Effect of Total Mixed Ration Feeding System on Dry Matter Intake, Nutrient Intake, and Onset of Estrus in Growing Dairy Cattle

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ABSTRAK

Barros A, Guadayo GF, Sevilla CC, Bautista JAN, Dizon JT, Loresco MM, Narag RAB, Angeles AA. 2024. Pengaruh sistem rasio pakan lengkap terhadap konsumsi bahan kering dan nutrisi serta awal estrus pada sapi perah yang sedang tumbuh. JITV 29(4):193-200. DOI:http://dx.doi.org/10.14334/jitv.v29i4.3354.

Studi ini dilakukan untuk membandingkan keuntungan pemberian pakan lengkap atau *total mixed ration* (TMR) dibandingkan dengan pemberian pakan komponen (COMP) terhadap konsumsi bahan kering (KBK), dan konsumsi nutrisi dalam hal protein kasar (PK), serat deterjen netral (NDF), dan konsumsi serat deterjen asam (ADF), serta timbulnya berahi. Sepuluh ekor sapi dara dan jantan muda persilangan Friesian Holstein dan Jersey di Dairy Training dan Research Institute digunakan untuk percobaan pakan selama 5 bulan. Penelitian menggunakan Rancangan Acak Kelompok Lengkap (RAKL) dengan 5 blok di bawah 2 kelompok perlakuan. Pakan TMR dan COMP menggunakan bahan pakan yang sama yaitu silase jagung, rumput gajah, konsentrat mash, campuran kacang-kacangan, molase, dan garam beryodium dengan jumlah dan kebutuhan nutrisi yang sama. TMR dicampur terlebih dahulu sebelum diberikan sementara bahan pakan COMP diberikan secara terpisah pada ternak dengan mengikuti jadwal pemberian makan.Data dikumpulkan dari konsumsi pakan harian dari ransum yang diberikan. Sisa pakan ditimbang setiap hari sebelum pemberian pakan dimulai pada pagi hari. Pertambahan berat badan (PBB) ditimbang setiap dua minggu sekali. Sampel dari pakan yang diberikan dan sisa pakan dikumpulkan seminggu sekali untuk dilakukan analisis kandungan nutrisi. Data dianalisis dengan menggunakan prosedur ANOVA dari Perangkat Lunak Statistik SAS. Hasil penelitian menunjukkan bahwa konsumsi BK, PK, NDF, dan ADF lebih tinggi pada kelompok TMR dibandingkan dengan kelompok COMP. Perbedaan rata-rata untuk PBB, rasio konversi pakan, dan timbulnya berahi tidak berbeda nyata. Secara keseluruhan, TMR diharapkan dapat bermanfaat dalam beternak sapi perah.

Kata Kunci: Komponen, Sistem Pemberian Pakan, Budidaya Sapi Perah, Pakan Lengkap

ABSTRACT

Barros A, Guadayo GF, Sevilla CC, Bautista JAN, Dizon JT, Loresco MM, Narag RAB, Angeles AA. 2024. Effect of total mixed ration feeding system on dry matter intake, nutrient intake, and onset of estrus in growing dairy cattle. JITV 29(4): 193-200. DOI:http://dx.doi.org/10.14334/jitv.v29i4.3354.

The objective of the study was to compare the advantages of total mixed ration (TMR) feeding versus component (COMP) feeding concerning dry matter intake (DMI) and nutrient intake in terms of crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) intake, and the onset of estrus. A total of ten growing Holstein Frisian (HF) x Jersey breeds were randomly assigned to participate in five months of feeding trials at the Dairy Training and Research Institute. The design structure employed a randomized complete block design (RCBD) comprising five blocking factors under two treatment groups. The TMR and COMP were composed of the same feed ingredients, including corn silage, Napier grass, concentrate mash, mixed legumes, molasses, and iodized salt, and they had the same quantity and nutrient requirements. The TMR was prepared and mixed in advance, prior to the commencement of the feeding trial. In contrast, the components of the COMP were offered separately to the cattle following the specified feeding schedule. The data were collected from the daily intake of the rations offered. The feed refusal was weighed daily before the morning feeding periods, while the body weight gain (BWG) was recorded every two weeks. While samples of the offered and refused feeds were collected once a week for nutritional analysis, the data were subjected to the ANOVA procedure of SAS Statistical Software. The results demonstrated that DM, CP, NDF, and ADF intake was higher in the TMR than in the COMP group. However, the differences in means for BWG, feed conversion ratio, and the onset of estrus were not significantly different. In conclusion, TMR is expected to be beneficial in raising growing dairy cattle.

