ISSN 0189-0514
J. Anim. Prod. Res. (2017) 29(1): 321-334

National Animal Production Research Institute
Ahmadu Bello University
P.M.B 1096, Shika-Zaria,
Kaduna State, Nigeria.
Email:japr@napri.gov.ng
Website: http://journals.napri.gov.ng

NUTRIENTS AND ANTI-NUTRIENTS CONTENT OF SOME CROP BY-PRODUCTS AND RESIDUES FOR RUMINANT FEEDING IN NIGERIA

***Yusuf, K. O., Ajeigbe, O. M., Oyebo, A. T., Aderinboye, R. Y. and Onwuka C. F. I.**
Department of Animal Nutrition, College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta, Nigeria
**Authors corresponding E-mail: yomowumi@gmail.com*

ABSTRACT

This study examined the chemical composition and anti-nutritional content of crop residues: Groundnut haulms, garden egg haulms, maize husks, maize stover, sweet potatoes vines, cowpea haulms and crop by –products (yam peel, potatoes peel, cowpea husk and groundnut husk, maize cob, plantain peels, bread fruit peels, orange peels). The proximate composition, fibre, minerals and anti- nutrient composition were determined using standard procedures. All the samples assessed were significantly different ($P<0.05$) from one another in their content of nutrients and anti-nutrients. Dry matter was highest in groundnut haulms (97.22%) and lowest in maize cob (81.25%). Cowpea haulms had highest crude protein (12.36%) while maize cob had the least (3.92%). Crude fibre was highest in maize cob (34.00%) and lowest in breadfruit peels (9.00%). The crop residues and by-product evaluated are rich in various minerals. The highest Ca content (78.81 mg/100g) was recorded in cowpea haulms and the lowest (3.03 mg/100g) in yam peels. The phytochemical screening revealed the presence of tannin, alkaloids, saponin, phenol, phytate, oxalate, steroids and trypsin inhibitor. It is worth-noting that breadfruit peels had the highest content of five out of eight anti-nutritional factors determined. The crop residues and by-products were rich in essential nutrients and most of them were low in anti-nutritional factors, hence can be used as alternative feed for ruminant animals.

Keywords: Nutritive value, phytochemical screening, crop residues, crop by-products, ruminants

INTRODUCTION

Ruminant animals (cattle, sheep and goats) play an important role in small and large scale farming systems in Nigeria. They provide manure for crop production, meat and milk for human consumption, hide and skin for leather shoes and bags and a ready source of income for farmers. Despite this importance, inadequate nutrition is a major problem hindering ruminant animals' production especially during the dry season when grass which forms the bulk of their feed is dry and of low nutritive value. The animals lose weight and some might even die as a result of inadequate nutrition during this period. In managing them, therefore, effort must be made to ensure that they are given enough quantity and high quality feed to maximize their production all year round. The agro-industrial sector produces a great amount of waste, residues and by-products which can be recovered and often upgraded to higher value and useful products for livestock consumption. Wastes increases pollution problems and represent a loss of valuable biomass and nutrients (Laufenberg *et al.,* 2003). Crop residues provide enormous opportunities for improving the current level of production from ruminants.

Agro-industrial by-products are waste or residues from the processing of crops and animals while crop residues are resultant waste after harvesting of crops on the field. Many of the residues/wastes can be discarded in landfills if they were not fed to ruminants. However, if they are utilized in the diets of ruminants they can support growth and lactation and result in the

production of human edible food. Ososanya *et al.* (2013) reported that corn cob and cowpea husk can be utilized by West African dwarf sheep. Groundnut haulms are nutritious and widely used for feeding livestock. Sweet potatoe vines could profitably replace 50% concentrate feed in male goat diet (Kebede *et al.,* 2011). Edache *et al.* (2012) reported that yam peels contains a reasonable high level of energy (2701 kcal/kg) and can be fed to livestock and poultry as a component of their diet. Cowpea haulms can provide protein and energy to sustain ruminant production during the extended dry season and are often used as a supplement for poor quality basal diet in sheep (Anele *et al.,* 2010). These by-products and residues are often variable in composition, strictly seasonal and local in production and often contain undesirable contaminants of organic or inorganic origin (Grasser *et al*., 1995; Mussatto, 2006). There are few existing information on the nutrient and anti-nutrient content of many of the agro-industrial by-products and crop residues in Nigeria. Hence the aim of this research was to assess the nutritive and anti-nutritive value of some by-products and crop residues for ruminant feeding in Nigeria.

MATERIALS AND METHODS

Location of the Experiment

The experiment was carried out at the laboratory of the Animal Nutrition Department, College of Animal Science and Livestock Production, Federal University of Agriculture Abeokuta, Ogun State, Nigeria. The area has an annual mean temperature of 34.7°C, a relative humidity of 82% and an annual mean rainfall of 1037mm. It is in the region 70m above the sea level and lies on latitude 7^{o} 13′ 58.19″ N, longitude 3^{o} 25′ 10.36″ E. (Google Earth, 2014).

Collection of samples and Preparation of samples for Analyses

The selected crop by-product and residues were collected in Abeokuta, Ogun State directly from processors. Fourteen different samples were collected; crop residues (Groundnut haulms, garden egg haulms, maize husks, maize stover, sweet potatoes vines, cowpea haulms) and crop by – products (yam peel, potatoes peel, cowpea husk, groundnut husk, maize cob, plantain peels, bread fruit peels and orange peels).Six samples were collected for each of the crop residues and by-products. The samples collected were oven dry at 65.5°C to constant weight and pooled together to determine the dry matter. The dried samples were later milled and sieved to 1.0mm particle sizes and stored in an air tight container pending chemical analysis.

