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Effect of Body Weight-Based Feeding on Production Performance of Cattle (Holstein Friesian) During Different Lactation Stages

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Key words
Livestock, Holstein Friesian cows, Body weight, Milk production, Milk yield, Lactation stages

ABSTRACT

This study investigated the effect of prevailing vs experimental (@10% of body weight) feeding regimes on milk yield of Holstein Friesian cows grown in subtropical climates at Livestock Research and Breeding Farm at the University of Agriculture Peshawar. For this purpose, 18 Holstein Friesian (HF) cows of 3rd/4th parity were randomly selected and divided into three groups, each having an equal number of cows, based on lactation stages. Each group was further divided into two sub-groups, where one group was maintained on the same prevailing feeding regime (control) while the other was subjected to feeding at 10% of the body weight (treatment) of animals. Milk yield was recorded twice a day for 35 days. Results showed that HF cows in early lactation had higher milk production in both the control and treatment groups than the cows in mid and late lactation stages, respectively. The treatment group had a significantly higher effect on the weekly and overall milk production of HF cows. It was observed that cows on experimental feeding had significantly higher milk yield in early, mid, and late lactation stages compared to the control feeding and a uniform pattern was observed throughout the experiment. It was concluded that weight-based feeding had a positive effect on the milk production of exotic animals.

INTRODUCTION

Pakistan is an agricultural country, and the majority of the population is dependent on this industry, either directly or indirectly. It accounts for half of the employed labor force and is the main source of foreign exchange earnings, contributing around 24 percent of GDP. Livestock farming is a source of income for more than 8 million rural families, with livestock accounting for 40% of their revenue. The livestock sector's contribution increased 3.0% from Rs 1,461 billion in 2020-21 to Rs. 1,505 billion in 2021-22 (GOP, 2021-22). Different cattle breeds of Pakistan are Sahiwal, Red Sindhi, Cholistani, Dhanni, Tarparkar, Baghnari, Dajal, Lohani, Rojhan and Kankrej (Afzal and Naqvi, 2004). Apart from the indigenous breeds, Pakistan possesses exotic cattle breeds among which Holstein Friesian (HF) is reared under commercial and Government farms. The average weight of the HF breed is 680-770 kg, color is black and white (FAO, 2020). The HF cow is a dairy cow breed known for its high milk productivity, good milk quality, prolonged lactation, and high feed intake (Prayitno *et al*., 2017). Cattle milk yield

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can be enhanced by improving feed quality and feeding based on body weight requirements. Feeding strategies can be used to increase feed intake. There are three feeding strategies, component feeding, selective feeding, and total mixed ration (TMR) and the TMR feeding system has the greatest impact on intake (Bargo, 2002). In the United Kingdom and many other areas of the world, a variety of concentrated feeding strategies are used in practice. Concentrates can be mixed with the forage component of the diet as part of a mixed ration, fed separately from forage via in-parlor or out-of-parlor concentrate feeding systems or fed through a combination of these methods. Improved feed intake potential and the ability of higher-yielding cows to mobilize body tissue to offer energy for milk early production are usually associated with increased milk yield (Purcell *et al*., 2016).

During the dry season, the body condition of dairy cows changes dramatically and cows postpartum performance is affected directly or indirectly by their body condition. Dairy cattle's maintenance and pregnancy requirements rise throughout pregnancy; however, feed consumption decreases during this period (Ingvartsen *et al*., 1999). While some body weight reduction is usual during the dry season, excessive weight loss should be avoided by meeting both maintaining and pregnancy caloric demands (Kim and Suh, 2003). High genetic merit dairy cows are more prone to body condition score (BCS) decrease than low-producing cows. BCS and milk production have a negative relationship. Moderate BCS, on the other hand, favored increased milk production (Damato, 2023). Negative energy balance is a common occurrence in dairy cows and limited feed may result in a negative energy balance. During late pregnancy and early lactation, cows have a reduced choice of feed consumption, which could be related to physical constraints, neurological cues, and hormonal signals (Ingvartsen *et al*., 1999). This drop in intake, along with the high energy requirements of lactation establishment, frequently results in a negative energy balance. Indeed, the onset of lactation is marked by increased energy demands associated with a quick increase in mild yield, resulting in a negative energy balance, mobilization of body reserves, and changes in milk composition (Bjerre-Harpoth et al., 2012). Therefore, this study was conducted by feeding the Holstein Friesian cows based on body weight, and lactation stage to improve the milk yield.

