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Effect of Wheat Straw based Total Mixed Ration on Feed Intake, Digestibility, Milk Yield and Quality of Lactating Dairy Cows

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ABSTRACT

A total of eight Boran X Frisian lactating dairy cows with milk yield (8.87 ± 2.16 litters d^{-1}, mean ±S.D), lactation stage (early - late) and parity (one - four) were randomly assigned in a double 4X4 Latin square design. The treatments were T1 = Control group (natural pasture hay ad libitum + 0.5 kg concentrate /litter of milk), T2= TMR-1(80: 20), T3 = TMR-2 (60: 40), T4 = TMR-3 (40: 60) proportion of wheat straw: concentrate, respectively. The experiment was consisted of four periods each having 15 days of adaptation, 49 days of feeding trial and 7 days of digestibility trial. Significantly the higher ($P<0.05$) feed intake and digestibility coefficients were observed in T4. Milk yield and feed conversion of the dairy cows were affected ($P<0.05$) and depressed with linear trends as wheat straw replaced with concentrate in the diet. Cows offered T4 produced 1.42 litters extra milk than cows receiving control diet (T1). However, fiber digestibility coefficients and milk compositions of the cows were nearly similar within the dietary treatments. Further study is required on the economics aspect before the diet is recommended for wider use under farmer conditions in Ethiopia.

Keywords: cow, digestibility, intake, milk yield, total mixed ration

1. INTRODUCTION

In conventional feeding, various feedstuffs like hay, concentrate pellet and other agro industrial by- products are fed separately in different time intervals (Calsamiglia, 2002). In conventional feeding system, feed selection is high which could be reducing the quantity of the feed offered The use of TMR feeds for dairy animal result in a better balance of nutrient intake by avoiding individual preferences for forage or concentrates ((Khan *et al,. 2010*).

Dejene *et al.* (2017) conducted an experiment on early lactating jersey cows and found the intake of natural pasture hay to be significantly higher in TMR group than the conventional feeding system. This research study was planned to evaluate the effect of either natural pasture hay and concentrate separate feeding

or wheat straw based total mixed ration on feed intake, digestibility coefficient, milk yield and composition of dairy cow.

2. MATERIALS AND METHODS

Description of the study area

The study was carried out at Holeta agricultural research center, Ethiopia. The center is located at 9° 03'28.82" E latitude and 38° 30'17.59" E longitude at an elevation of 2,400 m above sea level. The mean annual temperature and rainfall during the study were 18°C and 1225mm, respectively.

Experimental design

A total of eight Boran X Friesian lactating dairy cows with different parity (range one to four) but yielding more or less similar initial daily milk (8.87 ± 2.16 litters d^{-1}, mean ±S.D) were selected and randomly assigned in a double 4×4 Latin square design. The experiment was consisted of four periods each having 15 days of adaptation, 49 days of feeding trial and 7 days of digestibility trial. Cows were handled individually in a well-ventilated house. The house had appropriate drainage slope, gutter for urine removal and individual feeding troughs.

Feeding management

Sun dried wheat straw was chopped by using tractor car at the sieve size of 3-5 cm. Natural pasture hay for the control group and wheat based total mixed ration for the TMR groups were offered *ad-libitum* while the concentrate mix for the control group was offered twice a day during the morning and milking times (6.00AM and 2:00PM). Feed offer per each dietary treatment was periodically subjected to revision with changes in milk production based on NRC 2001 recommendation.

The treatments set up were:-

T1 = Control group (natural pasture hay *ad libitum* + 0.5 kg concentrate /litter of milk), T2= TMR-1(80: 20), T3 = TMR-2 (60: 40), T4 = TMR-3 (40: 60) proportion of wheat straw: concentrate, respectively.

Digestibility trial

At the end of the experimental periods, faeces from each cow were collected, measured, and recorded for the consecutive seven days. A 1% sample was taken and placed in a plastic bag. Composite samples (300g) of the daily collected faces were stored in deep freezer until the end of the collection period, when pooled samples were thawed and a subsample taken for oven drying at 65 °C for 72hr.

Chemical analysis

Faecal and feed samples were ground to pass through a 1mm sieve and analysed by methods of AOAC (1990). NDF ADF and lignin (Van Soest and Robertson 1985), in vitro organic matter digestibility (Tilley and Terry 1963) metabolizable energy was calculated by ME (MJ/kg) = 0.16 * *in vitro* organic matter digestibility (McDonald *et al*., 2002).

Milk yield and composition analysis

Cows were hand-milked twice a day at 6:00 AM and 6:00 PM in a milking house. The amount of milk produced from each cow was measured by using graduated glass cylinder. During the last 5 days of each period, milk aliquot sample from the morning and evening milking was taken for each individual cow. Milk was sampled in pre-labelled 50 ml plastic vials. An auto-scan milk analyser (milko-scan 133R) was used to determine fat, protein, total solids and lactose.

