Effect of ensiling on the nutritive value of groundnut hulls and wheat straw

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SUMMARY

In this experiment a laboratory ensiling technique was developed to inves- tigate the effect of biological treatment (ensiling), on the nutritive value of poor quality by-products such as groundnut-hulls (G.N.H.), and wheat straw (W.S.). Twenty four hours prior to packing into plastic bags, (lab. silos) the G.N.H. and W.S. were reconstituted with distilled water to a D.M. content of 45% and then ensiled for three weeks with and without molasses, bagasse or sugar-cane-tops (S.C_T.), added at 5 and 10% level on DM basis of the ensiled substrate. The average quantity of the ensiled material in each sac was 450 and 300 gms for G.N.H. and W.S. respectively. G.N.H. silage with and without additives was of good quality shown by lower pH, higher lactic acid, higher ammonia nitrogen content and lower DM loss, compared with that of W.S. which did not benefit from ensiling without additives. However molasses and bagasse added at 5 and 10% levels lowered the pH of W.S. sil- age by 20 and 17%, 20.6 and 15.7% respectively. The lactic acid content (L.A.) was significantly increased in the W.S. silage due to additives.

INTRODUCTION

Nutritionists in the Sudan were very much conceded with the severe animal feed shortages caused mainly by drought and desertification which affected the country for several consecutive years, and consequently resulted in a scarcity in animal products especially in urban areas.

The low quality agro-industrial by-products could not be used as available to support the animals life. From the various treatments used to improve the poor quality feeds, the biological treatment through ensiling seems to be the best practical method under Sudan conditions.

This experiment was designed to assess in vitro the nutritive value of some importatnt agro—industrial by-products before and after ensiling for three weeks.

MATERIALS AND METHODS

The agro-industrial by-products used in the experiment were groundnut- hulls (G.N.H.) and wheat straw (W.S.). The by-product additives used were sugar-cane-tops (S.C.T.), bagasse and molasses. All were acquired from dif- ferent parts of the country.

1 proximate analysis and IVDMD of G.N.H., W.S., S.C.T. and bagasse was carried out and the data are shown in table (1).

Table 1: Proximate analysis and IVDMD of some Agro-industrial by-products.

Agro-industrial by-products	DM	CP	CF	EE	Ash	NFE	NDF	ADF	Cellulose	Hemicellulose	Permanganate lignin	IVDMD	Acid insoluble ash
Wheat straw	96.4	1.73	50.11	5.32	10.0	32.84	77.77	55.5	35.45	22.27	8.79	43.24	11.27
Groundnut hulls	94.76	5.4	32.0	1.1	8.1	53.35	65.6	55.15	38.02	10.45	9.45	27.03	7.69
Sugar cane tops	97.1	3.6	35.5	0.7	8.0	52.2	71.32	39.53	31.52	31.79	5.42	45.56	2.6
Bagasse	98.16	1.3	42.0	1.0	1.99	53.71	84.4	84.69	41.38	35.71	6.63	35.4	0.68
Molasses	75.2	3.2	-	-	-	-	-	-	-	-	-	-	-

Twenty four hours before mixing with the additives, (molasses, bagasse or S.C.T.) G.N.H. and W.S. were reconstituted with distilled water to a DM of 45%. Then bagged in a large plastic sac which was then kept closed in a refrigerator ovemight, to ensure equilibration through the material.

Two sacs were used to fonn one silo, by inserting one into another with the sealed sides of both sacs opposite" to one another for extra strength and to avoid rupturing of the sacs along the sealed sides.

Before filling, the plastic sacs were labelled and weighed. Filling and com- pression of the material in the sac was carried out manually. The sacs were then closed by wraping with wire and folding back the end part of the sac to seal the opening at the wrapin g point with a layer of vaseline to ensure anaer- obic fermentation inside the sac. The sacs were then reweighed after filling. . The weight of the sacs were not equal but the range was kept as close as possible, especially among the replicates of the same treatment.