MATERIALS AND METHODS

Study location, animals selection and management

This study was conducted at the Livestock Research and Breeding Farm, The University of Agriculture Peshawar and the total duration of the experiment was 35 days. A total of 18 healthy lactating Holstein Friesian cows were randomly selected from the herd and distributed in two groups, i.e., conventional feeding group and feeding @ per kg body weight, each of 9 cows. Each group was further divided into three subgroups based on the lactation stage of the animal i.e. early lactation, mid-lactation, and late lactation, each of three cows. All the animals were tagged and body weight was recorded before the commencement of the research trail. Animals were then routinely weighed through a weighing scale every week throughout the trial period. All animals were given 24-h free access to fresh water and enough space for exercise.

Nutrition management

Animals were routinely offered forages twice a day, i.e., morning and evening. For this purpose, all animals were initially weighed before the commencement of the research trial. Forages offered during the research trial comprised freshly chopped maize having 23.21 dry matter, with wheat straw consisting of 90.46% dry matter. Concentrate of dry matter 88%, crude protein 15%, TDN 68%, ether extract 3.5% and ash 12% were also offered to animals. Feed formulation based on dry matter is shown in Table I.

Table I. Feed formulations (DM basis) in kilograms.

Groups	Body weight (Kg)	Forages (Kg) (Maize + wheat straw)	Concentrate (Kg)
Early lactation	539±45.84	43+5	5
Mid lactation	567±53.66	46 +5	5
Late lactation	576±41.48	57+5	5

Milk yield

Milk yield was measured through weigh measuring scale at the time of milking for both the control and experimental animal twice a day (Morning and evening).

Statistical analysis

The data was subjected to statistical software SPSS (V16.0) for analysis. The data was analyzed using a factorial design by two-way interaction effect and means between the groups were compared through an LSD test.

RESULTS

Table II represents the result of milk production during different weeks. In all weeks, the effect of lactation stages was highly significant and the treatment group milk production during early, mid, and late lactation was

Table II. Milk yield (liter) of Holstein Friesian cows in various lactation stages during different weeks.

Weeks	Groups	Early lactation	Mid lactation	Late lactation
1st	Control	90.00[b]	80.00[b]	72.00[b]
	Treatment	102.6[a]	95.33[a]	83.33[a]
	SEM	3.56	2.45	2.11
	P-value	0.001	0.001	0.001
2nd	Control	90.56[b]	80.27[b]	72.51[b]
	Treatment	103.2[a]	95.90[a]	83.97[a]
	SEM	3.67	2.14	1.88
	P-value	0.001	0.001	0.001
3rd	Control	91.06[b]	80.05[b]	71.43[b]
	Treatment	104.6[a]	93.30[a]	82.82[a]
	SEM	3.33	2.60	2.15
	P-value	0.001	0.001	0.001
4th	Control	92.00[b]	80.66[b]	71.00[b]
	Treatment	104.3[a]	96.83[a]	82.43[a]
	SEM	3.50	2.42	2.11
	P-value	0.001	0.001	0.001
5th	Control	92.06[b]	81.00[b]	70.83[b]
	Treatment	105.7[a]	97.66[a]	81.66[a]
	SEM	3.88	2.64	2.33
	P-value	0.001	0.001	0.001

Means with different letters with in the same column differs significantly at $P < 0.05$.

Table III. Mean comparison of milk production (liters) of different lactation stages in response to two groups (control and experimental) in five weeks interval.

Groups	Early lactation	Mid lactation	Late lactation
Control	455.3[b]	402.3[b]	357.2[b]
Treatment	519.0[a]	482.0[a]	413.6[a]
SEM	18.2	13.7	10.1
P-value	0.001	0.003	0.001

Means with different letters with in the same column differs significantly at $P < 0.05$.

the highest than the control group. Results for the mean comparison of overall milk production of cattle fed on body weight are shown in Table III. Milk production in the early lactation stage was higher followed by the mid and late lactation stage as well as treatment group had always higher production than the control group. Results for the mean comparison of the overall week of milk production of HF cattle fed on body weight are shown in Table IV. The mean production of milk increased week by week and the production of the treatment group was always higher significant than the control group. Table V shows the results of the combined mean comparison of milk production versus groups. Overall milk production in all weeks was recorded higher significantly in the early lactation stage than in the mid and late lactation stages.

