Estimation of Gas Production Pattern (In Ml) of Sheanut Cake Based Concentrate Mixtures By In Vitro Gas Production Technique

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Abstract: The effects of the Sheanut cake samples on *in vitro* methanogenesis was assessed by incubating samples with and without addition of a tannin-binder, polyethylene glycol (400 mg, PEG-6000). Sheanut cake (200 mg) was weighed into 100 ml calibrated glass syringes with pistons lubricated with Vaseline. The samples of Shea nut contained more than 7.0 per cent phenols and out of them 90 % are in the form of tannin phenols. However, majority of them are hydrolyzable tannin. The energy value of all the 3 forms are more than 7 MJ/kg DM and CP around 12 percent indicating that it could be a potential source of both energy and protein for ruminants. The tannin content is also not very high, although HT content is more than CT in all the 3-forms. The *in vitro* incubation of SNC with polyethylene glycol-6000 (as a tannin binder) showed an improvement of about 11 ml of gas indicating significant effect of tannin on fermentation. PEG-6000 binds with tannin; hence methane production recorded in the samples with PEG is that of 'no tannin'. When the gas samples were subjected to the analysis of methane, SNC samples produced 4.7 ml methane/g DM whereas when it was incubated with added PEG, methane production was 13 ml/g DM. The tannin present in SNC was responsible for suppression of methane to the tune of 64.0 %. Hence, SNC could be used as a source of tannin (contains 7 MJ/kg DM ME and around 12 percent CP) to suppress methane emission in ruminants.

Key words: IVGPT, Shea nut cake, Tannin content,

Introduction

Shea nut cake is the residue that remains after the extraction of shea butter from the nut. It is estimated that about 500,000 tons of shea nut cake is produced annually by the shea industry in the savanna zones of Ghana [1]. It is estimated that for every metric tonne nuts processed, 450–600 kg of shea nut cake is produced and about 60,000 metric tonnes of shea kernels are consumed locally in a year [2]. Thus, about 30,300,000 kg shea nut cake is generated locally in a year in Ghana. Meanwhile the industry has been projected to equalize the cocoa industry in future as shea butter gradually becomes the best substitute for the cocoa butter industries [3], [4]. Shea nut fruits are a source of energy during the dry season. The large fleshy seeds yield about 45% edible lardlike fat, the shea nut butter, used for food and cosmetics. A by-product of the butter extraction is shea nut cake or meal, which can be used as feedstuff. The green fruit of Shea (*Butryospermum parkii*) tree has a pulp that covers the seed or nut. The harvest follows 3 to 5 years cycle and yields 80 kg of nuts and from these

nuts, oil will be extracted and leaving the residue [5], [6]. Sheanut meal is now receiving increased attention as a potential feed ingredient due to the increased amounts that are available as a result of high demand for shea fat for cosmetics and as a cocoa butter substitute in chocolate [7]. The protein component potential of sheanut products has not yet been fully explored. The present *In vitro* gas production analysis study was therefore undertaken to analyze the degradation kinetics, determination of the total gas volume, rate of degradation using IVGPT & determination of the effect of SNC on methane emission of the sheanut cake expeller and solvent extractions for their suitability source of as poultry and animal feed.

Materials and Methods

In vitro gas production was carried out as per the procedure [8]. The effects of the Sheanut cake samples on *in vitro* methanogenesis was assessed by incubating samples with and without addition of a tannin-binder, polyethylene glycol (400 mg, PEG-6000**)**. Sheanut cake (200 mg) was weighed into 100 ml calibrated glass syringes with pistons lubricated with Vaseline. Buffered mineral solution was prepared and placed in a water bath at 39°C under continuous flushing with CO_2. Rumen fluid was collected before the morning feeding from ruminally-cannulated cattle. Ruminal contents were collected into a pre-warmed insulated flask, transported to the laboratory, homogenized and filtered through three layers of cheese cloth. Anaerobic condition was maintained by continuous flushing with CO_2. The well-mixed and CO_2 flushed strained ruminal fluid was added to the buffered mineral solution (1:2). The mixture was kept stirred with a magnetic stirrer under CO_2 in a water bath at 39°C. Ruminal fluid and buffer mixture (30 ml) was dispensed into each syringe containing the weighed tannin samples. After closing the clips on the silicon tube at the syringe tip, syringes were gently shaken and clips were opened to remove gas by pushing the piston upwards to achieve complete gas removal. The clip was closed, initial volume recorded, and the syringes were immediately placed in thermostatically controlled shaking water bath at 39°C. A parallel incubation of reference standard feedstuffs (hay and concentrate) obtained from the Hohenheim University, Germany, were also included [9]. The gas produced after 24 h was recorded and gas samples were collected in evacuated vials and analyzed for CH_4.

To determine the rate of degradation (t 1/2) of the substrate the sample was incubated for 96 h, with recording of the gas volumes at 2, 4, 6, 8, 10, 12, 24, 36, 48, 72 and 96 h.

Results and Discussion

The samples of Shea nut contained more than 7.0 per cent phenols and out of them 90 % are in the form of tannin phenols. However, majority of them are hydrolyzable tannin. The energy value of all the 3 forms are more than 7 MJ/kg DM and CP around 12 percent indicating that it could be a potential source of both energy and protein for ruminants. The tannin content is also not very high, although HT content is more than CT in all the 3-forms.

The degradation kinetics of the Sheanut cake indicated that the minimum gas production (Y min) was 0.81 ml and maximum being (Y max) 18.93 ml. The rate of degradation was 0.0707 with a half time (t1/2) of 9.8 h.