Proximate composition

Crude protein, crude fibre, ether extract and ash contents of the selected crop by-product and residues were determined according to AOAC (2000) and the amount of crude protein was calculated as (N x 6.25).

Fibre components

The fibre factions such as Neutral detergent fibre (NDF), Acid detergent fibre (ADF) and Acid detergent Lignin were determined according to VanSoest *et al.* (1991) method. Cellulose and Hemicellulose were calculated as the difference between ADF and ADL and, NDF and ADF respectively.

Mineral Composition

The samples were first ashed and dissolved, and the resultant solution aspirated into an air-acetylene flame. The mineral element determined were; Zinc (Zn), Manganese (Mn), Copper (Cu), Potassium (K), Sodium (Na), Iron (Fe),Magnesium (Mg) and Calcium (Ca) and this was

done by spectro-photometric methods, using flame emission spectrophotometer for Sodium (Na) and Potassium (K) and atomic absorption spectrophotometer for others(Fritz and Schenk, 1979).

Energy Content Determination

The gross energy of the selected samples was determined through the use of bomb calorimeter

Anti-nutritional factors

Quantitative anti-nutritional factors analyses for determination of anti-nutrients were carried out to assess the presence of tannin, saponin, alkaloid, steroid, phytate, phenol, oxalate and trypsin inhibitor by using the following standard methods (Harborne, 1998; Houghton and Raman, 1998; Parekh *et al.*, 2006).

Statistical analysis

All data collected were subjected to one-way analysis of Variance (ANOVA) and significant differences among means were separated using Duncan's Multiple Range Test (SAS, 1999).

RESULTS AND DISCUSSION

Table 1 shows the proximate, fibre and gross energy composition of some crop residues and by-products for ruminant feeding. There were significant differences ($p<0.05$) in all the parameters measured across the samples. Gross energy was highest (18.26 MJ/Kg) in groundnut husk and lowest (11.95 MJ/Kg) in maize cob. This is an indication that all the crop residues and by-products are high in energy as gross energy is the sum of all the energy contained in a feed. The dry matter ranged from 81.25% in maize cob to 97.29% in groundnut haulms. Dry matter comprises of all other nutrients found in a feedstuff, and the high values recorded in this study showed that the crop residues and by-products are rich in nutrients. Crude protein was highest (12.36% and 12.26%) with no significant difference ($p> 0.05$) in cowpea haulms and cowpea husk respectively. These values were a little higher than 10-12% crude protein level reported by Gatenby (2002) as a level that is adequate for ruminant production. Maize cob had the lowest (3.92%) crude protein content which means that it cannot be fed alone except with appropriate protein supplement. The crude protein value of cowpea husk is a bit lower than 13.95% reported by Chikwendu *et al*. (2014).Cowpea husks and haulms are among the most important crop residues obtained from cowpea plants and are used as fodder. Some farmers grow the crop for only this purpose. Adebowale (1981) reported that about 82 metric tonnes of cowpea husk and straws are produced in Nigeria annually. According to Aderolu (1997) cowpea husk when used as feedstuff can bring about appreciable weight gain thereby checking the characteristics weight losses during dry season.

Well cured cowpea haulms are a useful feed and can make excellent hay provided that the leaves are well preserved (too much exposure to the sun makes them fall off) and that the stems are adequately wilted (Cook *et al.*, 2005; FAO 2013). The crude protein value (4.67%) obtained for sweet potato peels was consistent with the result of Omoregie *et al.* (2009) while that of yam peel and groundnut husk were higher than values (8.64% and 4.43%) reported by Onwuka *et al.* (1997) and Abdul Rasaki *et al.* (2014) respectively. Aguihe *et al.* (2015) reported a crude protein content of 10.52% for yam peels while Yusuf *et al.* (2009) reported a crude protein of 5.20%. The differences between the results might be due to level of maturity of the tuber and type of cultivar used (Abara2003). The crude fibre values for the residues and by-products ranged from 9.00% in

Table 1: Proximate, Fibre and Gross Energy Composition of some crop residues and by-products (%)

