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Effect of Replacement of Wheat Straw with Maize Cobs with or without Physico-Chemical Treatment on Degradation of Dry Matter, Truly Digestible Organic Matter and Production of Microbial Biomass of Composite Ration *In Vitro* using Goat Rumen Liquor

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ABSTRACT

This study was carried out to investigate the effect of replacement of wheat straw by different levels of maize cobs in composite ration on *in vitro* degradation of dry matter, truly digestible organic matter and production of microbial biomass in order to determine its level of supplementation in ruminant ration. Wheat straw was replaced by maize cobs @ 0, 10, 20, 30, 40, 50 and 100% level to formulate composite rations. The different formulae of composite rations were used for *in vitro* gas production studies using goat rumen liquor with wheat straw. In physical treatment only soaking was done while under chemical treatment application of urea, molasses and combination of both urea and molasses were applied before conducting *in vitro* studies using goat rumen liquor. Proximate composition, fiber fractionation and calcium and phosphrous content of all the composite rations were estimated. The *in vitro* degradability of maize cobs based diets is better than wheat straw based composite ration. There was no significant (P>0.05) improvement in per cent IVDMD of maize cob based diet by water soaking irrespective of the soaking period, however, a significant (P<0.05) improvement in *in vitro* degradation parameters were observed with urea-ammoniation of maize cobs. No benefit of molasses treatment either in isolation or in combination was observed over maize cobs utilization as compared to urea-ammoniated maize cobs. It is concluded that feeding value of maize cobs is similar to wheat straw as indicated by IVDMD while urea-ammoniation appears to be the 'treatment of choice' for improving nutritive value of maize cobs.

Keywords: Maize cobs**,** Composite Ration, IVDMD, TDOM, MBP

India, with its limited resources is currently facing a deficiency of feedstuffs for feeding of its huge livestock population. This puts onus on the animal nutritionists to find alternatives to conventional feeds. Maize is one of the most important cereal crop grown in world including India. Maize production in India has grown at the annual growth rate of 5.5% from 14 Million MT in 2003-04 to 23 million MT in 2013-14 (FICCI, 2014). Maize cobs, which often are either burned or ploughed into the soil, could serve as source of feed energy suitable for ruminant livestock. Therefore, bioconversion of the discarded maize cobs for productive utilization in the ruminant ration seems to be a suitable alternative use and thus, present study was planned to scrutinize the effects of feeding of treated and untreated maize cobs as replacer to wheat straw on the performance of goats.

A number of unconventional feedstuffs and agro-industrial by-products are available for animal feeding (Qureshi, 1987). Unconventional feedstuffs like crop residues and agro-industrial by-products can play an important role in the feeding of sheep and goats under different management systems (Bistanji *et al.*, 2000). Such residues can supply a substantial part of the maintenance requirements of small ruminants in the Asian region (Jayasuriya, 1985). Adeyemi and Familade (2003) reported maize cobs with a proximate composition of 89.17% DM, 97.72% OM, 42.46% CF, 3.30% CP, 1.47% EE, 50.49% NFE and 2.28% total ash. Similar result was also reported by other researchers (Martínez *et al.*, 2008; Belewu and Babalola, 2009). Arias *et al.* (2003) reported that maize cobs had 65.0% *in vitro* dry matter digestibility and 66.4% *in vitro* organic matter digestibility. *In vitro* DM digestibility (IVDMD) increased with feed grade urea-treated and aqueous NH_3 treated maize cobs (Oji *et al.*, 2007). It was also reported that nutritive value of maize cobs can be increased by employing 3% urea (Yulistiani *et al.*, 2012). Hence, the present study was carried out to find *in vitro* digestibility characteristics of incorporation of maize cobs in ruminant ration using graded level using goat rumen liquor.

MATERIALS AND METHODS

Source of maize cobs

Present study investigated the potential value of maize cobs as a fibre source in ruminant ration. Locally available maize cobs (*Zea mays*) were collected from the doorsteps of farmers in the Kandi belt of Jammu division. Experiment was carried within the campus of FVSc. & A.H. SKUAST-J, RS Pura, Jammu.