Post ensiling analytical procedures:

Dry matter of the ensiled material before packing in the sacs was deter- mined. At the end of the third week the sacs were weighed and opened. Dur- ing the ensiling period the sacs were regularly weighed every two days. A fresh saniple of each silage was taken for analysis after discarding the mouldy surface layer which was of variable thickness, the remaining silage was stored deep-frozen until further analysis. The fresh silage was used only for the DM and pH determinations. The pH was determined by adding 10 gms of fresh silage to 50 ml distilled water and shaking the mixture for 5 minutes, then pl-I of the solution was measured using an Ell pH-meter (model 7030). ADF, lignin, cellulose and insoluble ash were determined according to Goering and Van Soest (1970). NDF was determined according to Robertson and Van-Soest (1977). Water-soluble extract was prepared for lactic acid (L.A.) and ammonia ntrogen determinations according to the enzymatic method for D-lactate deter- mination in biological fluids by Gawehn and Bergmeyer (1974), and Conway (1957) using Conway units, respectively. The in vitro dry matter digestibility (IVDMD) was determined according to the modified method of Tilley and Terry (1965). DM loss was calculated using the DM determination of the ensiled material before and after ensiling. Statistical analysis.' It was carried out according to Steel and Torrie (1960) using linear model for factorial experments.

RESULTS

Table (2) shows the effect of ensiling with and without additives on the chemical composition and in vitro dry matter digestibility (IVDMD), of G.N.H. and W.S. The IVDMD of W.S. and G.N.H.'was 27.75% and 6.25% higher after ensiling, while ensiling with additives showed no effect on the IVDMD of both materials.

Table 2: Effect of ensiling on the chemical composition and IVDMD of groundnut-hulls and wheat straw.

Item	Substrate	Before ensiling	Untreated silage	Silage with additives					
				5% molasses	10% molasses	5% bagasse	10% bagasse	5% S.C.T.	10% S.C.T.
NDF	GNH	65.6	63.77	65.52	62.37	69.17	69.62	69.73	65.06
	WS	77.77	76.39	72.64	69.84	78.13	78.35	76.15	80.74
ADF	GNH	55.15	59.25	60.34	57.3	62.5	61.2	61.32	58.71
	WS	55.5	51.02	47.85	46.52	50.04	49.75	52.85	52.93
Hemi-cellulose	GNH	10.45	4.52	5.18	5.07	6.67	8.42	8.41	6.35
	WS	22.27	25.37	24.79	23.32	28.09	28.6	23.3	27.81
Crude protein	GNH	7.25	13.75	13.0	14.0	13.19	13.31	12.81	12.81
	WS	2.0	3.52	3.66	4.17	3.33	3.23	3.18	3.25
IVDMD	GNH	27.03	28.72	22.73	30.95	26.0	25.67	22.28	26.51
	WS	43.25	55.34	51.2	46.12	49.06	44.3	47.77	48.03

The effect of additives on the ensiling losses and fermentation characteris- tics of G.N.H. and W.S. is summerized in table (3). There was no significant ($p > 0.05$) difference in the DM content of all silages produced. Inclusion of additives at the levels used were also without significant ($p > 0.05$) effect on the DM content. However there was a significant ($p < 0.01$) difference in the % DM loss of the silage produced with significant interactions between addi- tives levels ($p < 0.01$), additives substrate ($p < 0.05$) and levels-substrate ($p < 0.05$). It is clear that the % DM loss was reduced significnatly when additives 5 and 10% bagasse, 5% S.C.T. were added to thepnsiled materials

Table 3: Effect of additives on ensiling losses and fermentation characteristics of groundnut-hulls (G.N.H.) and wheat straw (W.S.).

Item	Ensiled substrate	Silage without additive	Silage with additives					
			5% molasses	10% molasses	5% bagasse	10% bagasse	5% S.C.T.	10% S.C.T.
DM content%	GNH	44.8	44.67	44.87	44.06	45.11	45.36	44.57
	WS	41.77	43.56	44.47	44.39	45.99	47.2	47.24
Total weight loss%	GNH	1.77	2.43	1.5	1.51	1.67	1.67	1.77
	WS	1.41	1.63	1.9	1.31	1.17	1.4	1.37
DM loss%	GNH	1.63^{a}	1.93^{b}	2.29^{b}	1.39^{b}	1.42^{b}	1.59^{a}	1.66^{a}
	WS	1.27^{a}	1.27^{a}	1.81^{a}	1.04^{b}	1.15^{b}	1.41^{b}	1.39^{b}
pH	GNH	5.13^{aa}	5.13^{aa}	5.0^{aa}	4.78^{aa}	4.72^{aa}	5.0^{aa}	4.97^{aa}
	WS	6.16^{a}	4.93^{a}	5.11^{a}	4.89^{a}	5.19^{a}	5.57^{a}	5.93^{a}
D-lactate content as%DM	GNH	0.07^{a}	0.12^{a}	0.24^{b}	0.2^{b}	0.17^{b}	0.1^{a}	0.11^{a}
	WS	0.0^{a}	0.22^{b}	0.29^{b}	0.26^{b}	0.26^{b}	0.07^{a}	0.26^{b}
NH-N as% of total N of silage	GNH	2.01^{a}	1.9^{a}	1.8^{a}	2.55^{a}	2.3^{a}	2.03^{a}	1.99^{a}
	WS	1.2^{a}	0.81^{a}	0.86^{a}	1.03^{a}	0.72^{a}	1.48^{a}	1.44^{a}

N.B.
Means within the same row followed by the same superscript are not significantly different.