Key Words: Component Feed, Feeding System, Growing Dairy Cattle, Total Mixed Ration

INTRODUCTION

Dairy farming represents one of several livestock production systems encompassing a range of farm sizes, from small subsistence farms to large-scale commercial operations. However, dairy farms have encountered numerous constraints due to the unavailability of quality and quantity of feed resources and the impact of these limitations on the growth, health, and reproduction of animals and their subsequent ability to produce milk.

The utilization of feed represents the most significant production expense for dairy farms and, therefore, necessitates efficient management. The expenditure on animal feed can represent as much as 60 to 70% of total production costs, given that it constitutes the most significant single production cost for livestock operations. A variety of feed ingredients can be used in animal rations, none of which are particularly noteworthy. It is of paramount importance to ensure that the nutrients are accessible in order to meet the nutritional requirements of the cattle. Various by-product feed alternatives are now available, offering an inexpensive means of providing additional nutrition.

Nevertheless, the most commonly utilized feed ingredients for animal feed are forage crops including maize (*Zea mays*), sorghum (*Sorghum bicolor*), Napier grass *(Pennicetum purpureum*), and legumes such as Moringa *(Moringa oleifera),* Kakawate *(Gliricidia sepium),* Ipil-ipil *(Leucaena leucocephala),* Indigo *(Indigofera tinctoria),* and Colopo *(Calopogonium mucunoides)* are fed on a fresh or dry matter basis. It is anticipated that the utilization of feed in an effective and efficient feeding system will increase dairy cattle's production traits, thereby reducing feed costs. TMR is one of the feeding systems that can reduce feed costs and is currently the most widely applied in dairy farms worldwide. This strategy allows for the effective and efficient utilization of available feed resources, thereby overcoming the feed shortage of dairy cows (Karunanayaka et al. 2021). A TMR feeding strategy for cattle involves combining feeds with varying nutrient content into a single feed mix. A TMR is provided to dairy cows, which comprises all of the necessary feeds and nutrients. It constitutes a complete and balanced diet, providing the nutritional requirements for optimal cow health. The regular management of TMR can ensure that the cows obtain the nutrients they require for healthy growth, production, and reproduction; this is due to the significant effect that TMR has on the feed intake, feed efficiency, body weight gain, and the attainment of early sexual maturity of growing dairy cattle. The feeding of TMR according to animal requirements is more efficient than the traditional feeding system.

It was hypothesized that the feeding trial of COMP and TMR on growing dairy cattle (HF x Jersey) would demonstrate an advantage of a TMR-based system, including the minimization of selective consumption, the predetermination of daily nutrient intake, and the incorporation of unpalatable or low-quality feeds in the TMR. Notwithstanding the aforementioned advantages, TMR feeding in dairy cattle production remains infrequent at the farm level.

The objective of the experiment was to obtain reliable data that would enable a comparison of the efficiency and effectiveness of TMR over the COMP feeding technique. The feed cost represents a significant proportion of the overall expense incurred by dairy farms. Therefore, ensuring that this component is utilized as efficiently as possible is essential. It represents the most significant financial outlay associated with heifer production. It is anticipated that enhancing feed efficiency through reducing feed costs will facilitate the implementation of an appropriate feeding strategy, thereby optimizing the utilization of feed and enhancing the production traits of dairy cattle.

The TMR feeding system used in this feeding trial was formulated from the following ingredients: Napier grass, corn silage, a mixture comprising Moringa, Kawate, and Ipil-ipil concentrate mash, molasses, and iodized salt; this is the same composition as that of the COMP feeding, with the exception that the COMP feeding was administered separately. The COMP and TMR feeds were formulated to have the exact nutrient requirements and were administered to the cattle at 3% of their body weight per day on a dry matter basis. The TMR feeding system is anticipated to confer an advantage in terms of growth and reproductive performance in replacement heifers.