In vitro experiment

In vitro experiment was conducted in three stages.

Experiment-1

Different composite rations based on wheat straw were formulated in which wheat straw was replaced by graded levels of maize cobs (Table 1). These different iso-nitrogenous complete diets were tested for *in vitro* degradation parameters as per Menke and Steingass (1988).

Table 1. Formulation of ccomposite rations with graded levels of maize cobs replacing wheat straw

Wheat straw replacement level	0%	10%	20%	30%	40%	50%	100%
Ingredient (%)							
Maize	10.00	10.00	10.20	10.30	10.00	10.00	12.00
Wheat bran	10.00	10.00	10.00	10.00	10.60	10.70	9.00
Mustard oil cake	13.00	13.00	12.80	12.70	12.40	12.30	12.00
Wheat straw	66.00	59.40	52.80	46.20	39.60	33.00	0.00
Maize cobs	0.00	6.60	13.20	19.80	26.40	33.00	66.00

Iso-nitrogenous composite ration using wheat straw and graded level of maize cobs (0, 10, 20, 30, 40, 50 and 100% of wheat straw replacement by maize cobs) was formulated by replacing wheat straw with maize cobs and subjected to *in vitro* gas production studies (Menke and Steingass, 1988) using goat rumen liquor collected from slaughter house.

Experiment-1I

Based on the result of experiment I, 100% replacement of wheat straw with maize cobs was taken in the experiment II. This was attempted by soaking (physical treatment) and urea (4%) and/or molasses (5%) as (chemical treatment). Twelve ml of water per gm of feed was found adequate for soaking. Soaking of samples was done at the bottom of syringes at different durations *viz*. 0min, 15min, 30min, 45min, 1 h, 12 h and 24 h were selected for soaking treatment by water and the results of this physical treatment were analyzed and subjected to *in vitro* gas production studies (Menke and Steingass, 1988) using goat rumen liquor.

Experiment-III

Further chemical treatment of urea (4%) alone, molasses (5%) alone and a combination of both urea (4%) and molasses (5%) were performed on maize cobs and wheat straw based composite rations. Four gram of urea was dissolved in 40ml of water which was then mixed thoroughly with 100g of maize cobs. Similar treatment was given to wheat straw. Urea treated wheat straw and maize cobs were then incubated in an air tight container for 15 days. Similarly in molasses treatment, 5g of molasses was mixed thoroughly with 100g of ground maize cobs, 100g of wheat straw, 100g of urea treated ground maize cobs and 100g of urea treated wheat straw. Treated residues were then incorporated in composite rations and studied for *in vitro* degradation parameters (Menke and Steingass, 1988).

Proximate analysis and fiber fractionation

Proximate analysis of maize cobs, wheat straw along with composite mixture before and after treatment was done as per AOAC (1995) and fiber fractions [Neutral detergent fiber (NDF) and Acid detergent fiber (ADF) were done as per standard method (Van Soest *et al.,* 1991).

On the day of incubation, the mixture of rumen liquor and particulate matter (*approximately 60:40*) was collected from local slaughter house into pre-warmed CO_2 filled thermos and carried to the laboratory. The rumen fluid was bubbled with CO_2 gas for few minutes and then mixed in a laboratory blender at medium speed to remove microbes attached to particulate matter. Rumen liquor was then strained through a double layer of muslin cloth. Strained liquor was then added to the buffer media when the media became colourless. Handling of rumen liquor was done under continuous flushing with CO_2.

Filling of syringes and incubation

All the buffer solutions were prepared as per Menke and Steingass (1988).The buffered rumen fluid (30ml) was dispensed to each syringe by a marked self made dispenser. After recording initial volume (± 0.5 ml), the syringes were placed in the incubator maintained at 39°C. The syringes were shaken by hand intermittently at 3 hours interval. All incubations were run in triplicate and four syringes with buffered rumen fluid were incubated as blanks. A zero hour blank in duplicate was also kept during dispensing of buffered rumen fluid into syringes. Standard was also run in triplicate with wheat straw alone as incubated sample. At the end of incubation (24 h) the amount of gas produced was measured by reading the position of the plug and the contents of the syringes were analyzed further.

