplement. Cereals crop residues are low in nutritive value because of their relatively low digestibility, low crude protein content and low content of available minerals and vitamins (Owen 1994,). Efforts to improve the nutritive value of the cereals residues through treatment with urea and other chemicals have not been very popular because technologies are often at the "high

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tech", for application by small holder subsistence farmers (Owen and Jayasuriya, 1989). These limitations coupled with the fact that urea is very expensive in Africa, it would be more profitable to use the urea to increase grain and stover yields instead of using it to upgrade crop residues. Carangal and Calub (1987) noted that while the feeding value of cereal stovers are very low, the haulms of leguminous crops like cowpea and peanut are very high owing to higher protein contents ranging from 13 to 19% in these legumes. The leguminous haulms are therefore, good supplement to improve the feeding value of cereals straw. Cowpea and groundnut are the major legumes and maize, millet and sorghum are the major cereals in West Africa and their residues constitute a major source of livestock feed (Singh et al., 2003). Through concerted efforts of National and International Institutions, improved varieties of these crops and improved cropping systems have been developed, which are increasing both grain and fodder yield production in this region (Singh et al., 2003, Singh and Ajeigbe, 2006). However, information on the intrinsic feed value of different crop residues and what proportion of cereals and legume residues should be fed to ruminants for maximum weight gain is limited. Therefore, this experiment was conducted to compare the weight gain in rams fed with crop residues from sorghum, millet, maize, cowpea and groundnut as sole and in various combinations with and without supplementation with wheat bran.

MATERIALS AND METHODS

This experiment was conducted in the dry season (February to April) of 2004 at the International Institute of Tropical Agriculture (IITA) Kano Station Research farm, Minjibir (12 08'N, 8 40E). A total of 77 Yankassa rams were used for the feeding trial and the experiment was conducted in a completely randomized design. Seven rams were used per treatment with each ram as a replication. The animals were allocated to each treatment such that the average initial weight was similar (about 29 kg/ram) for different treatments. Assuming that small ruminants can consume up to 3% of their body weight, about 870 g residue/ram would have been enough, but in this experiment, each ram was offered at least 1.5 kg residues as a basal diet with and without other supplements so that feed did not become a limiting factor, and the actual amount of feed required could be estimated. The 11 treatments consisted of different crop residues, which were roughly chopped and fed in different combinations as indicated as follows:

- Treatment 1 (T1): 1.5 kg sorghum fodder daily per animal.
- Treatment 2 (T2): 1.5 kg maize fodder daily per animal.
- Treatment 3 (T3): 1.5 kg millet fodder daily per animal.
- Treatment 4 (T4): 1.5 kg cowpea fodder daily per animal.
- Treatment 5 (T5): 1.5 kg groundnut fodder daily per animal.
- Treatment 6 (T6): 1.5 kg sorghum fodder + 300 g cowpea fodder daily per animal.
- Treatment 7 (T7): 1.5 kg sorghum fodder + 300 g groundnut daily per animal.
- Treatment 8(T8) 1.5 kg sorghum fodder + 200 g bran daily per animal.
- Treatment 9 (T9): 1.5 kg cowpea fodder + 200 g bran daily per animal.
- Treatment 10 (T10): 1.5 kg sorghum fodder + 300g cowpea fodder + 300 g bran daily per animal.
- Treatment 11 (T11): 1.5 kg sorghum fodder + 300g groundnut fodder + 300 g bran daily per animal.

The animals were treated against internal parasite using Levamisole HCL 1.5%W/V BP + Oxyclozanide 3.0% W/V BP + Cobalt Sulphate 0.382% W/V (1 ml per 2 kg body weight) and external parasites were conditioned for a week, feeding on the crop residues and bran. After conditioning, the rams were numbered according to the treatments and replications and placed in the livestock shed and tied to a pole. Each ram was provided with a feeding pen and received feed and water individually on daily basis according to treatment. Chopped sorghum/millet/maize residues were given at 8.00 am. Cowpea or groundnut haulms were offered in respective treatments at 9.00 am and fresh water was offered at 10.30 am and 4.00 pm and all animals had access to mineral block all the time. Feed refusals were collected every morning before offering another fresh feed and weighed separately for all the component cereal and legume residues. All the animals were weighed for 3 consecutive days every 10 days throughout the experimental period and the average weight over the three days was recorded as a final weight for that sampling period. The experiment started on February 17 and was terminated on April 27, after taking the final weight. Thus, the experiment lasted for a total period of 70 days. The data were analyzed using GENSTAT discovery 3 edition. Similar treatments were pooled and compared with contrasting treatments. Contrasts were calculated for pair wise comparisms. Least significant differences of the means were calculated as well as Duncan multiple range test (DMRT) using SAS program.

