NUTRITIVE VALUE AND ANTIOXIDANT PROPERTIES OF SOME CROP RESIDUES USED IN RUMINANT FEEDING

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ABSTRACT
The study was carried out to evaluate the nutritive value and anti-nutritive properties of five common crop residues used in ruminant feeding. The crop residues used were, millet bran, groundnut hay, rice mill waste, cowpea husk and maize cobs. The treatments were laid in a completely randomized design. The samples were shade dried, pulverized and analyzed for nutritive value (proximate constituents) and antioxidant properties which were replicated thrice. Data collected were analyzed using SAS (2000) and means were separated using Tukey's test at P<0.05. The results obtained showed that there was significant (p<0.05) difference among the treatments in all variable evaluated. Cowpea husk had the highest crude protein contents (13.77%) and nitrogen free extract (80.33%) while ash content was found to be highest in groundnut hay (7.15%) and maize cobs had the least dry matter content (90.14%). Alkaloids and saponins levels were highest in groundnut hay (0.70%) and millet bran (2.58%) respectively. Groundnut hay had the least radical scavenging activity (0.29µg/ml) and (0.31µg/ml) at 0.8mg/ml and 1.0mg/l respectively while maize cobs had the highest at both concentrations. The ferric reducing power effect was recorded highest in rice mill waste (0.65µg/ml) at 0.4ml/l and least in maize cobs (0.48µg/ml) at 0.2mg/ml concentrations. It is concluded that in terms of crude protein and nitrogen free extract, cowpea husk proved to be superior. However, groundnut hay had superior ash content. Similarly, cowpea husk had the highest total antioxidant activity.
Key words: crop residues, nutritive value, antioxidant

INTRODUCTION
Human population explosion is a source of worry globally. Food shortages and famine are becoming endemic in many places. To address these problems, scientists are investigating alternative feed sources, evaluating and utilization of food. Thus, feeding grains to ruminants is questioned because Man, a monogastric can utilize grains directly. On the other hand, ruminants are characterized by their ability to convert low quality roughages to meat, milk, natural fibres, leather and manure and other products that are useful to Man (Gertenbach, 2013). Hence, the use of crop residues in ruminant feeding has been advocated. The nutritive value of crop residues is influenced by several factors depending on the type of the crop. It is generally determined by feed composition, intake and utilization efficiency of digested matter (ACP, 2002). Various crop residues have diverse nutritional values and are used by different animal species.
An antioxidant is a molecule that inhibits the oxidation of other molecules or a substance that in small amount will inhibit the oxidation of other compounds (Prakash *et. al.*, nd). Oxidation is a chemical reaction that can produce free radicals, leading to chain reactions that may damage cells. The main characteristic of an antioxidant is its ability to trap free radicals. The aim of this study was to evaluate the nutritive value and anti-nutritive profile of common crop residues used in ruminant feeding.

MATERIALS AND METHODS
SAMPLE COLLECTION:
The crop residues evaluated were millet bran, rice mill waste, groundnut hay, cowpea husk and maize cobs. Maize cobs, cowpea husk and rice mill waste were obtained from the Faculty of Agriculture Farm, Bayero University Kano while groundnut hay and millet bran were obtained from farms in Kibiya Local Government Area.

SAMPLE PREPARATION:
The crop residues were shade-dried, pulverized using a grinder and stored in airtight containers as stated by Seal (2011). Proximate composition and antioxidant concentration as well as its activities were evaluated in the Biochemistry laboratory Bayero University Kano.

PROXIMATE ANALYSIS:
The nutritive value (proximate contents) of the samples comprising moisture, ash, ether extract, crude protein, crude fibre and Nitrogen Free Extract (NFE) were determined according to the standard methods outlined by AOAC (2000).

ANTIOXIDANT TESTS
The antioxidant analysis for the presence of saponins, tannins, alkaloids, and flavonoids were carried out according to the methods described by Ejikeme *et. al,* (2014) and Hassan *et. al,* (2015). Each analysis was carried out in triplicate.

EXTRACTION OF PLANT MATERIAL FOR ANTIOXIDANT ANALYSIS:
One gram of each plant material was soaked in 20ml aqueous methanol (20%) for 18 hours at room temperature. The extracts were filtered and diluted to 50 ml and aliquot were analyzed for their total phenolic content and their free radical scavenging capacity (Seal, 2011).

QUALITATIVE ANALYSES OF ANTIOXIDANT:
Two grams of each sample was measured and poured into a conical flask, 50ml of distilled water was added to the Sample and the mixture was shaken vigorously and allowed to stop for 30 minutes. The mixture was then filtered using Whatman filter paper and few drops of different indicators were added to the filtrate depending on the compound of concern.