Determination of substrate degradation and microbial bio-mass production

The contents of the syringes were transferred to 500 ml spoutless beakers by repeated washings with neutral detergent solution without sodium sulphite (Goering and Van Soest, 1970; Van Soest and Robertson, 1985). The contents were then refluxed for 1 h to extract the microbial matter from the undegraded feed (Blummel and Becker, 1997) and the residue was recovered in pre-weighed filter crucibles. After drying the crucibles (with residue) at 105°C to constant weight, ashing was done at 400°C to 500°C for 2 hours. Truly degradable organic matter (TDOM), organic matter digestibility (OMD), microbial biomass production (MBP), and efficiency of microbial biomass production (EMP) were calculated as follows:

TDOM = Feed (OM) incubated - residue (OM)

MBP = TDOM - (2.2 × net gas volume)

EMP ={TDOM - (2.2 ×net gas volume)} × 100/TDOM

PF = TDOM/net gas volume

Statistical analysis

Data obtained was subjected to analysis of variance using GLM procedure for *in vitro* trial results and the means having significant difference were ranked as per Duncan's multiple range test (Duncan, 1955)

RESULTS AND DISCUSSION

Proximate composition and fiber fractions of maize cobs and composite rations

Maize cobs contains 3.54±0.15% CP and 60.25±0.55% NFE. The NDF and ADF content of the maize cobs was 74.02±1.39 and 52.42±0.61%, respectively (Table 2). The wheat straw contains 3.50±0.13% CP and 47.98±1.10% NFE. The NDF and ADF content of the maize cobs was 75.01±2.36 and 54.59±2.25%, respectively. The protein content of urea alone and urea in combination with molasses increased to 8.76±0.55 and 8.16±0.21% respectively, with no difference in protein content of molasses treated cobs (Table 2). The calcium and phosphorus content of maize cobs was 1.25±0.04 and 0.44±0.03% whereas the values in wheat straw was 0.91±0.03 and0.26±0.02%, respectively.

Table 2. Percent chemical composition and fibre fractionation of maize cobs (treated and untreated) and wheat straw.

Attributes	Maize cobs	Urea treated maize cobs	Molasses treated maize cobs	Urea and Molasses treated maize cobs	Wheat straw
Moisture	5.06±0.23	25.42±0.49	5.89±0.07	23.42±0.48	9.72±0.69
Organic matter	97.23±0.21	97.39±0.16	97.48±0.11	97.66±0.04	88.56±0.71
Total ash	2.77±0.21	2.84±0.10	2.68±0.09	2.61±0.09	11.43±0.71
AIA	1.07±0.10	1.09±0.04	1.05±0.02	1.08±0.03	8.84±0.53
Crude protein	3.54±0.15	8.76±0.55	3.21±0.12	8.16±0.21	3.50±0.13
Ether extract	2.85±0.17	2.75±0.13	2.68±0.16	2.42±0.10	1.16±0.09
Crude fibre	30.58±0.35	24.62±0.78	26.27±0.61	24.32±0.53	35.91±1.33
NFE	60.25±0.55	56.47±1.79	65.32±0.40	59.42±0.28	47.98±1.10
NDF	74.02±1.39	65.24±0.52	73.36±0.51	64.23±0.41	75.01±2.36
ADF	52.42±0.61	46.42±1.58	51.38±0.80	45.28±1.42	54.59±2.25
Hemicellulose	21.60±2.00	18.81±1.08	21.97±1.32	18.95±1.44	20.42±3.25
Cellulose	44.10±0.60	39.64±1.80	43.30±0.84	38.83±1.47	47.20±2.48
ADL	8.31±0.01	6.78±0.24	8.08±0.04	6.45±0.24	7.38±0.65
Calcium	1.25±0.04	1.17±0.02	1.11±0.03	1.06±0.03	0.91±0.03
Phosphorus	0.44±0.03	0.46±0.04	0.49±0.03	0.50±0.01	0.26±0.02