Table IV. Mean comparison of milk production (liters) in early, mid and late lactation stages during different weeks.

Weeks	Groups	Milk yield	Range	
			Minimum	Maximum
1st	Control	80.66[b]	78.38	82.94
	Treatment	93.77[a]	91.50	96.05
	SEM	2.14	----	----
	P-value	0.001	----	----
2nd	Control	80.94[b]	78.76	83.12
	Treatment	94.16[a]	91.99	96.34
	SEM	1.78	----	----
	P-value	0.003	----	----
3rd	Control	81.00[b]	78.83	83.17
	Treatment	94.27[a]	92.10	96.44
	SEM	1.66	----	----
	P-value	0.001	----	----
4th	Control	81.11[b]	78.88	83.33
	Treatment	94.50[a]	92.27	96.72
	SEM	1.52	----	----
	P-value	0.002	----	----
5th	Control	81.30[b]	79.00	83.59
	Treatment	94.83[a]	92.53	97.13
	SEM	1.74	----	----
	P-value	0.002	----	----
Over all	Control	405.0[b]	393.91	416.12
	Treatment	471.5[a]	460.44	482.66
	SEM	15.5	----	----
	P-value	0.003	----	----

Means with different letters with in the same column differs significantly at $P < 0.05$.

Table V. Control and experimental group combined mean comparison of milk yield (liters) in early, mid and late lactation stages.

Lactation stages	Milk yield					
	WK-1	WK-2	WK-3	WK-4	WK-5	All weeks
Early lactation	96.34	96.92	97.37	97.96	98.62	487.19
Mid lactation	87.67	88.09	88.42	88.76	89.34	442.25
Late lactation	77.68	77.67	77.14	76.72	76.26	385.44
SEM	2.42	2.33	3.11	2.12	2.54	2.37
P-value	0.001	0.001	0.001	0.001	0.001	0.001

Means with different letters with in the same column differs significantly at $P < 0.05$.

DISCUSSION

The findings show that overall milk production in all weeks was higher in the treatment group in the early lactation stage than in the control group in the mid and late lactation stage. Similarly, Horan *et al*. (2005) carried out a study on the effect of 10% body weight-based feed on milk production of HF cattle and the findings showed higher production performance of animals fed with 10% body weight than the control group. Holcomb *et al*. (2001) also described that the animals fed on 10% body weight based have higher production than the control group. Similarly, Dewhurst *et al*. (2000) described that body weight-based feed has a positive effect on milk production in the early lactation stage. Raab (1994) and Okine *et al*. (1997) also concluded that with increasing range of forage ratio concentrates, the overall feed intake and milk yield increased. Tuan (2000) performed the same research work in tropical areas, and their findings are in line with the current study that by feeding the animals on body weight bases the overall milk yield increased. Similarly, Sirohi *et al*. (2010) worked on the production performance of dairy cattle by giving the feed based on body weight and the results showed that production in early lactation was higher than in the mid and late lactation stages. Gonda *et al*. (1996) findings are also in line with the current study and revealed that increasing the amount of DM-based feed had a positive relationship with the production performance of dairy cattle, and cows yield 10-15% more as compared to the control group. Related results were also documented by Sporndly (1986) that feeding the animals with 38% DM-based significantly increased milk fat percentage, milk yield, and live weight gain of the animals. Similar to the result of the present study, Kaiser *et al*. (2004) carried out a study on the effect of roughages and total mixed ration feed on a DM basis and its relation with the production performance of dairy cattle and documented those animals fed with roughages had lower milk yield and animals feed with total mixed ration on DM based had higher milk yield in all stages of lactation. The current results are also supported by the work of Suwannasin (2009) who found that feeding the animals with partially mixed ration on a DM basis increases the milk yield in all stages of lactation. Istasse *et al*. (1986) revealed in their study that forages and concentrates offered to the animals either in total milk mixed ration or separately on DM-based had a significant effect on the total milk yield of the animals with increased concentrates in ration.

According to the work done by Gordon *et al*. (1995) and Oba and Allen (1999), feeding animals with roughages based on DM has a negative correlation with the milk yield of milk which might be due to lower digestibility of roughages however the lower milk yield in late lactation stage might be due to devotion of greater proportion of dietary nutrients to pregnancy and to increase body conditions score, thus the dairy efficiency decreases. Nyambati *et al*. (2003) fed animals with different supplements i.e., lablab hay and commercial dairy meal on a DM basis and results showed that the milk yield increased with improving the body condition score of the animals but the supplemental feed had no significant effect on the body weight gain of the animals. The increments in milk production were due to the increased dry matter intake of the animals. The increase in the milk yield was also similar to those reported by Muia *et al*. (2000). Sattar *et al*. (2005) analyzed the dairy production data from 1991-2000, which supports the current results of milk yield in various lactation stages.

