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Evaluation of Poultry Droppings Based Concentrate mixtures For Ruminants by *In Vitro* Method

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ABSTRACT

The study was planned to ascertain the effect of inclusion of dried poultry droppings (PD) at graded levels on chemical composition, *in vitro* utilization and degradability of concentrate mixtures. Dried poultry Droppings were added @ 0,5,10,15,20 and 25% in various concentrate mixtures. *In vitro* utilization of concentrates having dried poultry droppings (PD)@ 10 &20% showed a significant increase (P<0.05) in Net gas production (NGP), Organic matter digestibility (OMD%), Dry matter digestibility (DMD%), Metabolisable energy (ME), Neutral detergent digestibility (NDFD %), Microbial mass Production (MMP) and partition Factor (PF). At 72 h incubation time, cumulative gas production (ml) in 5% poultry droppings-based concentrates was signiûcantly (P < 0.05) lower than those of 15 and 20 % poultry droppings based concentrates. The maximum rate of degradation (k) was observed in control concentrate (9.16%/h) and lowest in 25% poultry droppings based concentrate (7.46%/h). The value of " b" (gas production from insoluble fraction was lowest in 5% poultry droppings based concentrate (30.92 ml) and was highest in 15% poultry droppings concentrate (39.29 ml). and in control (39.5). On the basis of above results it can be concluded that dried poultry droppings can be included upto 20% in concentrate mixtures for cost-efficient livestock production.

KEYWORDS: Concentrate mixture, *In vitro*, Paddy straw, Poultry droppings,

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INTRODUCTION

In India, the poultry farming system generates a substantial amount of waste, with 38.33 million MT of poultry manure, 9486 MT of hatchery waste, and 1.74 million MT of slaughter house wastes produced during the 2018-2019 period alone (Prabakaran and Valavan, 2021). Large-scale accumulation of wastes such as manure in the poultry industry in the absence of suitable environmentally and economically sustainable management technologies, may leads to environmental pollution (Bolan et al.,2010). Animal excreta can be a valuable resources if used judiciously. The waste has the greatest economic value when used as animal feed (Fontenot and Hancock, 2001). Poultry litter waste contains various amounts of nutrients and these nutrients can be affected animals' health. However, dried poultry manure waste contains a substantial amount of digestible energy, crude protein, crude fat, crude fiber, cobalt, iodine, and other nutrients that enable ruminants to utilize the urea nitrogen of poultry and convert it into production (Ghaly and Macdonald, 2012) Consequently, poultry manure waste is readily available at a lower cost than other sources of feed offered to livestock, making it an attractive option for livestock farmers. Paul et al., (1993) reported that poultry manure contains a wide array of minerals such as phosphorous (0.56 - 3.92%), potassium (0.73 - 5.17) and calcium (0.81 - 6.13). Others elements such as magnesium (Mg), sulphur (S), manganese (Mn), copper (Cu), zinc (Zn), chlorine (Cl), boron (B), iron (Fe), and molybdenum (Mo) may also be present in the poultry manure. Poultry droppings can be a cost-effective feed for beef cattle ration. Beef producers are mainly worried about the safety of feeding huge amounts of poultry droppings to beef cattle and are susceptible to pathogenic microorganism infection (i.e., *Salmonella typhimurium*). Literature suggests that when poultry droppings dried, there is a possibility of fewer pathogens in it (Martin et al., 1998). The inclusion of caged poultry droppings in the diet may offer potential cost savings, contributing to the economic viability of buffalo farming and small ruminants (Ramaniah et al., 1998).The utilization of poultry droppings as feed in growing buffalo calves holds promise as a sustainable and environment-friendly feeding practice. Hence, the current study was planned to see its effect on *in vitro* utilization of varying levels of poultry droppings based concentrates.

MATERIALS AND METHODS

The current research was conducted at the Department of Animal Nutrition, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. The various concentrate mixtures were prepared by adding different graded levels of dried poultry droppings as given in Table 1.

Table 1. Composition of Concentrate Mixture (kg)

Parameters	0%	5%	10%	15%	20%	25%
Maize	34.2	35.2	34.7	34.7	35	33.7
Rice Kani	5	5	5	5	5	5
Mustard Cake	22	21	23	23	23	25
Soybean meal	5	5	5	5	4	0
Wheat Bran	8	8	2	2	2	2
Rice Polish	10	10	10	10	5.1	3
DORB	10	5	5	0	0	0
By Pass Fat	1	1	1	1	1.6	2
Mineral Mixture	2	2	2	2	2	2
Salt	1	1	1	1	1	1
Urea	1.5	1.5	1	1	1	1
Poultry droppings	0	5	10	15	20	25
Additives*	0.3	0.3	0.3	0.3	0.3	0.3

*yea sac, toxin binder and buffer @0.1 gm as Additives

Chemical Analysis

Proximate principles like crude protein, ether extract were determined as per procedures set by Association of Official Analytical Chemists (AOAC, 2007). Cell wall constituents like NDF and ADF were determined (Robertson and Van Soest. 1991). The difference between NDF, ADF and ADL was used to compute the hemicellulose and cellulose concentrations.