Statistical analysis

The data were analysed with R software version 3.5.2. (2018). Tukey's test was used to compare least square means and response criteria were declared different if $P<0.05$. The standard errors (S.E.) reported in the tables are for differences of least square means.

Response variables were analysed using the statistical model:-

$$Y_{hijk} = \mu + S_{h+} C_{i+} P_{j+} T_{k} + E_{hijk},$$

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Where, Yhijk is the dependent variable (intake, milk yield& composition), μ = overall mean, S_h = square effects, C_i= cow effect (parity) (i=1-4), P_j = effect of period (j=1-4), Tk= effect of treatment (diet) (k=1-4), Eijk= experimental error.

3. RESULTS AND DISCUSSION

Chemical composition

Among the experimental feed the two protein sources (Cotton seed cake &Noug seed cake noted to have the highest CP and the lowest digestible organic matter compared to the energy source (wheat bran). There was also slightly difference in nutrient composition of the TMR feeds and the higher CP and DOMD was observed in TMR-3 feed (Table 1).

Table 1:- Chemical composition of feed ingredients and total mixed ration (% DM basis)

Feed	DM	Ash	CP	NDF	ADF	ADL	DOMD	ME (MJ/kgDM)
Hay	92.46	7.24	5.6	63.24	42.88	8.10	47.5	7.6
Wheat straw	92.69	6.94	3.92	72.75	52.23	10.23	36.10	5.78
CSC	96.30	6.44	28.41	46.89	34.13	8.93	48.49	7.76
NSC	92.65	8.41	47.97	24.75	13.73	3.04	67.13	10.74
WB	90.82	4.54	17.18	40.12	10.16	1.97	69.87	11.18
Con .mix	90.23	6.31	21.50	47.74	23.62	5.07	70.12	11.22
TMR-1	92.26	7.05	10.42	66.91	46.53	13.71	42.90	6.86
TMR-2	91.49	7.47	11.94	61.70	40.97	9.63	49.70	7.95
TMR-3	93.46	8.08	13.97	57.96	35.11	8.03	56.51	9.04

DM= Dry matter, OM= Organic matter, CP= Crude protein, NDF= Neutral detergent fiber, ADF= Acid detergent fiber, DOMD= organic matter digestibility, ME =Metabolizable energy, TMR=Total mixed ration, T1 = natural pasture hay ad libitum + 0.5 kg concentrate mixture (CM) /litter of milk; T2= TMR-1 (80% WS: 20% CM), T3 = TMR-2 (60% WS: 40% CM), T4 = TMR-3 (40% WS: 60% CM).

Feed intake

There was significant (P<0.001) difference in DM and nutrient intakes among experimental cows (Table 2). Among cows receiving the TMR diet, substantially higher feed and nutrient intakes (P<0.05) was recorded for cows receiving T4. This finding is consistent with the finding of Khan *et al.,* (2010) and Geberemariyam et al. (2021) who reported TMR diet can improve feed intake of dairy animals.

Table 2:- Mean value of feed intake ((kg/day)

Intake	T1	T2	T3	T4	SEM	P value
Dry matter	10.43^{c}	10.79^{b}	11.82^{a}	11.95^{a}	0.09	0.0000
Organic matter	9.47^{d}	9.77^{c}	10.69^{b}	10.78^{a}	0.01	0.0000
Crude protein	0.93^{d}	1.28^{c}	1.51^{b}	2.04^{a}	0.01	0.0000
NDF	7.24^{b}	6.45^{c}	7.29^{a}	5.84^{d}	0.01	0.0000
ADF	5.09^{a}	3.41^{c}	5.23^{a}	4.08^{b}	0.01	0.0000

Means in each row with different letters have a significance difference at (P<0.0000), SEM=standard error of mean, T1 = natural pasture hay ad libitum + 0.5 kg concentrate mixture (CM) /litter of milk; T2= TMR-1, T3 = TMR-2, T4 = TMR-3.

Apparent digestibility

Digestibility coefficients of the feed were significantly (P<0.05) affected by the dietary treatments (Table 3). Significantly the higher (P<0.05) digestibility coefficients were observed in T4 .However, the NDF and ADF digestibility were not significantly affected by diet. The higher apparent digestibility of neutral detergent fiber and acid detergent fiber in the total mixed ration in the present study is in agreement with the reports Khan *et al.* (2010) who reported similar result a balanced rumen ecology which stabilize rumen fermentation pattern that facilitate the digestion of the fiber components while the present study is in contrary with the result of Felton *et al.* (2010) which could be associated with species of the animal and types of ingredients.