	Parameters										
Crop residues	**DM**	**CP**	**CF**	**EE**	**ASH**	**NDF**	**ADF**	**ADL**	**HCELL**	**CELL**	**GE**
Groundnut haulms	97.22[a]	8.61[d]	24.33[d]	8.50[h]	10.17[g]	38.98	18.70[h]	8.28[f]	20.27[d]	10.42[d]	15.90[c]
Garden egg haulms	92.57[b]	9.79[c]	23.33[e]	14.50[b]	8.17[h]	42.15	20.47[f]	10.46[c]	21.68[c]	10.00[de]	14.12[d]
Maize husk	81.34[h]	8.18[e]	20.67[f]	13.83[c]	20.33[c]	40.37	19.88f[g]	10.73[b]	20.49[cd]	9.15[e]	12.88[ef]
Maize stover	86.44[d]	9.15[cd]	32.33[c]	12.33[d]	19.00[d]	38.65	21.25[e]	9.61[e]	17.41[g]	11.64[c]	13.31[e]
Sweet potato haulms	84.19[e]	10.48[b]	31.67[c]	9.37[g]	24.00[b]	38.51	19.15[gh]	7.42[g]	19.39[e]	11.72[c]	16.63[b]
Cowpea haulms	86.77[d]	12.36[a]	18.33[g]	9.50f[g]	19.30[d]	35.22	16.55[i]	6.48[h]	18.57e[f]	10.20[d]	14.13[d]
Crop by-products											
Yam peel	92.58[b]	9.59[c]	13.50[h]	12.60[d]	11.47[f]	48.08	23.59[d]	10.31[d]	24.49[a]	13.45[a]	14.37[d]
Sweet potato peel	96.89[a]	4.67[g]	9.50[j]	18.27[a]	7.87[i]	37.42	19.36[g]	10.12[d]	18.06[f]	9.24[e]	15.54[c]
Cowpea husk	88.59[c]	12.26[a]	33.00[b]	11.30[e]	10.63[f]	33.87	12.53[j]	4.21[i]	21.38[c]	8.29[g]	14.27[d]
Groundnut husk	97.19[a]	5.94[f]	17.83[g]	11.77[e]	13.17[e]	40.18	20.96[ef]	12.19[b]	19.20[e]	8.79[f]	18.26[a]
Maize cob	81.25[h]	3.92[h]	34.00[a]	10.00[f]	10.67[f]	47.91	27.33[b]	10.86[c]	20.58[cd]	9.15[e]	11.95[f]
Plantain peels	82.39[g]	8.38[e]	10.67[i]	13.67[c]	26.33[a]	45.15	28.32[a]	12.11[b]	16.83[h]	11.64[c]	13.01[e]
Bread fruit peels	83.26[f]	8.48[de]	9.00[j]	13.33[c]	20.50[c]	35.91	20.43[f]	9.88[e]	15.48[i]	10.55[d]	13.78[de]
Orange peels	97.04[a]	4.70[g]	18.67[g]	13.33[c]	11.00[f]	48.35	25.15[c]	12.67[a]	23.29[b]	12.48[b]	16.27[bc]
SEM	2.20	0.56	1.91	0.50	130	0.97	0.73	0.40	0.52	0.86	0.30

[a,b c]Means within the same column with different superscript are significantly different ($p < 0.05$). DM: Dry matter, CP: Crude protein, CF: Crude Fibre, EE: Ether extract, NDF: Neutral Detergent Fibre, ADF: Acid Detergent Fibre, ADL: Acid Detergent Lignin, HCELL: Hemicellulose, CELL: Cellulose, GE: Gross Energy

bread fruit peel to 34.00% in maize cob. The crude fibre of bread fruit was higher than 5.22% reported by Oladunjoye *et al.* (2010). The crude fibre content of groundnut husk obtained in this study was higher than 5.9% reported by Abdul Rasaki *et al.* (2014).The variation may be due to the processing methods, plants species, and age of harvesting and maturity of the selected crops.

Ash content was significantly ($p<0.05$) highest (26.33%) in plantain peels and lowest (7.87%) in sweet potato peels. This is an indication that plantain peels has the highest content of minerals which is essential in animals' metabolism. The ash content of plantain peels and sweet potato peels obtained in this study were however higher than 16.94% and 4.61% reported by Oni *et al*. (2008) respectively. Ash represents the mineral level in a feed, which contains majorly phosphorus, calcium or potassium and large amount of silica (Verma, 2006). All the selected crop residues and by-products are rich in fibre fractions. They are left-over of harvesting and processing of crops after the removal of edible parts for man's use. The neutral detergent fibre (NDF) ranged from 33.87% in cowpea husk to 48.35% in orange peels. This was lower than 62.50% reported by Oluremi (2007). The NDF value of Bread fruit peels (35.91%) obtained was a little higher than 32.95% reported by Oladunjoye *et al.* (2010). The NDF values of sweet potato peels (37.42%), yam peels (48.08%) and plantain peels (45.15%) obtained in this study were higher than 24.36%, 29.97% and 31.14% reported respectively for sweet potato peels, yam peels and plantain peels by Oni *et al*. (2008). The NDF measures the total fibre or bulk component of the feed stuff which include cellulose, hemicellulose and lignin as the major components (Van Soest *et al*., 1994). The NDF is better related to intake and gastro-intestinal fill than any other measure of fibre. Acid detergent fibre (ADF) was highest in plantain peels (28.32%) and lowest in cowpea husk (12.53%). Oni *et al*. (2008) reported a lower ADF value of 14.78% for plantain peels. ADF measures the least soluble proportion of fibre (cellulose, lignin and acid insoluble ash) in feed (Van Soest *et al*., 1994). Acid detergent lignin ranged from 4.21% in cowpea husk to 12.67% in orange peels. ADL of orange peels was higher than 6.10% reported by Oluremi (2007). Variations in the results of the proximate and fibre composition in comparison with the results of previous authors might be due to geographical location, plant species, processing methods, level of maturity at harvest and length of storage.

The presence of minerals elements in feed is vital for the animals' metabolic processes. Minerals deficiencies or imbalance in soils and forages account partly for low animal production and reproduction problems (Akinsoyinu and Onwuka1988). The mineral composition of the selected crop residues and by-product (Table 2) indicated that they all rich in minerals but Mg, K, Ca and Fe are the most abundant. Sodium, ranged from 1.84 mg/100g in maize stover to 9.44 mg/100g in groundnut husk. Potassium, was highest (81.41 mg/100g) in plantain peels and lowest (45.90 mg/100g) in maize cobs. The highest Ca content (78.81 mg/100g) was obtained in cowpea haulms and the lowest (3.03 mg/100g) in yam peels. Calcium is required for building healthy bones in animals. Magnesium was highest (21.33 mg/100g) in cowpea haulms and lowest (6.78 mg/100g) in maize stover. Magnesium is necessary for efficient metabolism of carbohydrates and lipids. It is also involved in cellular respiration and general cellular biochemistry and function (McDowell *et al*., 1997). Manganese was highest (3.70 mg/100g) in cowpea haulms and lowest (0.14 mg/ 100g) in orange peels. Copper has the least concentration in all the minerals examined with the highest value (0.25 mg/100g) obtained in groundnut husk. Iron (Fe) was the most abundant minerals with the highest value (206.23 mg/100g) obtained in sweet potato haulms.