CONCLUSION

It is concluded from the present study that feeding HF cows on a live body weight basis significantly improves milk production as compared to conventional feeding practices. It is also concluded that conventional feeding practices are unable to fulfill the nutrition requirements of HF cows for increased milk production, particularly during early lactation stages. The feeding of animals should be adjusted /practiced according to the body requirements across the different lactation stages. It is recommended to adjust feed by the body's requirements at each stage of lactation.

DECLARATIONS

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IRB approval

The experimental work was approved by the Board of Studies (BOS) (January 2023) and conducted at the Department of Livestock Management, Breeding and Genetics, Faculty of Animal Husbandry and Veterinary Sciences (FAHVS), The University of Agriculture Peshawar, KP, Pakistan.

Ethical statement

The experiment was approved by the ethical committee of the Faculty of Animal Husbandry and Veterinary Sciences (FAHVS), The University of Agriculture Peshawar before the practical execution of this experiment.

Statement of conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Afzal, M. and Naqvi, A.N., 2004. Livestock resources of Pakistan: Present status and future trends. *Adm. Sci. Q.,* **9**: 1-2.

Bargo, F., 2002. *Feeding systems combining pasture with concentrate and total mixed rations for high producing dairy cows.* Penn State Universtiy Libraries.

Bjerre-Harpøth, V., Friggens, N.C., Thorup, V.M., Larsen, T., Damgaard, B.M., Ingvartsen, K.L. and Moyes. K.M., 2012. Metabolic and production profiles of dairy cows in response to decreased nutrient density to increase physiological imbalance at different stages of lactation. *J. Dairy Sci.,* **95**: 2362–2380.

Brady, E.L., Kelly, E.T., Lynch, M.B., Fahey, A.G., Pierce, K.M. and Mulligan, F.J., 2022. The effect of concentrate feeding strategy and dairy cow genotype on milk production, pasture intake, body condition score and metabolic status under restricted grazing conditions. *Livest. Sci*., **256**: 104815. https://doi.org/10.1016/j.livsci.2021.104815

Damato, A., 2023. Safe use of bentonite in dairy cows. assessment of physiological responses by studying metabolome and mineral content in biofluids and milk characteristics. https://www.research.unipd.it/bitstream/11577/3501252/2/Tesi_Definitiva_Anna_Damato.pdf

Dewhurst, R.J., Moorby, J.M., Dhanoa, M.S. and Fisher, W.J., 2002. Effects of level of concentrate feeding during the second gestation of Holstein-Friesian dairy cows. Feed intake and milk production. *J. Dairy Sci*., **85**: 169-177. https://doi.org/10.3168/jds.S0022-0302(02)74065-4

FAO, 2020. *Its origins, formation and evolution, 2020*. 1945-1981. Food and Agriculture Organization of the United Nations.

GOP, 2021-22. Economic Survey of Pakistan. pp. 26-53.

Gonda, H.L., Emanuelson, M. and Murphy, M., 1996. The effect of roughage to concentrate ratio in the diet on nitrogen and purine metabolism in dairy cows. *Anim. Feed Sci. Technol.*, **64**: 27-42. https://doi.org/10.1016/S0377-8401(96)01049-8

Gordon, F.J., Porter, M.G., Mayne, C.S., Unsworth, E.F. and Kilpatrick, D.J., 1995. Effect of forage digestibility and type of concentrate on nutrient utilization by lactating dairy cattle. *J. Dairy Res*., **62**: 15-27. https://doi.org/10.1017/S002202990003363X

Holcomb, C.S., Van Horn, H.H., Head, H.H., Hall, M.B. and Wilcox, C.J., 2001. Effects of prepartum dry matter intake and forage percentage on postpartum performance of lactating dairy cows. *J. Dairy Sci.*, **84**: 2051-2058. https://doi.org/10.3168/jds.S0022-0302(01)74649-8

Horan, B., Dillon, P., Faverdin, P., Delaby, L., Buckley, F. and Rath, M., 2005. The interaction of strain of Holstein-Friesian cows and pasture-based feed systems on milk yield, body weight, and body condition score. *J. Dairy Sci.*, **88**: 1231-1243. https://doi.org/10.3168/jds.S0022-0302(05)72790-9

Ingvartsen, K.L., Friggens, N.C. and Faverdin, P., 1999. Food intake regulation in late pregnancy and early lactation. *BSAP Occasion. Public.,* **24**: 37-54.