In vitro evaluation

The *in vitro* gas production analysis was done according to the method devised by Menke and Steingass (1988). After 24 hours, volume of gas produced in each treatment was determined. The following solutions were employed and incubated in a waterbath at 39°C: macro mineral solution, buffer solution, micro mineral solution, resazurine, reducing solution, and rumen fluid obtained from a male fistulated animal. The amount of gas produced after 24 hours was measured in each syringe. The calculation of ME is based on the gas output was the partition factor (PF) calculated as the ratio of the substrate's true in vitro degradation weight (mg) to the gas volume (ml) it produced, For digestion kinetics, incubation was carried out at 39°C and gas production was observed at 0, 1, 2, 4, 6, 8, 12, 18, 24, 36, and 48 hours after incubation. Gas production kinetics was calculated by Neway Program software.

Statistical Analysis

Data was analysed by Snedecor and Cochran (1994) by using SPSS version 2019. The differences in means were tested by tukey B and Duncan. The computer program Graph Pad prism 2007 was used to calculate the rate and extent of gas production in the non linear equation.

RESULTS AND DISCUSSION

Chemical composition of Concentrate mixture with graded levels of poultry droppings

Different concentrate mixtures (CM) were prepared using varying levels of poultry droppings (0, 5, 10, 15, 20 and 25%). The chemical composition of the concentrate mixture is given in Table 2. The CP content of control CM and poultry droppings varied from 25.04% to 25.75%. All the concentrate mixtures prepared were isonitrogenous in nature. The NDF content varied from 29.90 % to 38.43 %. The fat content of CM was between 5.10% to 6.25 %. The ash content in control concentrate was 7.85 %while in poultry droppings incorporated concentrates it varied from 7.88 to 12.60 % and OM varied from 87.40% to 92.12% in poultry dropping incorporated CM and in control concentrate it was 92.15%. The ADL content varied from 3.5 to 4.6 % in poultry dropping incorporated concentrates while in control it was 5.2 %.

Table 2. Chemical composition of Concentrate mixture having graded levels of poultry droppings (%)

Parameters	Concentrate Mixtures Level of Poultry droppings					
	0%	5%	10%	15%	20%	25%
DM %	92.0	91.0	92.0	92.0	92.0	91.5
CP %	25.04	25.3	25.1	25.75	25.51	25.6
EE %	5.10	6.00	6.25	6.05	6.10	6.2
Ash %	7.85	7.88	9.65	10.42	11.37	12.6
OM %	92.15	92.1	90.35	89.6	88.63	87.4
NDF %	29.9	33.5	36.8	38.4	37.4	38.4
ADF %	19.2	18	15.8	15.7	14.1	13.7
ADL %	5.12	4.6	4.5	3.8	3.9	3.5
Hemicellulose %	10.7	15.5	21.00	22.73	16.3	14.7

Effect of different levels of poultry dropping on *in vitro* utilization of nutrients of concentrate mixture

Evaluation of *in vitro* utilization (Table 3) showed that treatments with varied levels of poultry droppings (PD) groups showed non-significant differences among them with NGP values varying from 64.74 to 67.75 ml and NGP varying from 172.66 to 188 ml/g DM.