Table 2: Minerals Composition of some crop residues and by-products (mg/100g)

Samples	**Parameters**							
Crop residues	Sodium	Potassium	Calcium	Magnesium	Manganese	Copper	Iron	Zinc
Groundnut haulms	4.52^{d}	47.87^{h}	10.79^{i}	16.92^{c}	2.35^{c}	0.11^{b}	123.27^{c}	0.44^{d}
Garden egg haulms	2.05^{g}	74.76^{c}	52.50^{b}	20.66^{a}	1.51^{e}	0.06^{d}	27.53^{l}	0.27^{f}
Maize husk	2.66^{f}	71.15^{d}	18.92^{f}	16.43^{d}	2.47^{bc}	0.20^{a}	106.82^{e}	0.77^{b}
Maize stover	1.84^{h}	48.03^{h}	6.48^{k}	6.78^{i}	1.53^{e}	0.15^{b}	185.44^{b}	0.88^{a}
Sweet potato haulms	9.11^{a}	68.88^{f}	8.14^{j}	18.86^{b}	2.99^{b}	0.20^{a}	206.23^{a}	0.72^{b}
Cowpea haulms	5.33^{c}	58.55^{g}	78.81^{a}	21.33^{a}	3.70^{a}	0.09^{c}	68.39^{i}	0.32^{e}
Crop by-products								
Yam peels	4.08^{e}	70.37^{e}	3.03^{l}	6.95^{i}	0.42^{h}	0.06^{d}	15.25^{m}	0.17^{fg}
Sweet potato peels	4.15^{de}	68.00^{f}	7.59^{i}	8.02^{h}	0.54^{g}	0.04^{e}	13.13^{n}	0.14^{g}
Cowpea husk	6.31^{b}	73.98^{c}	41.04^{c}	19.15^{b}	1.26^{f}	0.12^{b}	85.70^{g}	0.54^{c}
Groundnut husk	9.44^{a}	46.13^{i}	16.66^{h}	7.63^{h}	0.99^{g}	0.25^{a}	38.68^{k}	0.20^{g}
Maize cob	2.61^{f}	45.90^{i}	16.03^{h}	16.43^{d}	2.47^{bc}	0.17^{ab}	100.62^{f}	0.77^{b}
Plantain peels	2.64^{f}	81.41^{a}	$22,46^{e}$	16.08^{e}	1.70^{d}	0.06^{d}	118.42^{d}	0.54^{c}
Breadfruit peels	5.57^{c}	74.09^{c}	17.52^{g}	9.88^{g}	0.84^{g}	0.08^{c}	54.40^{j}	0.34^{e}
Orange peels	4.75^{d}	79.41^{b}	39.13^{d}	13.16^{f}	0.14^{i}	0.06^{d}	74.81^{h}	0.27^{f}
SEM	3.36	2.69	4.46	1.13	0.21	0.02	12.34	0.05

$^{a,b\ c}$Means within the same column with different superscript are significantly different ($p<0.05$)

The presence of high content of Fe in potato haulms indicates that potatoes haulms is a good source of the element; Iron is an essential trace element, it help in haemoglobin formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats (Adeyege and Otokiti, 1999). Zinc was highest (0.88 mg/100g) in maize stover. Values of Mg, Ca, Zn and K for Garden Egg haulms obtained in this study were slightly higher than those reported by Arivalagan (2013) however, the value of Cu was similar. Minerals are essential nutrients, which are said to be present in the small amount in the body (Gafar and Itodo, 2011). They are essential because they play important role in metabolic process of the body and their absence can cause deficiency symptoms in animals (Gafar and Itodo, 2011; McDonald, 1995). As seen from the results, the crop residues and by-products have promising nutritional attributes as they are rich in minerals which are at par with the required recommendation for ruminant animals; Mg- 0.71-0.21g/ 100g (ARC, 1980; Suttle, 1983), K- 0.5-1.0 g/100g (McDowell,1992), Na- 0.01-0.25 g/100g (Fettman *et al*., 1984) and Ca- 0.17-1.53 g/100g (NRC,1989). Minerals perform several essential functions which are important for the existence of the organism. These include calcification of bones, coagulation, neuromuscular irritability, acid-base equilibrium, fluid balance and osmotic regulation.