*All attributes expressed as per cent DM except moisture; AIA: Acid insoluble Ash; NFE: Nitrogen free extract; NDF: Neutral detergent fiber; ADF: Acid detergent fiber; ADL: Acid detergent lignin

Crude protein content (DM%) was in agreement to Aregheore (2000) and Adeyemi and Familade (2003) but slightly lesser than Aregheore (1995). CF content (%DM) was found comparable to the values as reported by Arias *et al.* (2003) but lesser than as reported by Adeyemi and Familade (2003). The per cent EE content was higher than that reported by Martínez *et al.* (2008), Oduguwa *et al.* (2008) and Arias *et al.* (2003) but lower than reported by Belewu and Babalola (2009). NDF and ADF content (%DM) were found to be 74.02 and 52.42, respectively which were slightly higher than reported by Chanthakhoun and Wanapat (2011). These variations in proximate composition might arise due to the influence by certain factors such as cultivar, effective temperature sum and farm type as suggested by Szyszkowska *et al.* (2007). Furthermore, maize residues obtained by means of a cob harvester tended to have a higher nutritional quality which might be ascribed to an increased ratio in the cob harvested residues of plant and cob leaves having a more favourable chemical composition (Henning and Steyn, 1984; Snyman, 1985 and Schoonraad *et al.*, 1987). The proximate and fibre composition of maize cobs shows that it is a poor quality ligno-cellulosic feedstuff that is similar in its chemical composition to other low quality crop residues like wheat/paddy straw and can serve as potential replacer of these feedstuffs, supply of which is rapidly diminishing with the advent of new dwarf varieties of wheat/paddy and newer harvesting machines.

Urea-ammoniation of maize cobs increased its CP (8.76>3.54) content by more than 100%. This increase in maize cob's protein content on addition of urea treatment was similarly reported by Yulistiani *et al.* (2012). These values were slightly lesser as compared to the values reported by Hamad *et al.* (2010) but were similar to the values achieved by Khan *et al.* (2004). Furthermore, treated cobs also showed improvements in composition by decreasing the percentage values of CF, NDF and ADF. These differences can be attributed to the effect shown by urea on different proximate principles as suggested by Hartley (1985) and Oji *et al.* (2007). For practical use by farmers, urea is safer than using anhydrous or aqueous ammonia and also provides a source of nitrogen, which is a critical nutrient with respect to crop residues (Schiere and Ibrahim, 1989). Since urea is a solid chemical, it is also easy to handle and transport (Sundstøl and Coxworth, 1984) and urea can be obtained easily in many developing countries. Urea-ammoniation treatment of cereal straw is a technically effective and feasible technology to improve the nutritive value of fibrous crop residues (Dolberg, 1992) since, ammonia (by urea hydrolysis) treatment of coarse roughages crop residues has shown promise by way of breaking lignin-carbohydrate bonds and thereby improving their nutritive values (Tengyun, 2000). Lignin is an important cell wall material which acts as a physical barrier between potentially digestible materials (cellulose and hemicelluloses) and digestible enzymes and the efficient utilization of such cellulosic feed materials (Varga and Kolver, 1997).

Urea treatment may therefore be most suitable for small-scale farmers to improve the quality of maize cobs. Using urea is regarded as a practical and available method in livestock production, especially in developing countries, as it is relatively cheap, adds nitrogen to the ration and is relatively safe to work with.

In vitro dry matter degradability variables

Experiment I

The complete diets were formulated with treated and untreated maize cobs replacing wheat straw and were tested for IVDMD and other degradability parameters. There is linear increase in per cent IVDMD with increase in replacement level, which became significant (P<0.01) at 40% replacement level. Highest IVDMD was observed at 100% replacement level of maize cobs to wheat straw in complete diets.