In addition to genetics and body weight factors, nutritional intake can influence the onset of puberty. Nutritional factors such as protein, energy, minerals, and vitamins have been demonstrated to influence reproductive function. Heifers fed an appropriate diet typically reach puberty between nine and 15 months of age (Senger 2012). Following the onset of puberty, a heifer will continue to exhibit regular estrous cycles, occurring every 21 days (the normal range is every 18 to 24 days). Several hormones and organs regulate the estrous cycle in cattle. The monitoring and reading of the estrus are frequently conducted based on the common estrus signs, which include the cow standing to be mounted by other cows and moving forward with the weight of the mounting cow; this is the most common and accurate symptom of estrus, Mounting other cows is an indicator that the cow is in or approaching the estrous phase. The mucus discharge is an unintended consequence of elevated estrogen levels during estrous. Mucus may be observed on the tail, thighs, flanks, or perineal region of the cow or in the form of long, viscous, clear elastic strands hanging from the vulva. The vulva enlarges in the heat, becoming

moist and red on the internal surface, exhibiting restlessness and a tendency to trail.

MATERIALS AND METHODS

Feeding trials

The experimental units were 10 growing HF x Jersey with an initial average body weight of 195±21.9 kg, assigned in feeding trials. The design structure applied a Randomized Complete Block Design (RCBD) with five blocking factors based on initial body weight and sex in two farms where animals were treated under two treatments. The animals in Treatment 1 (COMP feeding) were provided with corn silage, fresh Napier grass or hay, concentrate mash (26% CP, 2530 kcal/kg ME), and air-dried legume mixture (Moringa, Kakawate, Ipil-ipil), molasses, and iodized salt. The animals in Treatment 2 were fed a TMR comprising the same ingredients. The Napier grass was chopped using a machine chopper with a 2 to 5-cm particle size, the same size as the corn silage. The corn silage was obtained from the silage bunker of the Dairy Training and Research Institute, Institute of Animal Science, College of Agriculture and Food Science, University of the Philippines Los Baños.

In the initial feeding trial, the treatment groups were fed COMP and TMR formulated with the following proportion: 41.26% corn silage, 13.74% Napier grass, 2% Ipil-ipil and Kakawate, 1% Moringa, 35.76% concentrate mash, and iodized salt. These formulations were created using the Best Mixed software. At the same time, the COMP and TMR were formulated with approximately 15.9% crude protein and 2470.0 kcal/kg metabolizable energy to be provided daily to growing HF x Jersey dairy cattle.

The TMR feed was physically combined by hand mixing shortly after the requisite ingredients were weighed and placed on the floor. This process was repeated until homogeneous mixing was achieved, thereby preventing the cattle from dividing the feed into sections. The TMR was manually combined once a day in the morning, with the quantity required for the cattle being calculated on a daily basis. The cattle were fed for a period of five months, with 14 days to the adjustment period to allow for acclimation to the feed, pen, and environment. Immediately following the adaptation period, the animals were weighed to determine their initial weight. The feed was administered twice daily at 08:30 and 13:30 for the component feed and three times daily for the TMR at 08:30, 13:30, and 16:00, respectively. The amount offered was 3% dry matter per animal's body weight per day.

Data were collected daily through observation of the daily feed intake (in kilograms per day) of the rations offered. The daily feed refusal was weighed before the morning feeding commenced, while the body weight gain was recorded and weighed at two-week intervals. The samples of feed offered and feed refusals were collected once a week for the purpose of nutrient analysis to determine the nutrient intakes of the animals.

Onset of estrus

Six (6) HF x Jersey heifers with average initial weights of 195.08±17.99 kg and average ages of 361±16.70 days were identified as exhibiting signs of estrus through visual observation. The detection of estrous behavior was initiated at the commencement of the feeding trial when the cattle were approximately 12 months of age. The observation was conducted four times daily, at 7 a.m., 9 a.m., and 6 p.m. and 8 p.m. The signs of estrous that were observed included mounting to other cows, bellowing, mucus discharge from the vagina, swelling, and reddening of the vulva, as well as other indications. If a cow was identified as being in estrus for the first time, this was confirmed and verified at the subsequent estrus cycle (21 days) to ascertain a definite estrus day. The onset of estrus indicated that the growing female was reaching sexual maturity.

Data analysis

The data obtained from the daily feed intake (kg/d), nutrient intake, body weight gain (kg), average daily gain (kg/d), and feed conversion ratio were subjected to the analysis of variance (ANOVA) using the SAS Statistical Software. The correlation between age, body weight, and feed intake with the age at first estrus and the number of days of heat occurrence after feeding was measured using an Excel spreadsheet.