The net gas production (ml/gDM) during 24 hr was statistically comparable in Concentrate mixtures (CM) CM 0, CM 5,CM 10 and CM 25% with poultry droppings (PD). It varied from 176.66 ml to 180.66 ml. The Net gas production (NGP, /24 h) also followed the same trend. The net gas production during 24 h was significantly lower in Concentrate mixture 15 and was observed highest in CM 20 % with poultry droppings. The partitioning factor (PF) is the ratio of organic matter degraded (mg) *in vitro* to the volume of gas (ml) produced. A higher partitioning factor means that proportionally more of the degraded matter is incorporated into microbial mass i.e. the efficiency of microbial protein synthesis is higher. The partition factor calculated *in vitro* provides useful information for predicting the dry matter intake, microbial mass production in the rumen and the methane emission of the whole ruminant animal. In this study, PF value (mg/ml) was significantly ($P<0.05$) higher in CM10 and lowest in CM 25 % with poultry droppings However ,it was statistically comparable in other CM with poultry droppings.. The OMD % was significantly higher in concentrate mixture 20% (86.88%) followed by CM 10 % and CM 25% (84.20%) with PD. The NDFD % was significantly lower ($P<0.05$) in CM 0 (40.24%) and highest in CM 10 (61.45%) followed by CM 20% with poultry droppings. The dry matter digestibility (DMD, %) was significantly higher in concentrate mixture 20 (86.66%) followed by CM 25 % (84.26%) with poultry droppings (PD). The metabolizable energy (ME, MJ/kgDM) was significantly lower in CM 0 (9.60) and significantly higher in CM 20 (10.31)followed by CM 25 % (9.95) with poultry droppings. A significant lower ($P<0.05$) microbial mass production (MMP, mg) was observed in concentrate mixture 25 (124.76) and was found significantly ($P<0.05$) higher in concentrate mixture 20 % (139.00) with poultry droppings. The efficiency of microbial mass production (EMMP,%) was significantly (P<0.05) lower in CM 25 (44.57%) and was significantly higher in CM 20%(48.81%) with PD. The Short chain fatty acids (SCFA, mmole) was significantly found lower in CON 15% (0.762) and was higher in CON 20% (0.780) with poultry droppings .

Table 3. Effect of different levels of poultry dropping on *in vitro* utilization of nutrients of concentrate mixtures

Parameters	Concentrate mixtures						SEM	p-Value
	Level of poultry droppings							
	0%	5%	10%	15%	20%	25%		
NGP, ml/24hr	67.75[ab]	66.75[ab]	66.75[ab]	64.75[a]	70.50[b]	66.25[ab]	0.658	0.181
NGP,ml/g DM	180.66[ab]	178.00[ab]	180.66[ab]	172.66[a]	188.0[b]	176.66[ab]	1.75	0.181
TDS, mg	345.48	345.56	338.81	335.92	332.36	327.75	1.96	-
OMD, mg	278.48	279.56	277.81	280.42	279.86	284.75	0.801	0.116
PF, mg/ml	4.11[ab]	4.18[ab]	4.33[b]	4.10[ab]	4.29[ab]	3.97[a]	0.043	0.107
OMD, %	80.60[a]	80.90[a]	83.47[b]	81.99[a]	86.88[c]	84.20[b]	0.66	0.00
NDFD, %	40.24[a]	47.46[b]	61.45[e]	55.79[cd]	59.04[de]	53.94[c]	2.19	0.00
MMP, mg	129.43[ab]	132.71[ab]	137.97[b]	128.76[ab]	139.00[b]	124.76[a]	1.76	0.073
EMMP, %	46.47[ab]	47.47[ab]	49.19[b]	46.35[ab]	48.81[b]	44.57[a]	0.56	0.109
ME, J/kgDM	9.60[a]	9.74[a]	9.88[a]	9.61[a]	10.31[b]	9.95[a]	0.07	0.00
DMD, %	80.80[a]	80.26[a]	83.46[bc]	82.40[b]	86.66[d]	84.26[c]	0.65	0.018
SCFA, mmole	0.797[ab]	0.786[ab]	0.797[ab]	0.762[a]	0.830[b]	0.780[ab]	0.0077	0.181

Means bearing different superscripts in a row differ significantly (P<0.05).

Estimated parameters of concentrates mixture containing varying levels of poultry droppings

Cumulative gas production profiles from the *in vitro* fermentation of concentrates containing graded levels of poultry droppings (PD) are shown in Figure 1 and the estimated parameters are given in Table 4 . The cumulative volume of gas production increased with increasing time of incubation. The gas produced after 72 h incubation ranged from 28.00 to 34.00 ml per 0.200 g of dry matter. At 72 h incubation , cumulative gas productions (ml) with 5% CM incorporated poultry droppings (PD) has significantly (P < 0.05) lower than those of 15 and 20 % CM incorporated with poultry droppings(PD). However, in all poultry droppings-based concentrates the cumulative gas production at 72 h is statistically comparable (CM 10 to CM 25%) with PD . The gas production in all the concentrates (CM) at 24 h has differed statistically significantly. The gas production was statistically significantly lower in CM 5% with poultry dropping and significantly higher in CM 0 %.(control)

Table 4. *In vitro* gas production from concentrate mixtures when incubated at different time intervals