ESTIMATION OF ALKALOID CONTENT:
Two and a half grams of each plant sample was weighed into a 250 cm^3 beaker and 200 cm^3 of 10 % acetic acid in ethanol was added to each plant powder and allowed to stand for 4 hours. This was filtered and the extract was concentrated on a water bath to one - quarter of the original volume followed by addition of 15 drops of concentrated ammonium hydroxide drop wise to the extract until the precipitation was complete. The whole mixture was allowed to settle for 3 hours, the supernatant was discarded and the precipitates washed with 20cm^3 of 0.1M of ammonium hydroxide and then filtered using Whatman filter paper. The residue was dried in an oven and weighed using electronic weighing balance (Ejikeme *et. al,* 2014**).**

ESTIMATION OF TOTAL FLAVONOID CONTENT:
The total flavonoid content of crude extract was determined by the aluminium chloride colorimetric method. Fifty microliter of crude extract (1 mg/ml ethanol) were made up to 1 ml with methanol, mixed with 4 ml of distilled water and then 0.3 ml of 5% $NaNO_2$ solution; 0.3 ml of 10% $AlCl_3$ solution was added after 5 min of incubation, and the mixture was allowed to stand for 6 minutes. Then, 2 ml of 1 mol/L NaOH solution were added, and the final volume of the mixture was brought to 10 ml with double-distilled water. The mixture was allowed to stand for 15 min, and absorbance was measured at 510 nm. The total flavonoid content was calculated from a calibration curve, and the result was expressed as mg rutin equivalent per g dry weight (Baba and Malik, 2015)**.**

ESTIMATION OF TOTAL SAPONIN CONTENT:

Fifty microliter of plant extract was added to 250 µL of distilled water. To this, 250 µL of vanillin reagent (800 mg of vanillin in 10 mL of 99.5% ethanol) was added. Then 2.5 mL of 72% sulphuric acid was added and it was mixed very well. This solution was kept in a water bath at 60 °C for 10 min. After 10 min, it was cooled in ice cold water and the absorbance was read at 544 nm. The values were expressed as diosgenin equivalents (mg DE/g extract) derived from a standard curve (Makkar *et. al*, 2007).

DETERMINATION OF TOTAL ANTIOXIDANT ACTIVITY

The antioxidant activity of the extracts was evaluated by the phosphomolybdenum method according to the procedure of Prieto *et al.* (1999). Three mililiter of reagent solution (0.6mM sulfuric acid, 28mM sodium phosphate and 4mM ammonium molybdate) was added to 0.3 ml of the plant extracts. The tubes containing reaction solution were incubated at 95°C for 90 minutes. Then the absorbance of the solution was measured at 695nm using spectrometer against blank after cooling to room temperature.

DETERMINATION OF FREE RADICAL SCAVENGING ACTIVITY (FRSA) USING DPPH METHOD

The free radical scavenging activity of the extract was measured using DPPH by the method of Blios (1958). A 0.1 mM solution of DPPH in methanol was prepared and 1 ml of this solution was added to 3 ml of various concentrations (0.2 to 1.0 mg/l) of sample dissolved in methanol to be tested. After 30 min, absorbance was measured at 517 nm. Ascorbic acid was used as a reference material. The scavenging activity was calculated as follows:

DPPH radical scavenging activity (%) = [(Absorbance of control – Absorbance of sample)/Absorbance of control] × 100 (Babu *et. al*, 2013).

DETERMINATION OF ANTIOXIDANT ACTIVITY USING FERRIC REDUCING ANTIOXIDANT POWER (FRAP)

The reducing power of the extract was determined according to the method of Oyaizu (1986). The mixture was incubated in a water bath at 50°C for 20 minutes. Afterwards, 2.5ml of a 10% (w/v) trichloroacetic acid solution was added and the mixture was then centrifuged at 3000 rpm for 10 minutes. A 2.5ml aliquot of the upper layer was combined with 2.5ml of distilled water and 0.5 ml of a 0.1% (w/v) solution of ferric chloride, and absorbance was measured at 700nm (Babu *et. al*, 2013)

Data Analysis*:*

The data collected were subjected to analysis of variance (ANOVA) using SAS 2000 and means were separated using Tukey's test at ($p<0.05$)

RESULTS AND DISCUSSION

Table 1: Proximate Composition of Some Crop Residues used in Ruminant Feeding

CROP RESIDUES	PARAMETERS (%)					
	Ash	Dry Matter	Crude protein	Crude fibre	Ether extract	Nitrogen free extract
Millet bran	4.98^{b}	94.13	9.42^{b}	6.48^{d}	4.04^{a}	75.07^{b}
Groundnut hay	7.15^{a}	91.98	12.53^{a}	11.50^{c}	1.02^{d}	67.81^{c}
Rice mill waste	4.30^{bc}	93.22	9.15^{b}	40.33^{a}	1.53^{c}	44.69^{e}
Cowpea husk	2.55^{d}	92.26	13.77^{a}	2.79^{e}	0.57^{e}	80.33^{a}
Maize cobs	3.18^{cd}	90.14	6.59^{c}	31.83^{b}	3.43^{b}	54.96^{d}

a,b,c,d and e means with different superscripts across column are significantly ($p<0.05$) different.