Anti-nutritional factors (ANFs) are compounds which reduce the nutrient utilization and/or intake of plants or plants products used as human food or animal feed. They are also referred to as secondary metabolites (Kumar, 1992).There were significant ($p<0.05$) differences in all the ANFs (Table 3) measured across the samples. Tannin ranged from 0.04 mg/100g in maize cob to 10.27 mg/100g in cowpea husk. Tannins in feed stuffs decrease palatability and protein digestibility and can be found in most tree leaves, pasture legumes and agro-industrial by-products (Makkar, 1991). Plants containing that have high amounts of condensed tannin (CT)- can however, be advantageous to ruminants by protecting dietary protein against degradation in the rumen and increase amino acid supply to the abomasum and small intestine, resulting in an improved nutritional status of the animal (Barry *et al*., 2001). According to D'Mello (2002) goats can tolerate condensed tannin than cattle and sheep. The range in this study is however safe for ruminants as it is very low compare to 60 to 100g/Kg DM considered depressing feed intake and growth in ruminants (Barry and Duncan, 1984). Goats are known to have a threshold capacity of 9% (90 g/kg/ DM) dietary tannin (Nastis and Malachek, 1981). Min *et al*. (2003) reported that low concentration of condensed tannin (20-45g CT /kg) are helpful to ruminant animals, while high concentration (>55g CT/kg) may have negative effects.The concentration of condensed tannins above 4 per cent has been reported to be toxic for ruminants as they are more resistant to microbial attack and are harmful to a variety of microorganisms (Waghorn *etal.*, 1990).All the selected crop residues and by- products contain tannin tolerable by ruminants. Saponin was highest in Bread fruit peels (78.79mg/100g) and lowest in maize cob (0.21 mg/100g). The tolerable level of saponin in goat is 1.5 – 2% (Onwuka, 1983). Feedstuffs containing saponin have been shown to have defaunating properties (Teferedegne, 2000) and capable of reducing methane production (Hu *et al*., 2005). Studies have shown that saponin inhibits microbial fermentation and synthesis in the rumen. Saponins are characterised by bitter taste and foaming properties (Kumar, 2003). All the samples in this study contain low levels of saponin. The selected crop residues and by-products recorded low levels of phenol. Phenols aid in maintaining microflora balance and exhibit antimicrobial effect against pathogenic bacteria (Hara-Kudo *et al*., 2005; Guray *et al*., 2011). Phytic acid act as a strong chelator, inhibiting the synthesis and secretion of protein and mineral-phytic acid complexes, the net being reduced protein and mineral bioavailability (Erclman, 1979; Spinelli *et al*., 1983; Khare, 2000).

Table 3: Anti-nutrient content of some crop residues and by-products (mg/100g)

Samples	**Parameters**							
Crop residues	**Tannin**	**Saponin**	**Phenol**	**Steroid**	**Phytate**	**Oxalate**	**Alkaloids**	**Trypsin Inhibitor**
Groundnut haulms	5.11^{d}	1.66^{c}	0.52^{d}	1.13^{b}	212.66	98.64^{g}	1.67^{d}	16.70^{b}
Garden egg haulms	1.89^{e}	1.41^{d}	0.19^{h}	0.05^{e}	1.82	102.38^{e}	0.35^{g}	0.02^{g}
Maize husk	0.10^{h}	0.82^{e}	0.10^{i}	0.04^{f}	10.42	1.04^{k}	0.47^{g}	0.02^{g}
Maize stover	0.11^{h}	0.61^{f}	0.11^{i}	0.03^{f}	201.56	614.09^{a}	0.41^{g}	0.0.4^{g}
Sweet potato haulms	0.36^{g}	0.48^{g}	0.26^{g}	0.18^{d}	116.72	67.38^{i}	1.73^{d}	2.46^{d}
Cowpea haulms	9.68^{b}	2.37^{b}	0.41^{e}	0.22^{d}	108.35	368.91^{c}	3.83^{c}	0.00^{h}
Crop by-products								
Yam peels	0.73^{f}	0.45^{g}	0.15^{h}	0.08^{e}	81.36	101.37^{f}	1.28^{e}	0.67^{e}
Sweet potato peels	0.44^{g}	0.62^{f}	0.32^{f}	0.21^{d}	123.68	78.92^{h}	1.43^{e}	2.51^{d}
Cowpea husk	10.27^{a}	0.78^{e}	0.34^{f}	0.36^{c}	160.13	567.23^{b}	4.57^{b}	0.00^{h}
Groundnut husk	5.67^{c}	2.37^{b}	0.61^{b}	1.29^{b}	380.78	228.66^{d}	4.66^{b}	24.61^{a}
Maize cob	0.04^{i}	0.21^{i}	0.04^{j}	0.04^{f}	104.51	0.91^{k}	0.23^{h}	0.03^{g}
Plantain peels	0.49^{g}	0.33^{h}	0.49^{e}	0.15^{d}	33.67	1.09^{j}	0.23^{h}	0.11^{h}
Breadfruit peels	2.04^{e}	78.79^{a}	2.04^{a}	4.23^{a}	416.76	1.02^{k}	6.67^{a}	10.30^{c}
Orange peels	0.72^{f}	0.49^{g}	0.72^{c}	0.41^{c}	27.82	1.02^{k}	1.13^{f}	0.33^{f}
SEM	2.17	3.08	0.13	0.24	21.73	43.23	0.41	1.42

$^{a,b\ c}$Means within the same column with different superscript are significantly different ($p < 0.05$)

The high levels of steroids in breadfruit peels compared to other AIBP's as a naturally occurring source is good for nutrition of ruminants as synthetic implants are mostly used to improve animal performance. National Research Council (1994) reported that number of steroid implants are used for feeding beef cattle in United States and earlier reports showed increased performance responses as high as 69.9% (Bouffault and Willemart, 1983) and a 14% higher feed efficiency (Thonney, 1987). A threshold level of less than 5% of total feed served was prescribed by Laurena *et al*. (1994) for phytate. The low level of phytate in the selected crop residues and by-products points to their potential as ruminant feed resource that will make minerals available to the animals. Oxalate ranged from 0.23 mg/100g in plantain peels and maize cob to 6.67 mg/100g in breadfruit peels. Oxalate affect calcium and magnesium and react with proteins to form complexes which have an inhibitory effect in peptic digestion. They also cause muscular weakness, paralysis, gastro-intestinal tract irritation, blockage of the renal tubules by calcium oxalate crystals, development of urinary calculi and hypocalcaemia (Soetan and Oyewole, 2009). Dietary oxalates may be degraded by rumen microbes into carbon dioxide and formic acid, therefore ruminants, unlike monogastric animals can consume considerable amounts of high oxalate plants without adverse effects, due principally to microbial degradation in the rumen (Ologhobo, 1992; Smithal Patel *et al*., 2013). Hence, all these adverse effects are less or not experienced in ruminants. Plants containing about 10% oxalate on dry weight bases cause toxicity (Makkar, 1991).