The *in vitro* incubation of SNC with polyethylene glycol-6000 (as a tannin binder) showed an improvement of about 11 ml of gas indicating significant effect of tannin on fermentation. PEG-6000 binds with tannin; hence methane production recorded in the samples with PEG is that of 'no tannin'. When the gas samples were subjected to the analysis of methane, SNC samples produced 4.7 ml methane/g DM whereas when it was incubated with added PEG, methane production was 13 ml/g DM. The tannin present in SNC was responsible for suppression of methane to the tune of 64.0 %. There are already published literatures indicating that tannins suppress methane emission. Hence, SNC could be used as a source of tannin (contains 7 MJ/kg DM ME and around 12 percent CP) to suppress methane emission in ruminants.

Proximate Principles and fibre fractions of sheanut cake and sheanut cake based diets

Sheanut cake and sheanut cake based rations were analysed for proximate principles and fibre fractions. Sheanut cake contained crude protein, crude fibre and ether extract values of 13.12, 9.84 and 2.43 indicates optimum quantities of nutirients that can replace certain concentrate ingredients. Based on these values 9 rations with deoiled rice bran and 9 rations with wheat bran were formulated by replacing with sheanut cake which are isonitrogenous and isocaloric with crude protein values around 20 per cent. All the rations were analysed for proximate principles which are presented in the tables 4 and 5.

Table I. Chemical composition of sheanut cake based ration replacing deoiled rice bran.

Ration	DM	CP	CF	EE	NFE	Ash	AIA	NDF	ADF
DOR 1	85.24	20.85	5.65	2.33	61.06	10.11	4.24	45.51	14.94
DOR 2	86.20	20.88	5.13	1.91	61.57	10.51	4.13	56.97	21.65
DOR 3	85.06	20.91	6.00	2.51	59.74	10.85	4.02	52.72	19.92
DOR 4	85.41	20.60	6.00	2.54	60.44	10.42	3.99	56.34	19.37
DOR 5	84.97	19.58	6.12	2.54	61.67	10.08	3.96	56.04	19.32
DOR 6	85.22	20.92	6.37	2.58	59.47	10.65	3.90	51.25	20.75
DOR 7	86.02	20.39	6.49	2.58	60.36	10.19	3.90	51.66	19.65
DOR 8	84.56	20.37	6.67	2.58	60.09	10.29	3.90	54.19	15.43
DOR 9	86.36	20.85	6.90	2.70	59.26	10.30	3.83	44.15	20.85

DM- Dry matter, CP- Crude Protein, CF- Crude fibre, EE- Ether extract, NFE- Nitrogen free extract, AIA- Acid insoluble ash, NDF- Neutral detergent fibre, ADF- Acid detergent fibre

Table II. Chemical composition of sheanut cake based ration replacing wheat bran.

Ration	DM	CP	CF	EE	NFE	Ash	AIA	NDF	ADF
WB 1	81.20	20.87	6.09	2.39	60.73	9.92	3.37	55.63	18.94
WB 2	86.78	20.78	6.30	1.80	61.21	9.91	3.32	62.24	18.92
WB 3	88.85	20.91	6.41	2.56	60.91	9.20	3.31	70.99	18.62
WB 4	86.50	20.25	6.43	2.57	61.56	9.19	3.30	63.22	18.42
WB 5	86.55	20.09	6.49	2.73	60.69	9.99	3.29	53.50	18.27
WB 6	86.95	20.47	6.60	2.74	60.66	9.53	3.10	51.33	17.10
WB 7	86.79	20.07	6.70	2.76	61.15	9.32	3.00	53.17	16.42
WB 8	87.05	20.91	6.81	2.78	60.09	9.40	3.00	54.55	16.10
WB 9	88.27	20.90	6.90	2.69	59.91	9.59	3.00	52.40	14.52

DM- Dry matter, CP- Crude Protein, CF- Crude fibre, EE- Ether extract, NFE- Nitrogen free extract, AIA- Acid insoluble ash, NDF- Neutral detergent fibre, ADF- Acid detergent fibre

Gas Production Pattern (in ml) of sheanut cake based concentrate mixtures

In vitro gas production pattern of sheanut cake based concentrate mixtures replacing deoiled rice bran and wheat bran in Rusitec are presented in table 12 and table 13 respectively.

Table III. Gas Production Pattern (in ml) of sheanut cake based concentrate mixtures replacing deoiled rice bran.

	INCUBATION IN HOURS					
Rations	0 H	8 H	12H	24 HRS	36 HRS	48 hrs
DOR 1	0	68	826	2654	3454	4363
DOR 2	0	48	782	2600	3332	4125
DOR 3	0	39	634	2586	3202	3823
DOR 4	0	19	592	2501	3039	3674
DOR 5	0	14	549	2459	3080	3564
DOR 6	0	10	529	2410	2939	3475
DOR 7	0	8	518	2385	2930	3401
DOR 8	0	5	483	2299	2722	3243
DOR 9	0	4	460	2290	2712	3109

Table IV. Gas Production Pattern (in ml) of sheanut cake based concentrate mixtures replacing wheat bran.

	INCUBATION IN HOURS					
Rations	**0 H**	**8 H**	**12H**	**24 HRS**	**36 HRS**	**48 hrs**
WB 1	0	72	853	2711	3512	4363
WB 2	0	51	796	2627	3399	4125
WB 3	0	42	642	2598	3288	3823
WB 4	0	21	611	2534	3121	3674
WB 5	0	15	566	2482	3103	3564
WB 6	0	11	541	2435	3008	3475
WB 7	0	8	534	2411	2989	3401
WB 8	0	5	494	2328	2812	3243
WB 9	0	5	476	2304	2798	3121
SNC 1	0	4	450	2254	2704	3101
SNC 2	0	4	435	2311	2746	3110

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