RESULTS AND DISCUSSION

Feed and nutrient intake

Table 1 presents the data on feed intake and nutrient intake from the COMP and TMR feeding systems on the growing HF x Jersey, divided into two treatment groups. The total dry matter and daily dry matter intakes of growing dairy cattle fed a diet COMP, and TMR was found to be higher in the TMR group than in the COMP group, with a significant difference at the $P<0.01$ level. A significant difference ($P<0.01$) was observed in crude protein intake between the two treatment groups. The NDF intake exhibited a highly significant difference ($P<0.001$) between the two dietary treatment groups. The result was observed in

Table 1. Feed intake and nutrient intake of the cattle in two different treatment groups

Parameters	Treatments		SEM	P-Value
	COMP	TMR		
Feed Intake, kg:				
Total DMI, kg	953.13[a]	1146.89[b]	44,86	0.0024
DDMI, kg/d	6.14[a]	7.32[b]	0.34	0.0053
Nutrient Intake, kg/d				
CP	1.18[a]	1.34[b]	0.09	0.0062
NDF	3.23[a]	4.20[b]	0.14	0.0004
ADF	1.52[a]	2.55[b]	0.04	<.0001

COMP= component, TMR= total mixed ration, DMI= dry matter intake, DDMI= daily dry matter intake, CP= crude fiber, NDF= neutral detergent fiber, ADF= acid detergent fiber. a-b means within columns with different superscipts were highly significant different (P<0.01)

the cattle-fed COMP, which exhibited a lower NDF value than the cattle that received TMR feeding. The intake of ADF was found to be the highest (P<0.001) in cattle-fed TMR.

The objective of the feeding trial was to ascertain whether there were any advantages to TMR over the traditional component feeding system on DM intake, CP intake, NDF and ADF intake, and the onset of estrus. The rations were formulated on a dry matter basis. The amounts of each feed were fed on as fed basis. All cattle in the group got the same ration and consumed a mixed amount of forages and concentrates intended for production and health. The intake of TMR and component feed demonstrated a significant difference. Feeding a TMR increased feed intake due to the minimization of selective consumption of the growing dairy cattle.

The notable discrepancy in feed intake observed in this feeding trial is consistent with the findings of a recent study (Lee et al. 2015), which reported that TMR feeding resulted in higher feed intake (P<0.05) during the growing period compared to other treatments. The findings of the present study are also supported by the results reported by Li et al. (2021), who observed that TMR feeding resulted in increased average daily feed intake and daily gain. It may be posited that consumption of TMR by growing dairy cattle is greater than that of other ruminants due to the lack of alternative feed options. Consequently, the nutritional profile of each feedstuff was consistent and easily definable, approximating a nutritionally complete diet (Schingoethe 2017). This finding was consistent with the purported benefits of TMR for cattle, including enhanced feed efficiency, increased feed utilization, and the consumption of the optimal proportion of ingredients for a balanced ration. Compared to the COMP feeding regimen provided in a separate manner, the cattle were allowed to select their own diet.

Furthermore, the forage particle size was considered in the analysis of dry matter intake; this is linked to the rate at which feeds are digested in the rumen, which in turn affects the animal's ability to digest the feed (Yang & Beauchemin 2006, as cited by Melendez & Roy 2016). The TMR diet in this feeding trial had a particle size of less than 5 cm, which resulted in rapid mastication and subsequent passage. The rapid passage rate may result in an increase in DMI. Conversely, large particle size will result in a longer chewing time, which will, in turn, affect the intake. However, this will facilitate the degradation of fiber in the rumen and enhance the homogeneity of the feed (Melendez & Roy 2016).

Several factors exert an influence on the voluntary DMI of animals. Individual animal characteristics: physical condition, body weight, the physical fill of the reticulorumen, and metabolic-feedback elements (Illius & Jessop 1996; Mertens 1994, as cited by Allen 2000), can also influence voluntary DMI. In the case of growing dairy cattle of the HF x Jersey crossbreed, their dry matter intake is largely contingent upon the individual response to the feeds, the feed types, and the feeding management that predicts the voluntary DMI.