Alkaloids cause gastro-intestinal and neurological disorders (Aletor, 1993), their synthetic derivatives are used as medicinal agents as analgesic, anti-malaria, antiseptics and bactericidal (Evans 2002). Alkaloid was highest in breadfruit peels (6.67mg/100g) and lowest in maize cob and plantain peels with the value of 0.23mg/100g. According to Makkar (1991) alkaloids is very toxic and affects central nervous system and cause muscular incoordination. Trypsin inhibitors are polypeptides that form complexes with trypsin on a one-to-one molar ratio obstructing enzyme action (Carlini and Udedibie, 1997). Trypsin inhibitor was highest (24.61mg/100g) in groundnut husk and lowest (0.00mg/100g) in cowpea husk. It was however, worth-noting that bread fruit peel had higher contents in five of the eight anti-nutritional factors determined. These are saponin, phenol, steroid, phytate and alkaloid. Thus care must be taken when feeding them to livestock as it may require other form of processing apart from drying to further remove the anti-nutritional factors or lower the threshold below the allowable range in diets of animals. The limitation impose on the use of breadfruit meal has been attributed to anti-nutritional factors (Oladunjoye *et al*., 2010).

CONCLUSION

All the crop residues and by-products assessed in this study are rich in essential nutrients which indicates that they can be fed alone or in mixture with other feed stuffs for ruminants. Sweet potato peels, groundnut husk, maize cob and orange peels cannot be fed alone because of the low crude protein content. Protein supplementation will be necessary. Breadfruit peels will require other form of processing apart from drying to further reduce the anti-nutritional factors.

REFERENCES

Abara, A.E. (2003). Tannin content of *Dioscorea bulbifera*. *Journal of Chemical Society of Nigeria*, 28: 55-56.

AbdulRazaki, S., Otie, D. andOniwapele Y.A. (2014). Proximate Analysis and Anti-Nutritional Factors of Groundnut and Melon Husk. *Journal of Animal and Feed Research* 4: 25-28.

Adebowale, E.A. (1981). The maize replacement value of fermented cassava peels (*Manihot utilissima* Pohl) in rations for sheep. *Tropical Animal Production*, 6: 66-72

Aderolu, A.Z. (1997). Maize grit and sorghum dried brewer's grain as feeding stuffs for Sokoto Gudali. M.Sc. Project. Department of Animal Science, University of Ibadan, Nigeria

Adeyeye, E.I. and Otokiti, M.K.O. (1999). Proximate Composition of some nutritionally valuable minerals of two varieties of *Capsicum annum* (Bell and Cherry pepper). Discovery and Innovation, 11: 75-81

Afshar-Mirsaei, M. and Naser M. (2008). Nutritive value of some Agro-industrial by products for ruminant. *World Journal of Zoology*, 3(2):40-46

Aguihe, P.C., Kehinde, A.S. and Iyayi, E.A. (2015). Effect of enzyme (Maxigrain®) supplementation on performance characteristics and nutrient digestibility of growing Japanese quails (*Cortunix cortunix japonica*) fed diets containing yam peel meal. *Nigerian Journal of Animal Science*, 17 (1): 65-74

Akinsoyinu, A.O. and Onwuka, C.F.I. (1988). Mineral constituents of some browse plants used in ruminant feeding in southern Nigeria. *Nigerian Journal of Animal Production*, 15: 57-62

Aletor, V.A. (1993). Allelochemicals in plant foods and feeding stuffs. Part 1. Nutritional, Biochemical and Physiopathological aspects in animal production. *Veterinary Human Toxicology*, 35 (1): 57-67

Anele, U.Y., Arigbede, O. M., Sudekum, K. H., Ike, K. A., Oni, A.O., Olanite, J.A., Amole, G.A., Dele, P. A. And Jolaoso, A.O. (2010). Effects of processed cowpea (*Vigna unguiculata* L Walp) haulms as a feed supplement on voluntary intake, utilization and blood profile of West African dwarf sheep fed basal diet of *Pennisetum purpureum* in the dry season. *Animal Feed Science and Technology*, 159 (1-2): 10-17

AOAC, (2000). Official Methods of Analysis. Association of Official Analytical Chemist Inc. 15th Edition Washington

ARC, (1980). The nutrient requirement of farm animal Technical review and summaries Agricultural Research Council London, UK

Arivalagan, M., Bhardwaj, R., Gangopadhyay, K.K., Prasad, T.V. and Sarkar S.K.. (2013). Mineral composition and their genetic variability analysis in eggplant *(Solanum melongena* L.) germplasm. *Journal of Applied Botany and Food Quality*, 86: 99-103

Barry, T.N. and Duncan, S.J. (1984). The role of condensed tannins in the nutritional value of *Lotus pedunculatus* for sheep. I. Voluntary intake. *Journal of Association of Official Analytical Chemists* 65: 496-497.

Barry, T.N., McNeill, D. M. And McNabb, W.C. (2001). Plant secondary compounds; their impact on nutritive value and upon animal production. Proceedings XIX International Grassland Conference, Sao Paulo, Brazil. Pp 445-452

Bouffault, J. C., and J. P. Willemart. 1983. Anabolic activity of trenbolone acetate alone or in association with estrogens. In Anabolics in Animal Production, E. Meissonnier, ed. Paris: Office International des Epizooties.