RESULTS

The summarized data for the feed intake, feed refusals and relative weight gain in respect of different treatments are presented in Table 1. There was no significant difference in the mean initial weight/ram between different treatments, but significant differences were observed in the final mean weight/ram between different treatments. This was partly due to differences in the amount of feed intake/refusal and intrinsic nutritional values of different feed combinations.

Feed Intake

All the rams left some residues unconsumed each day, but the leftovers were more in cereals compared to the legumes. The mean percentage of crop residues eaten by the animals were 46% for millet, 50% for maize, 53% for sorghum, 86% for cowpea and 94% for groundnut indicating preference for legumes over cereals residues and preference for sorghum over maize and millet among the cereals. Among the cereals, sorghum residues had the highest intake of 797 g/day, which was significantly higher than millet intake (714 g/day), but not significantly

Table 1. Effect of stall feeding crop residue on the weight gain of Yankassa ram in West Africa Savanna.

Treatment	Initial weigh (kg)	Feed intake (g)	Feed refuse (g)	Feed taken (%)	Final weight* (kg)	Weight gain (kg)	Weight gain (%)
1.5kg sorghum stover/ day	28.9	797	703	53	24.8 ^{d}	-4.18	-14
1.5kg maize stover/day	28.9	752	748	50	24.3 ^{d}	-4.61	-16
1.5kg millet fodder /day	28.8	714	786	46	25.6 ^{cd}	-3.18	-11
1.5kg cowpea fodder/day	28.8	1284	216	86	32.5 ^{ab}	3.74	13
1.5kg groundnut fodder /day	28.5	1406	94	94	32 ^{ab}	3.56	12
1.5kg sorghum fodder+300g cowpea fodder /day	28.9	1030	770	57	29.6 ^{b}	0.78	03
1.5kg sorghum fodder+300g groundnut /day	28.9	1034	765	57	28.9 ^{bc}	-0.06	00
1.5kg sorghum fodder+200g bran /day	28.5	1008	692	59	30 ^{b}	1.51	05
1.5kg cowpea fodder+200g bran /day	28.8	1495	205	88	34.4 ^{a}	5.58	19
1.5kg sorghum fodder+300g cowpea fodder+300g bran /day	28.7	1335	765	64	34 ^{a}	5.38	19
1.5kg sorghum fodder+300g groundnut fodder+ 300g bran /day	28.9	1330	770	63	34.3^{a}	5.39	19
Mean	28.8	1107.7	592	65	30.05	1.27	4.61
Var. ratio		179.21	173.5	157.17	9.17	46.54	40.5
F. prob.		<.001	<.001	<.001	<.001	<.001	<.001
LSD (5%)	ns	58.58	58.59	3.629	3.54	1.68	5.99

*Weights followed by same letter are not significantly different.

different from maize residue intake (752 g/day). The groundnut fodder had a significant higher daily intake (1406 g/ram) than other crop residues followed by cowpea fodder (1284 g/ram), which was also significantly higher than the cereals residues intake. Including 300 g of legume residues in the cereal basal diet increased the overall in take to 57%, while including 200 g of wheat bran to the cereal residues increases the absolute intake (1030 g/day) as well as percentage intake to 59%. Including bran in the cereal-legume feed increase; it was also noted that in the treatments that included bran, the overall intake was more and 100% of the bran was consumed