Table 2: Antioxidant Concentration of Common Crop Residues used in Ruminant Feeding

VARIABLES	CROP RESIDUES				
(%)	Millet Bran	Groundnut hay	Rice mill waste	Cowpea husk	Maize cobs
Alkaloids	0.46[b]	0.70[a]	0.25[c]	0.46[b]	0.66[a]
Saponins	2.58[a]	2.34[abc]	2.47[ab]	2.04[bc]	1.94[c]

Means with different superscripts across rows are significantly ($p<0.05$) different

Table 3: Free Radicals Scavenging Activity of some Crop Residues used in Ruminant Feeding.

CONCENTRATION	CROP RESIDUES				
(mg/l)	Millet bran	Groundnut hay	Rice mill waste	Cowpea husk	Maize cobs
0.2	0.39[b]	0.40[ab]	0.38[b]	0.45[a]	0.39[ab]
0.4	0.39[ab]	0.32[b]	0.43[a]	0.45[a]	0.40[a]
0.6	0.36[b]	0.33[b]	0.43[a]	0.34[b]	0.35[b]
0.8	0.33[b]	0.29[c]	0.47[a]	0.32[bc]	0.48[a]
1.0	0.34[b]	0.31[b]	0.50[a]	0.34[b]	0.51[a]

a,b,c means in the same rows with different superscript are different significantly ($p<0.05$)

Table 4: Ferric Reducing Antioxidant Power of some crop residues used in Ruminant Feeding

CONCENTRATION	CROP RESIDUES				
(mg/l)	Millet bran	Groundnut hay	Rice mill waste	Cowpea husk	Maize cobs
0.2	0.53[c]	0.52[d]	0.54[b]	0.60[a]	0.48[e]
0.4	0.53[d]	0.57[c]	0.65[a]	0.61[b]	0.52[d]
0.6	0.56	0.59	0.62	0.62	0.53
0.8	0.57[cd]	0.60[b]	0.59[bc]	0.63[a]	0.55[d]
1.0	0.58[bc]	0.63[a]	0.60[b]	0.65[a]	0.57[c]

Means with different superscripts across rows are significantly different ($p<0.05$)

Table 5: Total Antioxidant Activity of Some Crop Residues used in Ruminant Feeding

VARIABLES	CROP RESIDUES				
	Millet bran	Groundnut hay	Rice mill waste	Cowpea husk	Maize cobs
Antioxidant activity (µg/ml)	1.46[d]	2.04[b]	1.28[e]	2.62[a]	1.83[c]

a,b,c,d and e means with different superscripts across rows are significantly different ($p<0.05$)

All the crop residues analyzed in this study had crude protein (CP) content higher than the critical level 7% required for optimum microbial function of the rumen (Van Soest 1982) except maize cobs which has a value (6.59%) closer to that reported by Bogale *et.al* (2008) who treated pea straw. This indicates that there is no need for protein supplementation in the diets of ruminants when these crop

residues are utilized. However, the CP content of groundnut hay was not in line with literary report by Ayoade *et. al,* (1983). These differences may be due to plant varieties, methods of processing and handling of the plant material.

The values of the dry matter (DM) content obtained from this study were comparable where the value obtained for millet bran (94.13%) was similar to 94.2% reported for wheat straw by Bogale *et. al,* (2008). However, DM content of maize cobs (90.14%) obtained in this study differed from report of Olagunju *et .al,* (2013). This result was also not in agreement with reports by Tonamo *et. al,* (2015).

The ash content obtained was in agreement with report by Aregheore and Ikhatua (1999).

The alkaloid levels of crop residues were considerably higher than those reported by Onyeonagu and Njoku (2010).

Tilley and Terry (1963) reported that most crop residues contain saponin but the quantities of saponin produced by the crop residues are too low to pose major animal health problem. The saponin levels obtained in this study (1.94% to 2.58%) are within the range (0.03% - 5.18%) reported for crop residues and agro industrial by products by Onyeonagu and Njoku (2010).

Results with respect to free radical scavenging activity of some common crop residues, where the scavenging effect of rice mill waste increases with an increase in the concentration of the sample from 0.2mg/l to 1.0mg/l is supported with the findings of Senguttuvan *et. al,* (2014) who treated medicinal plants at different concentration of the plant extracts (50µg/ml to 250µg/ml). At 1.0mg/l concentration, rice mill waste and maize cobs showed strong radical scavenging activity of 0.50µg/ml and 0.51µg/ml respectively while ground hay showed relatively poor free radical scavenging activity of 0.31µg/ml. This variation might be due to the phenolic content of the plant extracts (Zahin *et. al,* 2009).

The result obtained from the present study revealed that the ferric reducing antioxidant power of some common crop residues increased with an increase in the concentration of the extracts which is in agreement with reports by Senguttuvan *et. al,* (2014) when medicinal herbs were evaluated.

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