Table 3. *In vitro* degradability variables of complete feed comprising of maize cobs replacement at graded levels to wheat straw.

Per cent Wheat straw Replacement by maize cobs*	IVDMD (%)	TDOM (mg/200mgDM)	GP (ml/200mgDM)	MBP (mg/200mgDM)	EMP (%TDOM)	PF
0 (Maize 10%, WB 10%, MOC 13%, MC 0%, WS 66%)	50.00^{a} ±0.28	102.60 ±0.92	31.00 ±0.57	34.40 ±2.19	33.47 ±1.83	3.31 ± 0.09
10 (Maize 10%, WB 10%, MOC 13%, MC 6.6%, WS 59.4%)	50.50^{ab} ±0.28	103.20 ±1.38	29.50 ±0.28	38.30 ± 0.75	37.10 ± 0.22	3.49 ± 0.01
20 (Maize 10.2%, WB 10%, MOC 12.8%, MC 13.2%, WS 52.8%)	50.75^{ab} ±0.43	103.65 ±0.14	30.50 ±0.28	36.55 ± 0.49	35.26 ± 0.52	3.39 ± 0.02
30 (Maize 10.3%, WB 10%, MOC 12.7%, MC 19.8%, WS 46.2%)	51.25^{ab} ±0.72	105.80 ±1.90	29.50 ±0.86	40.90 ± 3.81	38.50 ± 2.90	3.60 ±0.17
40 (Maize 10%, WB 10.6%, MOC 12.4%, MC 26.4%, WS 39.6%)	52.75^{bc} ±0.14	106.75 ±1.41	30.00 ±0.57	40.75 ± 2.68	38.09 ± 2.01	3.56 ± 0.11
50 (Maize 10%, WB 10.7%, MOC 12.3%, MC 33%, WS 33%)	53.75^{c} ±0.72	107.50 ±2.07	30.00 ±1.73	41.50 ± 5.88	38.32 ± 4.73	3.63 ± 0.27
100 (Maize 12%, WB 9%, MOC 12%, MC 66%, WS 0%)	56.25^{d} ±0.72	108.55±1.87	29.50±1.44	43.65 ±1.29	40.31 ±1.89	3.69 ±0.11

* Text and figures in parenthesis represents the ingredient composition of complete feed; WB-Wheat bran; MOC- Mustard oil cake; MC- Maize cobs and WS-Wheat straw; IVDMD: In vitro dry matter degradability, TDOM= Truly degradable organic matter, MBP= microbial biomass production, EMP= efficiency of microbial biomass production; PF= Partition factor; ^{abcd}Mean values bearing different superscripts within a column differ significantly (P<0.01)

The TDOM (mg/200mgDM) values varied from 102.60 to 108.55 with no significant (P>0.05) difference among various replacement levels. The gas volume varied from 29.50 to 31 ml/200mgDM and there was no significant (P>0.05) difference between different levels from each other. The MBP varied from 34.40 to 43.65mg/200mg DM and EMP varied from 33.47 to 40.31 (%TDOM) in various replacement levels. The PF values varied from 3.31 to 3.69 and the values differed non-significantly in different replacement levels (Table 3).

The IVDMD increased significantly (P<0.01) in 100% replacement group with lowest value from control and highest in 100% replacement level. There was no significant (P>0.05) difference among various replacement levels in TDOM (mg/200mgDM) and gas production (ml), although the highest value of TDOM was observed in 100% replacement group. These values were similar to those reported by Snyman and Joubert, (2002) However, Arias *et al*., (2003) reported higher values for maize cobs *in vitro* dry matter digestibility as 65.0% and *in vitro* organic matter digestibility as 66.4%. Further TDOM values of maize cobs was found similar to Aregheore (2000) who has reported maize cobs OM digestibility (%) as 55.5±1.9. The gas volume produced was lesser than the gas produced in Aregheore (2000) study (43.9±2 ml/24 h). The MBP value was highest in 100% wheat straw replacement level. The EMP values (%TDOM) were highest in 100% replacement level. The PF values also differed non-significantly in various replacement levels. The values were highest in 100% replacement levels. The results clearly indicated better *in vitro* utilization of maize cobs as compared to wheat straw. All the degradability parameters including microbial production were improved by increasing inclusion of maize cobs. As no negative impact of wheat straw replacement with maize cobs was observed, the use of maize cobs as sole source of roughage appears to be a feasible alternative