Weight gain

Even though there was no significant difference in the initial mean weight of rams in different treatments groups, the final weights of rams differed significantly in different treatment groups (Table 1). Rams fed on cereals residues alone lost significant amount of body weight, while those fed on legumes alone gained body weight. The average weight loss was 16% for maize, 14% for sorghum and 11% for millet and the average weight gain was 13% for cowpea and 12% for groundnut. Thus even though rams consumed more maize residue than millet, they lost more weight from eating maize residues alone than eating millet residues alone. Rams fed on 1.5 kg of cowpea fodder plus 300 g wheat bran had the highest weight gain of 5.58 kg (19.4%), but this was not significantly different from feeding a combination of sorghum, cowpea, groundnut and bran (treatments 10 and 11). Treatments including bran were significantly better for weight gain than feeding crop residues alone. There was however, no significant difference between the rams fed with 1.5 kg sorghum stover plus 300 g of cowpea fodder and those that fed the same amount of sorghum stover plus 300g of groundnut fodder (-0.06 kg). The results of the pair wise comparism of the treatments using contrast are given in Table 2. Significant differences in ram weight gains were observed between feeding legumes only and cereal only. However, there were no significant difference in weight gain among the cereals and no significant difference in weight gain between feeding cowpea and groundnut either sole or as supplement. When the weight of feeding on one feed (sorghum, maize, millet, groundnut or cowpea) was compared with feeding on feed mixture, significant differences were observed with the mixture providing significantly higher weights gain than single feed.

The relative weight gain by rams fed in different treatment groups over time is presented in Figure 1, which shows that the treatments can be classified into 4 groups. Group 1 is made up of treatments in which rams were fed with cereals (millet, sorghum and maize) residues only and they all lost weight ranging from 3.18 4.61 kg. The second group is made - up of treatments that

Table 2. Contrast analysis of the different treatment combinations.

Treatment contrast	Aim	F probability
T1-T3 Vs T4-T5	Cereal versus legume stovers	< 0.001
T1-T5 Vs T6-T11	Compare single source rations versus multi source	< 0.001
T1 Vs T3	Sorghum versus millet	0.629
T1,T3 Vs T2	Maize versus sorghum or millet	0.563
T4 Vs T5	Cowpea versus groundnut	0.775
T6-T7 Vs T10-T11	Effect of bran	<.001
T6 Vs T7	Supplementation with groundnut or cowpea	0.659
T1,T8 Vs T4,T9	Sorghum versus cowpea	<.001
T8 Vs T10-T11	Bran only versus legume plus bran	0.008
T10 Vs T11	Cowpea versus groundnut	0.906