The difference in pH was highly significant ($p < 0.05$) among the two substrates, additives and levels, with highly significant ($p < 0.05$) interactions between additives-substrates, additive-levels, levels-substrate and substrate- additives-levels.

The drop in pH due to additive was in the following sequence starting with the highest drop, 5% bagasse, 5% molasses, 10% bagasse and 10% S.C.T. in case of W.S. silage. While G.N.H. silage showed a significant ($p < 0.05$) drop in pH with 10% bagasse only.

The D-lactate content of the different silage was significantly ($p < 0.05$) variable among the additive and levels, but not significantly ($P > 0.05$) be- tween the additives-levels, and levels-substrates.

The D-lactate content was increased with all additives at both levels except for 5% S.C.T. The maxi- mum increase was due to 10% molasses, then 5% and 10% bagasse and last- ly 10% C.S.T. The increase in the D-lactate content of G.N.H. silage due to additives was in the following order, l0% molasses, 5% molasses and 5% bagasse.

Considering the standard parameters used for silage quality evaluation i.e. DM loss%, pH, D-lactate (lactic acid) content and ammonia nitrogen both W.S. and G.N.H. resulted in a good quality silage when fermented with 10% molasses and 5% bagasse.

DISCUSSION

Considering the standard parameters used as quality criteria in silage re- search such as DM loss%, pH, D-lactate and ammonia nitrogen content, both W.S. and G.N.H. resulted in good silage, when ensiled with a source of soluble carbohydrate such as the additives used in this experiment. However en- siling without additives was of value only in case of G.N.H., while W.S. sil- age was of poor quality as reflected by the high average pH of 6.16 and only traces of lactic acid. Similar finding was reported by Cupta and Pradhan (1977) when they found a beneficial effect due to molasses addition on mixed wheat straw and groundnut cake.

The effect of additives on nutrient preservation and silage quality was more pronounced in case of W.S. silage as indicated by the data of W.S. sil- age with 5% molasses and 5% bagasse pH of 4.93 and 4,89, and D-lactate content of 0.33 and 0.26% on DM basis, respectively. This supports the pre- vious finding on Cupta and Pradhan (1977), that a better quality silage could be obtained from W.S. by correct supplementation with the optimum level of moisture needed for ensiling.

Enzmann et. al. (1969) ensiled chiped and ground poplar supplemented with minerals and urea, the silage obtained successfully sewed as an emer- gency ration for cows and sheep. This however could be a low cost process- ing technique or preservation method for low-quality by-products in Sudan. The relatively poor quality silage of W.S. without additives could also be due to the difficulty and problems encountered with air exclusion during packing the material in the silo. Pratt and Gilmore (1957) explained that the difficulty of creating a satisfactory anaerobic condition in case of straw was due to their characteristics hollow stems. This air infilteration resulted in scat- tered moldy spots all through the silo in case of W.S. silage, which may probably be due to clostridia femientation. In addition the aerobic pockets distributed through different areas of the silo will favour the gram-negative bacteria of the coliforrn type due to the de- pletion of sugars through the continuous plant cell respiration and hence less nutrients being available for subsequence fermentation, Weise (l968) and Oh- yama et. al. (1970). Takahashi (1970) reported that at high levels of oxygen the development of yeast inhibited lactic acid production.

This was confimied by the data of D-lactate content of W.S. silage in this experiment. It was obvious from the data in table (3) that molasses and bagasse had improved the silage quality of G.N.H. and W45; and reflected by the highest yield of D-lactate. This appeared to be a manifestation of the suitability of molasses and bagasse as a substrate for lactic acid bacteria, while S.C.T. had given inconsistent and negative results as a source of energy for the process. Similar findings conceming molasses were also reported by Gupta and Pradhan (1977) who reponed that molasses is a suitable substrate for lactic acid bacteria and resulted in a higher production of L.A. when used in silage from W.S. supplemented with sulpher and urea. Finally ensiling of G.N.H. and W.S. proved to be an economical practical process for nutrient preservation and production which could help in bridging the animal feed deficit in the Sudan.

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