Experiment II

The results showed that there was no significant (P>0.05) difference in digestibility due to soaking at different time intervals (Table 4). The MBP value was highest in control *i.e.* no soaking and lowest in 12 h soaking. However, the different values varied non-significantly (P>0.05). The value of EMP was highest in control. The PF showed highest value in 1 h soaking treatment.

Table 4. *In vitro* degradability variables of complete feed comprising of 100 per cent maize cobs replacement to wheat straw at different soaking periods.

Soaking treatment	IVDMD (%)	TDOM (mg/200 mg DM)	Gas Production (ml/200mgDM)	MBP (mg/200mgDM)	EMP (%TDOM)	PF
0 min soaking	56.50 ±0.72	110.05±0.95	29.00 ±0.00	46.25±0.95	42.01b ±0.50	3.79cd ±0.03
15 min soaking	56.75 ±1.01	111.10±0.91	30.00 ±0.00	45.10±0.91	40.58ab ±0.49	3.70bc ±0.03
30 min soaking	57.25 ±0.43	111.34±0.95	30.00 ±0.57	45.34±0.95	40.71ab ±0.50	3.77bcd ±0.00
45 min soaking	57.25 ±1.29	111.21±1.21	30.00 ±1.15	45.21±1.21	40.63ab ±0.64	3.83cd±0.03
1 h soaking	57.75 ±0.14	111.44 ±0.92	30.00 ±1.73	45.44±0.92	40.76ab ±0.49	3.91d±0.08
12hsoaking	58.25 ±0.43	112.29±0.92	31.00 ±0.00	44.09±0.92	39.25a ±0.49	3.62a ±0.02
24h soaking	58.50 ±0.57	112.80±1.20	31.00 ±0.57	44.60±1.20	39.51ab±0.64	3.69bc ±0.00

*Text and figures in parenthesis represents the ingredient composition of complete feed; WB-Wheat bran; MOC- Mustard oil cake; MC- Maize cobs and WS-Wheat straw; IVDMD: In vitro dry matter degradability, TDOM= Truly degradable organic matter, MBP= microbial biomass production, EMP= efficiency of microbial biomass production; PF= Partition factor

Diet composition- (Maize 12%, WB 9%, MOC 12%, MC 66%, WS 0%)

^{abcde}Mean values bearing different superscripts within a column differ significantly (P<0.01)

There was no improvement in digestibility of maize cob based diets due to soaking. The TDOM (mg/200mgDM) and gas volume (ml) showed no significant (P>0.05) difference among various soaking intervals. The value of EMP was highest in control. The PF value was highest in 1 h soaking treatment. It has been hypothesized that as water soaking causes swelling of cell wall structures and, thus, make cell wall more accessible to cellulolytic microbes (Ndlovu and Manyame, 1988). Earlier studies (Chaturvedi *et al.*, 1973 and Ndlovu and Manyame, 1988) reported that although water soaking improves intake of cereal straw, it has no effect over apparent digestibility. The results confirmed the similar observation for maize cobs.

Experiment III

These results show that the urea treatment of maize cobs improved digestibility as compared to untreated or molasses treated maize cobs (Table 5). Same effect was noted for treated and untreated wheat straw based complete diets also. The IVDMD values varied from 56.25% to 71.25% in treated and untreated maize cob based complete feed while it ranged from 53.75% to 68.75% in treated and untreated wheat straw based complete feed. The urea treated maize cobs and urea treated wheat straw based diets showed highest IVDMD values of 71.25% and 68.75%, respectively.