The highest CP intake was observed in cattle fed a TMR, while the lowest was in cattle that received component feeding. The disparate CP intake was consistent with the findings of Chander (2011), who reported that all animals in the treatment groups were provided with diets containing an identical percentage of CP. However, the observed increase in CP intake may be attributed to variations in the DM intake of the feeds. These findings align with those of Sarker et al. (2020), who conducted a similar study investigating the comparative advantages of TMR feeding over conventional feeding. The data demonstrate that the DM and CP intake of the TMR group was significantly (P<0.05) superior to that of the control group. Sarker et al. (2020) investigated the impact of paddy straw-based TMR on milk yield, milk composition, and rumen parameters in lactating cows. Their findings revealed that CP intake differed significantly (P<0.05) between

cattle-fed TMR blocks and those receiving component feeding.

The NDF intake exhibited a highly significant difference ($P<0.001$) between the two dietary treatment groups. The result was observed in the cattle-fed COMP, which exhibited a lower NDF value than the cattle that received TMR feeding. This result was similar to the findings of Hundal et al. (2004), who observed a significantly higher ($P<0.05$) NDF digestibility when the diet was fed as TMR as compared to the conventional feeding system. The intake of ADF was found to be the highest ($P<0.001$) in cattle that were fed TMR. These findings were also under those of Sarker et al. (2020) who observed a significant difference ($P<0.05$) in ADF intake between TMR feeding groups.

Moreover, the increased consumption of the TMR diet resulted in elevated levels of CP, NDF, and ADF intake; this was because the amount of CP, ADF, and NDF consumed significantly depended on the amount of DM consumed from the TMR. The value of CP, NDF, and ADF intakes from TMR feeding increases proportionately to the quantity of DM consumed. Allen (2000) reported that forage NDF content was more highly related to the DMI of forage than other chemical measures. Furthermore, Waldo (1986), as Allen (2000) cited, suggested that NDF content is the best single chemical predictor of DMI by ruminants. Mertens (1994), as cited by Allen (2000), employed NDF as the sole feed characteristic to forecast the filling effect and energy content of diets; when energy intake is constrained, a positive correlation was observed between DMI and NDF concentration. Conversely, a negative correlation was noted between DMI and NDF concentration when filling intake is limited. Furthermore, the nutritional impact of NDF is contingent upon a multitude of factors, including the form, digestibility, and chemical composition of the TMR (Allen 2000). The digestibility of forages, co-products, and other fibrous feeds varies considerably, impacting the energy supply.

Body weight gain and feed conversion ratio

Table 2 presents the data regarding weight gain and feed conversion ratio for 10 growing dairy cattle (HF x Jersey) over the course of five months. The data presented in Table 2 indicate that there was no statistically significant difference ($P>0.05$) in BWG, ADG, and FCR between the growing dairy cattle that were fed a COMP and those that were fed a TMR diet. However, the observed values for BWG and ADG were higher in the TMR-fed cattle.

Ten (10) growing dairy cows were included in the feeding trial with an average initial weight of 195.10±28.62 kg for cows fed COMP and 194.90±15.99 kg for cows fed TMR. After 153 days (22 weeks) of the feeding trial, there was no significant difference ($P>0.05$) in BWG and ADG between the two treatment groups; this was in line with Saraye (2014), who reported that after the experimental period, there was no significant difference ($P>0.05$) between the two feeding methods. The result also aligned with Lee et al. (2015), who reported that daily gain was not different during the growing period. Sarker et al. (2020) found that the body weight gain was not significantly different ($P>0.05$) but was slightly higher in TMR feeding groups; however, no significant differences were found between the two treatments. The result was also in agreement with Sarker et al. (2020), who reported no differences in body weight gains for roughage and concentrate ratio in TMR formulation; this was in contrast to the finding of Nissanka et al. (2010) that the TMR feeding system was significantly different ($P<0.05$) from conventional feeding in Friesian heifers.

The growing dairy cattle in the two dietary treatment groups showed that the cattle-fed TMR had practically higher BWG than the cattle-fed COMP. However, there was more significant variability in the initial body weight of cattle receiving COMP versus TMR, especially in block 5, as the feeding trials started at 237.5 kg versus 191 kg; this may have affected the body weight gain and may not have shown the difference between the COMP and TRM groups; this is consistent with the results of the study by Ngadiyono et al. (2019), who reported, that the difference between breed and initial body weight significantly affected the ADG in cattle.