Carlini, C. R. and Udedibie, A. B. I. (1997). Comparative effect of processing methods on haemaglutinating antitryptic activities of *Canavalia braziliensis* seed. *Journal of Agriculture and Food Chemistry* 45: 4372-4377

Chikwendu, J.N., Igbatim, A.C. and Obizoba, I.C. (2014). Chemical composition of processed cowpea tender leaves and husks. *International Journal of Scientific and Research Publication*, 4 (5)

Cook. B.G., Pengelly, B.C., Browns D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hauson, J., Mullan, B.F., Patridge, I.J., Peters, M., Schultze-Kraft, R. (2005) Tropical forages. CSIRO, DPI&F (Qld), CIAT and ILRI, Brisbane Australia

D'Mello, J.P.F. (2002).Contaminants and toxins in animal feeds. http//www.fao.org/Agrippa/Publications/521_en.htm

Edache, J. A., Yisa, A. G. and Okpala, E. J. (2012). Effect of replacing maize with yam peel meal on short term laying performance of Japanese quails (*Cortunix cortunix japonica*) *Pakistan Journal of Nutrition*, 11 (7): 516-519.

Erdman, J.W. (1979). Oilseed phytates: Nutritional role in ruminant nutrition implications. *Journal of Am. Oil Chemist Soc*. 56: 736-741.

Evans, W.C. (2002). *Trease and Evans Pharmacognosy*, 15th edition, W.B. Sanders, London, Pp 183-184 and 191-393.

FAO, (2013). Food System for Better Nutrition. Food and Agriculture Organization of the United Nations, Rome, Italy.

Fettman, M. J., Chase, L. E., Bentinck-smith, J., Coppeck, C.E. and Zinn, S.A. (1984). Nutritional Chloride deficiencies in early lactating Holstein cows. *Journal of dairy Science*, 67: 231.

Fritz, J.S., Schenk, G.H., (1979). Quantitative Analytical Chemistry, 4th edn., Allyn and Bacon, Boston, MA.

Gafar, M.K. and Itodo, A.U. (2011). Proximate and mineral composition of hairy indigo leaves. *Electronic Journal of Environmental, Agricultural and Food Chemistry*, 10: 2007-2018

Gatenby, R. M. (2002). Sheep. The Tropical Agricultural Series. McMillan publishers. Pp. 408-515.

Grasser, L.A., J.G. Fadel, I. Garnet and E.J. DePeters, (1995). Quantity and economic importance of nine selected by-products used in California dairy rations. *J. Dairy Sci.*, 78: 962-971.

Google Earth (2014). http//www.google.earth

Guray, E., Ocak. N., Altop. A., Cankaya, S., Aksoy, H.M. and Ozturk, E. (2011). Growth performance, meat quality and caecal coliform bacteria count of broiler chicks fed diet with green tea extract. Asian- *Australasian Journal of Animal Science,* 24 (8): 1128

Hara-Kudo, Y., Yamasaki, A., Sasaki, M., Okubo, t., Minai, Y., Haga, M., Kondo, K. And Sugita-Konishi, Y. (2005). Antibacterial action on pathogenic bacteria spore by green tea catechins. *Journal of the Science of Food and Agriculture,* 85: 2354-2361

Harborne, J. B. (1998). Phytochemical methods: A guide to modern techniques of plant analysis. 3rd edition.Chapman & Hall Pub. London, UK.

Houghton, P. J. and Raman, A. (1998). Laboratory Handbook for the Fractionation of Natural Extracts. London: Chapman and Hall.

Hu, W., Liu, J., Ye, J., Wu, Y. And Guo, Y. (2005). Effect of tea saponin on rumen fermentation *in vitro*. *Animal Feed Science and Technology,* 120: 333-339.

Kebede, T., Gutu, T. and Tadesse, E. (2011). Performance and economic efficiency of browsing ArsiBale goats supplemented with sweet potato (*Ipomea batatas* L) vine as replacement for concentrate. *International Journal of Livestock Production*, 2 (7): 92-99

Khare, S.K. (2000). Application of immobilized enzymes in soya beans processing. The third international soybean processing And utilization conference (ISPCPC III) of the Innovation Era for Soybeans, 15-20 October, 2000, Tsukuba, Ibaraka, Japan, Pp 381-382

Kumar, R. (1992). Anti-nutritional factors, the potential risks of toxicity and methods to alleviate them. In: Speedy, A. and Pugliese, P. (Eds). Legume trees and other fodder trees as protein sources for livestock. Food and Agriculture Organization of the United Nations (FAO), Kuala Lumpur, pp 145-157

Kumar, R.,(2003). Antinutritive factors, the potential risks of toxicity and methods to alleviate them. http://www.fao.org/DOCREP10031T0632E/T0632E10.htm

Laufenberg, G., Kuntz, L. and Nystroem, M. (2003). Transformation of vegetable waste into value added products a. The upgrading concept, b. Practical implementation. *Bioresource Technology*, 87 (2): 167-198

Laurena, A.C., Jamela, M.A., Revilleza, R. And Mendoza, E.M.T. (1994). Polyphenols, phytate, cyanogenic glucosides and trypsin inhibitor activity of several Philippine indigenous food legumes. *Journal of Food Composition and Analysis*, 7: 194-202

Makkar, H. P. S. (1991). Antinutritional Factors in Animal Feedstuffs –Mode of Action. *International Journal of Animal Science*, 6: 88-94

McDonald, P., Edwards, R.A., Greenhalgh, J. F. D. And Morgan, C. A. (1995). Animal Nutrition, 5th edition, Longman UK, Pp607

McDowell, L. R. (1992). Mineral in Animal and Human Nutrition. First Edition, Academic press, San Diego, CA, New York, USA

McDowell, L. R. (1997). Minerals for grazing ruminants in tropical region. Bulletin of the Institute of food and Agricultural Sciences, University of Florida, Gainesville, USA Pp 81

Min, B.R., Barry, T.N., Attwood, G.T. and McNabb, W.C. (2003). The effect of condensed tannins on the Nutritional and Health of Ruminants fed fresh temperate forage: A Review. *Animal Feed Science and Technology,* 106: 3-19

Mussatto, S.I., G. Dragone and I. C. Roberto, (2006). Brewers spent grain: Generation, characteristics and potential applications. *J. Cereal Sci., 43: 1-14.*

Nastis, A. S. and Malachek, J. C. (1981). Digestion and utilization of nutrients in oak browse by goats. *Journal of Animal Science,* 53: 283-290.