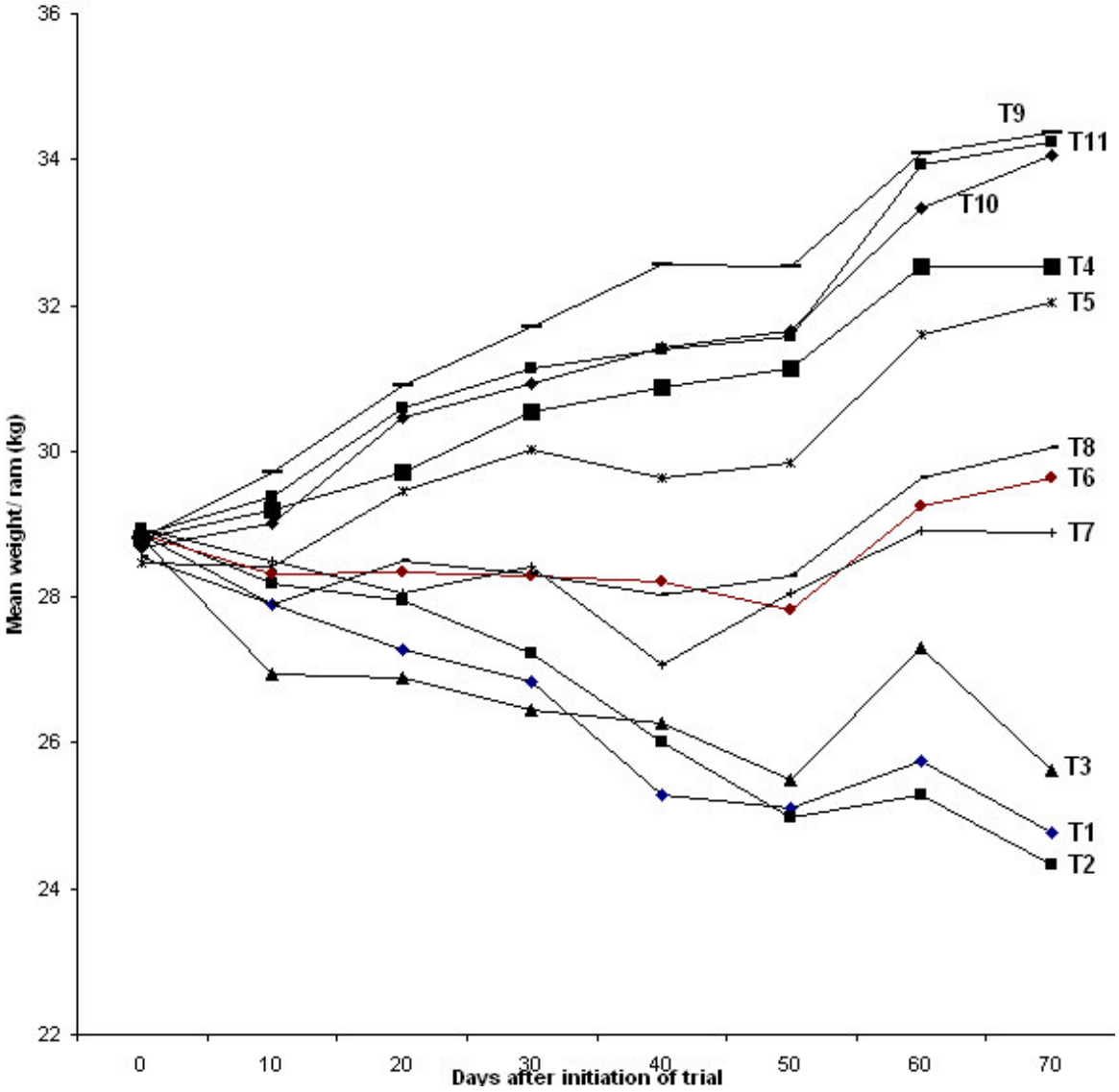

Figure 1. Effect of feeding crop residues on weight gain in Yankassa rams* (*Ajeigbe et al., 2008).

Table 3. Composition of feed used.

Feed	Crude protein	P(%)	Ca(%)	K(%)	Fe (ppm)	Reference
Cowpea	13.63, 14.19, 17.8	0.19, 0.288, 0.132	1.05, 1.425	1.56	225.94	Ajeigbe, 2003; Mosimanyana and Kiflewahid, 2006
Groundnut	14.8 - 21.6					Omokanye et al., 2001
Sorghum	3.24, 5.5, 5.56	0.07 -0.168, 0.103	0.32, 0.379	0.83	161.06	Ajeigbe, 2003; Mosimanyana and Kiflewahid, 2006
Maize	2.69, 3.29, 7.84	0.03-0.09, 0.123	0.24, 0.278	1.14	271.47	Ajeigbe, 2003; Mosimanyana and Kiflewahid, 2006
Millet	6.2, 5.52	0.222,0.043	0.309			Ajeigbe, 2003; Mosimanyana and Kiflewahid, 2006
Wheat bran	16,11.48	1.2, 0.31	0.381			Mosimanyana and Kiflewahid, 2006

that maintained or slightly increased the weight of rams and this included sorghum-cowpea, sorghum-groundnut and sorghum-bran. The third group comprised of treatments with only sole cowpea or groundnut residues and showed good level of gain (3.56 to 3.74 kg in 70 days) in weight. The fourth group with highest weight gains included treatments with a combination of sorghum, cowpea, groundnut and bran.

The results further indicated that the gain or loss of weight was gradual over the 70 days feeding period (Figure 1) and even though some rams lost up to 4 kg weight, they did not die or got sick. In fact when the normal feeding was restored after termination of the experiment, these rams quickly recovered and restored their normal weight.