Table 5: *In vitro* degradability variables of complete feed comprising of urea and/or molasses treated maize cobs and wheat straw based diets respectively.

diet	IVDMD (%)	TDOM (mg/200 mg DM)	GP (ml/200mgDM)	MBP (mg/200mgDM)	EMP (%TDOM)	PF
Diet 1 WS based ration (Maize 10%, WB 10%, MOC 13%, WS 66%)	53.75^{a} ±0.72	100.99^{a} ±0.57	26.00^{a} ±0.57	45.99^{c} ±0.57	45.53^{d} ±0.31	4.03^{d} ±0.02
Diet 2 MC based ration (Maize 12%, WB 9%, MOC 12%, MC 66%)	56.25^{ab} ±0.72	101.99^{a} ±1.15	28.50^{ab} ±0.86	42.59^{c} ±1.15	41.74^{c} ±0.65	3.77^{c} ±0.04
Diet 3 MC with urea (Maize 15%, WB 12%, MOC 6%, TMC 50%, UMC 16%)	71.25^{c} ±0.72	107.99^{b} ±0.57	31.50^{b} ±0.28	37.59^{b} ±0.57	34.80^{b} ±0.34	3.37^{b} ±0.01
Diet 4 MC with molasses (Maize 12%, WB 9%, MOC 12%, MC 66%)	56.25^{ab} ±0.72	104.49^{ab} ±0.28	29.50^{ab} ±0.86	36.29^{b} ±0.28	34.73^{b} ±0.17	3.37^{b} ±0.00
Diet 5 MC with urea + molasses (Maize 15%, WB 12%, MOC 6%, TMC 50%, UMC 16%)	60.00^{b} ±1.44	104.49^{ab} ±0.86	30.00^{b} ±1.73	31.89^{a} ±0.86	30.51^{a} ±0.57	3.16^{a} ±0.02
Diet 6 WS with urea (Maize 15%, WB 12%, MOC 6%, TWS 50%, UWS 16)	68.75^{c} ±0.72	106.99^{b} ±1.73	31.00^{b} ±0.57	36.59^{b} ±1.73	34.15^{b} ±1.06	3.34^{b} ±0.05
Diet 7 WS with molasses (Maize 10%, WB 10%, MOC 13%, WS 66%)	56.25^{ab} ±0.72	103.99^{ab} ±1.15	28.50^{ab} ±0.28	42.39^{c} ±1.15	40.74^{c} ±0.65	3.71^{c} ±0.04
Diet 8 WS with urea+molasses (Maize 15%, WB 12%, MOC 6%, TWS 50%, UWS 16)	58.75^{b} ±0.72	103.49^{ab} ±0.86	30.50^{b} ±0.28	35.29^{ab} ±0.86	34.09^{b} ±0.55	3.33^{b} ±0.02

*Text and figures in parenthesis represents the ingredient composition of complete feed; WB-Wheat bran; MOC- Mustard oil cake; MC- Maize cobs; WS-Wheat straw; TMC-Treated maize cobs; UMC-Untreated maize cobs and TWS-Treated Wheat straw; IVDMD: In vitro dry matter degradability, TDOM= Truly degradable organic matter, MBP= microbial biomass production, EMP= efficiency of microbial biomass production; PF= Partition factor; ^{abcd}Mean values bearing different superscripts within a column differ significantly (P<0.01)

The TDOM was significantly (P<0.01) differed among various treatment groups. Similarly gas volume also varied significantly among (P<0.01) between different treatments. The MBP value was highest in untreated wheat straw based feed. The EMP values were highest in untreated wheat straw based feed. The PF values varied from 3.16 to 4.03 and the values differed significantly (P<0.01) in various treatments groups. The values were highest in untreated wheat straw based feed.