NRC, 1994. National Research Council. Metabolic Modifiers: Effects on the Nutrient Requirements of Food-Producing Animals. Washington, D.C.: National Academy Press.

National Research Council. 1989. Alternative Agriculture. Washington, D.C.: National Academy Press.

Oladunjoye, I.O.; Ologhobo, A.D. and Olaniyi, C.O. (2010). Nutrient composition, energy value and residual anti-nutritional factors in differently processed breadfruit (*Artocarpus altilis*) meal. *Afr. J. Biotechnol*., 9(27): 4259-4263.

Ologhobo, A.D. (1992). Nutritive value of some tropical (West African) legumes for poultry. *Journal of Applied Animal Research,* 2: 93-104.

Oluremi, O.I.A, Ngi, J., and Andrew, I.A. (2007). Phytonutrients in citrus fruit peel meal and nutritional implication for livestock production. *Livestock Research for Rural Development*, 20 (4).

Omoregie, E., Igoche, L., Ojobe, T.O., Absalom, K.V. and Onusiriuka, B.C. (2009) Effect of varying levels of sweet potato (Ipomea batatas) peels on growth, geed utilization and some biochemical responses of the Cichlid (*Oreochromis niliticus*). *African Journal of Food Agriculture Nutrition and Development,* 9 (2).

Oni, A.O., Arigbede, O.M., Oni, O.O., Adelusi, O.A., Yusuf, K.O. and Onwuka, C.F.I. (2008). Chemical composition and dry matter degradation characteristics of some agro-industrial by-products in humid tropics. Proceedings of the 13th Annual Conference of the Animal Science Association of Nigeria (ASAN), September 15-19, 2008, Ahmadu Bello University Zaria, Nigeria, Pp554-557.

Onwuka, C.F.I., (1983). Nutritional evaluation of some Nigerian browse plants in the humid tropics. PhD Thesis. University of Ibadan, Ibadan, Nigeria

Onwuka C.F.I., P.O. Adetiloye and C.A. Afolami (1997). Use of household wastes and crop residues in small ruminant feeding in Nigeria. *Small Ruminant Res.,* 24: 233-237

Ososanya, T.O., Alabi, B.O. and Sorunke, A.O. (2013). Performance and digestibility of corn cob and cowpea husk diets by West African dwarf sheep. *Pakistan Journal of Nutrition,* 12 (1): 85-88

Parekh, J., Karathia, N. and Chanda, S. (2006). Evaluation of antibacterial activity and phytochemical analysis of *Bauhinia variegate* L. Bark. *African Journal of Biomedical Research,* 9 (1) 53 – 56.

SAS, 2003. STATISTICAL ANALYSIS SYSTEMS (SAS), (2003). The SAS system for windows. Release 9.1 SAS Institute, Cary, NC.

Smitha Patel, P.A, S.C. Alagundagi and S.R. Salakinkop. (2013). The anti-nutritional factors in forages- a review. *Current Biotica* 6 (4): 516-526

Soetan, K.O. and Oyewole, O.E.(2009). The need for adequate processing to reduce the anti-nutritional factors in plants used as human foods and animal feeds. A review. *African Journal of Food Science*, 3: 223-232

Suttle, N.F. (1983). Meeting the mineral requirement of sheep. In: sheep production (Haresign, W. editor) London, Butterworths, Pp 167-183

Spinelli, J., Houle, C.R. and Wekell, J.C. (1983). The effect of phytates on the growth of rainbow trout (*Salmo gairdneri*) fed purified diets containing various quantities of calcium and magnesium. *Aquaculture*, 30: 71-83.

Teferedegne, B. (2000). New perspectives on the use of tropical plants to improve ruminant nutrition. Proceedings of Nutrition Society. 59: 209-214.

Thonney, M. L. 1987. Growth, feed efficiency and variation of individually fed Angus, Polled Hereford and Holstein steers. *J. Anim. Sci*. 65:1.

Van Soest, P. J. (1994). *Nutritional Ecology of the Ruminant*. Comstock Publishing Associates, Ithaca, New York.

Van Soest, P.J., Robertson, J.B. and Lewis, B.A. (1991). Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science*74 (10): 3583-3597. http://jds.fass.org/cgi/reprint/74/10/3583.pdf.

Verma, (2006). A textbook of Animal Nutrition. Kalyani Publisherd, New Delhi Pp126-132.

Waghorn G. C., Tavendale, M.H. andWoodfield, D.R. (1990). Methanogenesis from forages fed to sheep. Proc. New Zealand Grassland Assoc., 51:171-175.

Yusuf, K.O., Isah, O.A., Oni, A.O., Arigbede,O.M., Adeleye, O.O. and Onwuka, C.F.I. (2009). Performance and nutrient digestibility of West African dwarf goats fed diet containing yam peel meal. Proceedings of the 34th annual conference of the Nigerian Society for Animal Production, March 15-18, 2009. University of Uyo, Akwa Ibom State, Pp 519-521.