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Table 3:- Apparent digestibility (%)

Apparent digestibility	T1	T2	T3	T4	SEM	P value
Dry matter	59.98^{b}	65.21^{ab}	66.04^{ab}	69.03^{a}	3.01	0.05
Organic matter	56.28^{b}	62.44^{ab}	62.81^{ab}	66.81^{a}	3.07	0.05
Crude protein	59.72^{b}	65.12^{ab}	68.90^{a}	69.50^{a}	2.74	0.05
Neutral detergent fiber	64.42	68.46	68.53	70.61	1.77	0.26
Acid detergent fiber	46.90	56.96	53.37	59.32	1.79	0.33

Mean values without common superscripts are different at p <0.05, *SEM=standard error of mean, T1 = natural pasture hay ad libitum + 0.5 kg concentrate mixture (CM) /litter of milk; T2= TMR-1 (80% WS: 20% CM), T3 = TMR-2 (60% WS: 40% CM), T4 = TMR-3 (40% WS: 60% CM).*

Feed conversion, milk yield and composition

Milk yield and feed conversion of the dairy cows were affected (P<0.05) by treatments and depressed with as wheat straw replaced with concentrate in the diet (Table 4). Cows offered dietary T4 produced 1.42 litters extra milk than cows receiving control diet (T1). However, milk compositions of the cows were nearly similar within the dietary treatments. The current finding is similar with the finding of Geberemariyam et al. (2021) who reported with different proportion of silage and concentrate based TMR feeding milk composition is not affected.

Table 4:- Feed conversion, milk yield and composition of dairy cows

Parameter (kg/day)	T1	T2	T3	T4	SEM	P -value
Milk yield	6.45^{d}	7.20^{c}	7.45^{b}	7.87^{a}	0.21	0.05
Dry matter intake	10.43^{c}	10.79^{b}	11.82^{a}	11.95^{a}	0.09	0.0000
Milk composition (%)						
Protein	3.05	3.20	3.13	3.20	0.16	0.87
Fat	3.85	3.56	3.75	3.69	0.19	0.77
Lactose	3.15	3.54	3.46	3.96	0.27	0.30
Ash	0.73	0.71	0.41	0.70	4.33	1.01
Total solid	11.03	11.20	11.23	11.69	0.27	0.36
Feed conversion #	1.62^{a}	1.50^{d}	1.59^{b}	1.52^{c}	0.01	0.000

#DM intake/ milk yield, mean values without common superscripts are different at p <0.05, *SEM=standard error of mean, T1 = natural pasture hay ad libitum + 0.5 kg concentrate mixture (CM) /litter of milk; T2= TMR-1 (80% WS: 20% CM), T3 = TMR-2 (60% WS: 40% CM), T4 = TMR-3 (40% WS: 60% CM).*

4. CONCLUSION

Milk yield and feed conversion of lactating dairy cows were improved as the proportion of chopped wheat straw in the diet was reduced from 80 to 40% and replaced with a concentrate mixture rich in protein.

Conflict of interest

The authors declare that they have no conflict of interest.

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Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

Data and materials availability

All data associated with this study are present in the paper.

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REFERENCES AND NOTES

1. AOAC. 1990. Official Methods of Analysis. 15th Edition. Arlington, Virginia, USA. pp. 12-98
2. Calsamiglia S., Ferret A. and Devant M. (2002). Effects of pH and pH fluctuations on microbial fermentation and nutrient flow from a dual-flow continuous culture system. *Journal of Dairy Sciences* 85:574–579.
3. Felton, C. A., and DeVries, T. J. (2010). Effect of water addition to a total mixed ration on feed temperature, feed intake, sorting behavior, and milk production of dairy cows. *Journal of Dairy Sciences* 93: 2651–2660.
4. Geberemariyam Terefe, Mulugeta Walelgne, Getu Kitaw, Dereje Fekadu, Mesfin Dejene, Aemiro Kihalew., Bethlehem Mekonnen and Mola Shumye. 2021. Effect of Maize Stover Silage based Total Mixed Ration on Milk Yield and Composition of Cross Breed (BoranX Fresian) Dairy Cow. Ethiop. J.Agric.Sci.31 (1) 83-91.
5. Khan S.R., Singh S.K. and Mudgal Vishal. (2010). Effect of feeding complete rations on the performance of lactating crossbred cow. *Indian Journal of Animal Nutrition* 27(3):261-264.
6. Lacto scan Milk Analyzer.2016. Operational manual.4, Narodni Buditeli str. 8900, Nova Zagora, Bulgaria. 79p.
7. McDonald, P.R., Edwards, A., Greenhalgh, T.F.D. and Morgan, C.A. 2002.Evaluation of feeds. Animals Nutrition 5th edition. pp.221-228.
8. National Research Council. (2001). Nutrient Requirements of Dairy Cattle. 7th rev.ed. National Academic Sciences. Washington, DC.
9. R Core Team.2018. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.
10. Tilley, J.M.A. and Terry, R.A. 1963. A two stage method for the in vitro digestion of forage crops. Journal Britannia Grassland Society.18: 104-111.
11. Van Soest, P.J. and Robertson, J.B.1985.Analysis of Forages and Fibrous Foods a Laboratory Manual for Animal Science. Cornell University, Ithaca, NY.

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