From the results (Table 5) of experiment III, it was revealed that the urea treatment of maize cobs improved digestibility compared to untreated or molasses treated maize cobs. Same effect was noted for treated and untreated wheat straw based complete diets also. The IVDMD values varied from 56.25 to 71.25% in treated and untreated maize cob based complete feed while it ranged from 53.75 to 68.75% in treated and untreated wheat straw based complete feed. The urea treated maize cobs and wheat straw based diets showed highest IVDMD values of 71.25 and 68.75% respectively. The values differed significantly (P<0.01) among different treatments. The TDOM (mg/200 mg DM) values varied from 100.99 to 106.99 with significant (P<0.01) difference among various treatment groups. The gas volume varied from 26.0 to 31.5 ml/200mgDM and there was significant difference (P<0.01) between different treatment groups. The MBP value was highest in untreated wheat straw based feed. The EMP values varied from 30.51 to 45.53(%TDOM) in various treatments groups. The PF values varied from 3.16 to 4.03 and the values differed significantly (P<0.01) in various treatments groups. These results were comparable with the values reported by Yulistiani *et al.* (2012) where the results revealed that untreated corn cob had low quality nutritive value which was indicated by its low protein content (2.9%) and low *in vitro* digestibility (42.5%). Furthermore, a 3% level of urea treatment increased maize cob's protein content and as well increased its *in vitro* digestibility significantly by 43%. Several investigators have examined the use of supplemental nitrogen in relation with IVDMD. Schmid *et al.*, (1969) found that 10 mg urea per 0.25 g substrate dry matter produced the highest digestibility in a variety of forages. 5 mg and 10 mg urea were added to 0.25 mg of the normal and three brown midrib mutant genotypes over harvests to determine the possible influence of added nitrogen on IVDMD. The added urea tended to improve IVDMD of all entries. Further the relationship between various structural components, particularly lignin, and IVDMD are of interest in attempting to explain the results. The negative relationship between lignification and digestibility found in certain plant species would strongly implicate the lower content of lignin as a major contributing cause for the increased IVDMD. ADF and ADL were found negatively correlated (P<0.01) with IVDMD with a negative correlation of -0.62 (P<0.01) between ADL and IVDMD (Schmid *et al.*, 1969). Also, hemicellulose is more closely associated with lignin than any other polysaccharide fraction and is believed to be bonded to phenolic constituents (Van Soest, 1994). The cellulose and the hemicellulose of the maize cobs may, therefore, not be made readily available for microbial degradation, thus, decreasing its DMD value. In contrast, *in vitro* DM digestibility improved by 13–17% with either feed grade urea or aqueous NH3 treatment of the maize residues (Snyman and Joubert, 2002). Fibrous constituents are negatively influenced *in vitro* gas production (Melaku *et al.,* 2003). Nelson *et al*. (1984) using maize cobs containing 40% moisture reported the 48 h DMD values of 2, 3 and 4% ammonia treated samples to be 61.30, 61.69 and 65.94%, respectively. Oji *et al.* (2007) reported that i*n vitro* DM digestibility (IVDMD) increased with feed grade urea-treated and aqueous NH_3 treated maize cobs as comparable to the urea treated maize cob based ration and urea treated wheat straw based ration. While treatment of maize residues with feed grade urea and aqueous NH_3 caused changes in chemical composition and increased IVDMD, DMI, OMI and digestibilities of organic components, there were no differences in effect between the urea and NH_3 (Oji *et al.*, 2007). Although, molasses treatment also improved *in vitro* digestibility but there was no significant (P>0.05) difference between untreated and molasses treated cobs and wheat straw based ration. This might be due to the availability of readily soluble carbohydrates in molasses which delay the digestibility of more fibrous portion of cobs and wheat straw. Hlophe (1987) studied the effect of supplementation of maize cobs with urea, molasses and maize grain on the *in vitro* **dry matter digestibility of maize cobs** and reported a positive effect on digestibility.

CONCLUSION

It is concluded that maize cobs can be utilised at 100% replacement of wheat straw in goat ration. Further significant improvements of proximate composition and IVDMD can be achieved by urea treatment (4%) of maize cobs.

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