Istasse, L., Smart, R.I. and Ørskov, E.R., 1986. Comparison between two methods of feeding concentrate to sheep given a diet high or low in concentrate with or without buffering substances. *Anim. Feed Sci. Technol.,* **16**: 37-49.

Kaiser, A.G.,. Pilz, J.W., Burns, H.M. and Griffiths. N.W., 2004. *Successful silage.* Dairy Australia and New South Wales Department of Primary Industries Publishers. Orange, NSW, Australia. pp. 420.

Kim, I.H. and Suh, G.H., 2003. Effect of the amount of body condition loss from the dry to near calving periods on the subsequent body condition change, occurrence of postpartum diseases, metabolic parameters and reproductive performance in Holstein dairy cows. *Theriogenology,* **60**: 1445-1456.

Muia, J.M.K., Tamminga, S., Mbugua, P.N. and Kariuki, J.N., 2000. The nutritive value of Napier grass (*Pennisetum purpureum*) and its potential for milk production with or without supplementation: A review. *Trop. Sci.,* **40**: 109-131.

Nyambati, E.M., Sollenberger, L.E. and Kunkle, W.E., 2003. Feed intake and lactation performance of dairy cows offered napiergrass supplemented with legume hay. *Livest. Prod. Sci.*, **83**: 179-189. https://doi.org/10.1016/S0301-6226(03)00094-0

Oba, M. and Allen, M.S., 1999. Evaluation of the

importance of the digestibility of neutral detergent fiber from forage: Effects on dry matter intake and milk yield of dairy cows. *J. Dairy Sci.*, **82**: 589-596. https://doi.org/10.3168/jds.S0022-0302(99)75271-9

Okine, E.K., Khorasani, G.R. and Kennelly, J.J., 1997. Effects of source of forage and level of concentrate on chewing activity and milk production response in late lactation cows. *Can. J. Anim. Sci.*, **77**: 253-258. https://doi.org/10.4141/A96-091

Prayitno, C.H., Mukminah, N. and Jayanegara, A., 2017. Effects of different feeding methods on feeding behavior, feed intake, and digestibility of lactating dairy cows. *Int. J. Dairy Sci.*, **12**: 73-80. https://doi.org/10.3923/ijds.2017.73.80

Purcell, P.J., Law, R.A., Gordon, A.W., McGettrick, S.A. and Ferris, C.P., 2016. Effect of concentrate feeding method on the performance of dairy cows in early to mid-lactation. *J. Dairy Sci.*, **99**: 2811-2824. https://doi.org/10.3168/jds.2015-9988

Raab, L., 1994. High energy supply ensures low forage replacement. *Neue Landwirtschaft*, **3**: 56-58.

Sattar, A., Mirza, R.H., Niazi, A.A.K. and Latif, M., 2005. Productive and reproductive performance of Holstein-Friesian cows in Pakistan. *Pak. Vet. J.,* **25**: 75.

Singh, A.K. and Bhakat, C., 2022. The relationship between body condition score and milk production, udder health and reduced negative energy balance during initial lactation period: A review. *Iran. J. appl. Anim. Sci.*, **12**: 1-9.

Sirohi, S.K., Walli, T.K. and. Mohanta, R.K., 2010. Supplementation effect of bypass fat on production performance of lactating crossbred cows. *Indian J. Anim. Sci.,* **80**: 733-736.

Sporndly, R., 1986. Intake and production response of dairy cows to a fixed ratio of silage to cereals, fed as separate feeds, blended or ensiled together. Ensiling of blended grass and grain and its utilization by dairy cows. *Report*, **155**.

Suwannasin, N., 2009. *Production efficiency and economic return of crossbred dairy cow fed partial mixed ration (PMR) in dry season.* MSc thesis, Kasetsart University, Bangkok, Thailand.

Tuan, B.Q., 2000. *Effects of protein and concentrate levels on rumen digestion and milk production of crossbred dairy cattle in Hanoi.* Doctoral dissertation, Hanoi University of Agriculture.