Treatment	Concentrate mixtures						SEM	p-value
	Level of poultry droppings							
	0%	5%	10%	15%	20%	25%		
2 Hrs	1.75	1.25	0.75	1	1.25	1.25	0.114	0.194
4 Hrs	3.5^{ab}	3.00^{ab}	2.50^{a}	3.25^{ab}	3.50^{ab}	4.25^{b}	0.177	0.031
6 Hrs	9.5	7.0	6.75	8.75	9.25	7.0	0.396	0.064
8 Hrs	15.5^{b}	11.5^{a}	12.0^{ab}	14.0^{ab}	14.2^{ab}	11.0^{a}	0.534	0.018
10 Hrs	19.2^{b}	14.0^{a}	16.0^{ab}	18.0^{ab}	17.7^{ab}	14.5^{a}	0.630	0.025
12 Hrs	22.0^{c}	16.2^{a}	18.0^{ab}	20.7^{bc}	20.5^{bc}	17.0^{a}	0.668	0.004
24 Hrs	29.7^{c}	23.0^{a}	26.2^{abc}	29.25^{c}	28.7^{bc}	24.5^{ab}	0.806	0.007
36 Hrs	31.0^{c}	23.7^{a}	27.5^{abc}	29.5^{bc}	29.5^{bc}	25.5^{ab}	0.796	0.005
48 Hrs	33.75^{b}	26.75^{a}	30.25^{ab}	33.00^{ab}	32.25^{ab}	28.50^{ab}	0.838	0.035
60 Hrs	34.75^{b}	28.00^{a}	31.50^{ab}	34.00^{ab}	33.50^{ab}	30.00^{ab}	0.803	0.042
72 Hrs	34.75^{b}	28.00^{a}	31.50^{ab}	34.00^{ab}	33.50^{ab}	30.00^{ab}	0.803	0.042

Means bearing different superscripts in a row differ significantly (P<0.05)

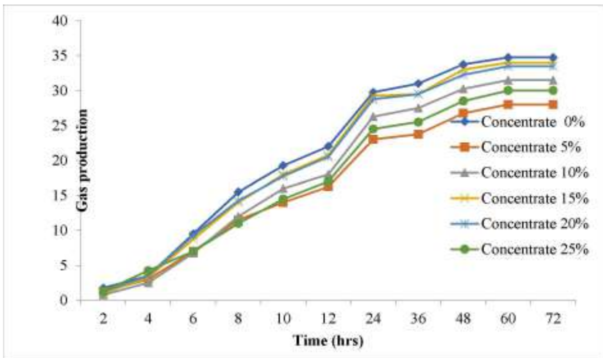

Fig 1. Estimation of gas production in concentrate mixtures when incubated at different time intervals

The maximum rate of degradation (k) was observed in control concentrate (CM) (9.16%/h) and lowest in 25% poultry droppings based concentrate (7.46%/h). The value of ‘a’ was found lowest in 5% CM (3.40) and highest in 15% CM incorporated with poultry droppings (5.81).(Table 5)

If ‘a’ is positive, then there is a component which is degraded rapidly and/or a component which is soluble. When a negative value for ‘a’ is obtained this means that there has to be an initiation period for degradation to start (termed the lag phase)

The value of “b” (gas production from insoluble fraction was lowest in 5% CM incorporated with poultry droppings(PD) (30.92 ml) and was highest in 15% poultry droppings incorporated concentrate mixture (CM) (39.29 ml). and in control (39.5ml). No significant difference was observed in lag time in control and poultry droppings concentrates mixtures.

Table 5. Estimated parameters of Concentrate mixtures of containing varying levels of poultry droppings

Parameters	Treatments						P value
	Con 0%	Con 5%	Con 10%	Con 15%	Con 20%	Con 25%	
a	-5.34^{bc}	-3.40^{a}	-5.25^{bc}	-5.81^{c}	-5.27^{bc}	-3.71^{ab}	0.0057
b	39.58^{a}	30.9^{c}	36.42^{ab}	39.3^{a}	38.23^{ab}	33.38^{bc}	0.0037
c	0.0916^{a}	0.0789^{bc}	0.0804^{bc}	0.0833^{ab}	0.0887^{ab}	0.0746^{c}	0.0046
a + b	34.2^{a}	27.5^{b}	31.18^{ab}	33.4^{ab}	32.9^{ab}	29.67^{ab}	0.0366
Lag time	1.60^{a}	1.50^{a}	1.95^{a}	1.85^{a}	1.65^{a}	1.60^{a}	0.2806
RSD	1.18^{a}	1.04^{a}	1.17^{a}	1.25^{a}	1.04^{a}	1.00^{a}	0.2904
ED	20.4^{a}	15.6^{b}	17.45^{ab}	19.5^{ab}	19.4^{ab}	16.40^{b}	0.0154

c = gas production rate, a = gas production (ml) from quickly soluble fraction, b = gas production (ml) from insoluble fraction, (a + b) = potential gas production

CONCLUSION

On the basis of above results it can be concluded that dried poultry droppings can be included upto 20% in concentrate mixtures for cost-efficient livestock production.

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