DISCUSSION

The treatments can be grouped into 4; group 4 (consisting of treatments 9, 10 and 11) are the high weight gainer, group 3 (consisting of treatments 4 and 5) are the moderate weight gainer, while group 2(consisting of treatments 6, 7 and 8) are weight maintainer and group 1 (consisting of treatments 1, 2 and 3) are weight losers. The present study has provided an estimate of the intrinsic feed value of the crop residues of major cereals and legumes to small ruminants as well as an estimate of the potential proportion of different crop residues and other supplements for moderate weight gain in Yankassa rams in West Africa. Feeding on residues of cereals like maize, millet and sorghum alone, resulted in the weight lost of the animals between 11 to 16%. This is because of the relatively low digestibility, low crude protein content and low content of available minerals and vitamins in the cereals residues (Owen, 1994). Results from several other researchers (Table 3) have shown that the legumes are generally higher in crude protein and other minerals than the cereals. Among the cereals residues offered, rams consumed more sorghum than maize and millet residue than millet and sorghum, but feeding on millet residues caused less weight loss than maize. A relatively higher consumption of maize residue may be due to its softer stems than millet and sorghum, but maize residues may be less nutritious. This may be due to higher grain yield of maize than millet and sorghum and therefore, greater transfer of nutrients from leaves and stems to grain. In complete contrast to cereals residues, rams consumed more residues of cowpea and groundnut and when the rams were fed solely on cowpea and groundnut residues, they gained from 12 to 13% weight in 70 days. Adding even a little bit of cowpea and groundnut residues (300 g) with cereal residues, was just enough in maintaining the weight. This may be due to the fact that cowpea and groundnut residues have higher digestibility (mean of 67 and 56%, respectively) and higher (13 - 19%) crude protein content (Ajeigbe, 2003, Singh et al., 2003), which is above the minimum (7%) crude protein recommended (ARC,1980). Digestibility of groundnut haulms is lower than cowpea haulms (Savadogo et al., 2000), and this is shown in this study where supplementing the sorghum diet with cowpea gave a higher weight gain than supplementing the sorghum with groundnut. The quantities of feed offered to the rams allow some level of selection and this may have reduced the differences observed between the legumes. The addition of bran to the cereals and legumes residues resulted in even higher weight gain indicating the additive effect of extra mineral, protein and energy from bran. This is in agreement with the suggestion of Miles et al. (1994) that digestible energy in cereal-legume residues could also be limiting. The resultant weight gain due to addition of wheat bran could be attributed to its high total digestible nutrients (TDN) of 70% and crude protein (17%) content (Gilbery et al., 2000). Since various types of bran are available from the processing of household cereals and legumes, this would be a good supplement with cereal and legume residues-based feed for rams.

It was interesting to note that even though rams fed on millet, maize and sorghum residues alone lost from 11 to 16% of their body weight in 70 days; there was no single mortality or sickness. This reveals the hardiness of the Yankassa breed of sheep in its traditional environment. It also shows that even though cereals residues alone may not be enough to improve the livestock productivity, it can be used to keep the animals alive for sometime, until the balanced feed becomes available. This is how the smallholder farmers are managing to maintain their livestock during the dry season in West Africa. This often happens to oxen and cattle, which are maintained on cereals residues only during the dry season and they lose up to 20% of their body weight (Bartholomew et al., 1993). Farmer can however, spread the use of their limited leguminous fodder to cover the whole or most part of the dry season by giving about 300 to 500 g per animal. As the human and livestock populations increase and agriculture becomes more intensive, the problem of feeding livestock will be exacerbated. Therefore, there is an urgent need to increase both food and fodder production using improved cropping systems of cereals and legumes that improve both the quality and quantity of the crop residues (Mortimore et al., 1997).

Recently, improved dual-purpose cowpea varieties have been developed, which in combination with an improved cowpea–cereals strip-cropping systems have shown over 300% superiority in gross production and income (Singh et al., 2003; Ajeigbe et al., 2006). This system involves planting of 2 rows of cereals: 4 rows of cowpea in place of the traditional 1:1 system. This cropping system with more legumes and less cereals requires less fertilizer and produces more grain and better quality fodder and ensures better nutrient recycling for soil fertility maintenance (Singh and Ajeigbe, 2002). Thus, farmers practicing the improved cowpea-cereal systems now have options for different feeding strategies for their livestock in the dry season in the savanna zones of West Africa depending on feed resources available. For weight maintenance of stall fed small ruminants, a basal feed of cereal stalk and supplementation with leguminous residues would be sufficient. However, inclusion of bran in the diet would result in weight gain. Controlled stall-feeding also enables the farmer to collect manure and save the cost of fertilizers. Such a system would be especially beneficial to the resource-poor farmers in the dry savannas of West Africa.

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