Increases in body weight gains were linear for heifers and steers of all ages in both treatment groups. Average daily gains ranged from 0.61 to 1.09 kg, was in line with NRC recommendations based on nutrient requirements. The use of TMR for young heifers may result in a better balance of nutrient intake by avoiding individual preferences for forage or concentrates, as reported by Borland & Kesler (1979) and cited by Nissanka et al. (2010).

The data presented in FCR shows that the cattle fed TMR exhibited a lower feed conversion ratio (FCR) of 9.5:1 in comparison to the COMP group, which demonstrated an FCR of 8.3:1. The physiological capacity of the growing dairy cattle to convert feed into meat indicated that the cattle fed COMP required 8.3 kg of DM to produce 1 kg of meat compared to the TMR group, which required 9.5 kg of DM to produce 1 kg of meat. This value was comparable to the findings of Heinrichs et al. (2016), who reported that the older heifers fed with poor forage had an FCR of 8:1 or more (with some cases exhibiting an FCR of 15:1). It is possible to achieve an efficiency value of 6:1 to 7:1 through the use of TMR feeding. Yearling heifers fed high-quality feeds and forages can readily achieve a feed-to-gain ratio of 5:1. However, when fed less

Table 2. Body weight gain and feed conversion ratio of the cattle in two different treatment groups

Parameters	Treatments		SEM	P-Value
	COMP	TMR		
Initial BW, kg	195.10	194.90	18.52	0.9872
Final BW, kg	314.70	317.90	30.74	0.8772
BWG, kg	119.60	123.00	12.80	0.6776
ADG, kg/d	0.78	0.80	0.08	0.6285
FCR	8.34	9.52	0.09	0.0560

COMP= component, TMR= total mixed ration, BW= body weight, BWG= body weight gain, ADG= average daily gain, FCR= feed conversion ratio

digestible high-forage diets, this ratio can decline to 8:1 or higher. Shike (2013) defined the feed conversion ratio as the ratio of dry matter intake to live weight gain to quantify feed efficiency. A typical range of feed conversion ratios is 4.5 to 7.5, with a lower number being more desirable as it would indicate that a steer required less feed per pound of gain.

Onset of estrus

Table 2 illustrates the impact of the feeding system on the onset of the estrus of growing dairy cattle HF x Jersey breeds, with the animals being fed either a COMP or a TMR diet. The results show no statistically significant difference (P>0.05) in the feeding of TMR about the onset of estrus. However, heifers fed TMR exhibited an earlier onset of estrus following the implementation of feeding trials.

The initial age (day) of the dairy heifers was not significantly different (P>0.05) at the commencement of the experiment. The age at first estrus was lower in the TMR group, although no substantial difference was noted between the two treatment groups. The number of days during which heat occurred following the commencement of feeding was lower in the TMR feeding groups. Nevertheless, the two dietary treatment groups observed no significant difference (P>0.05).

The diet was formulated to meet the nutrient requirements of the heifers in TMR feeding systems. It was established that the ration had been formulated following the recommendations set forth by the NRC with a metabolizable energy content of 2.47 Mcl/kg and a CP of 15.9%. Karunanayaka et al. (2021) stated that a proper nutritional formulation of the diet is essential to ensure the provision of all nutrients. TMR may prove an efficacious nutritional strategy for improving follicular dynamics concerning reproductive hormones and metabolites. The relationship between nutrient intake (Table 3), the onset of estrus, and the number of days of heat occurrences (NDHA) after feeding was moderately negatively correlated; this indicates that dietary factors were among the influences on the age at first estrus in growing dairy cattle HF x Jersey breeds.

In addition to nutritional factors, body weight gain did not affect the age of puberty (Table 3) despite the close relationship between weight gain and the onset of puberty. The onset of puberty in heifers is contingent upon many factors, including but not limited to breed, age, and body weight. Most dairy breeds reach puberty by 11-12 months of age or even earlier if they are fed per the minimum standards set forth by the National Research Council for energy, protein, minerals, and vitamins (Stevenson & Ahmadzadeh 2011). Breeders frequently employ the weight of 275 kg to 350 kg as a criterion for sexual maturity in cows. The aforementioned data exceeded the results obtained from the feeding trial, wherein the age at first estrus of dairy heifers of HF x Jersey breeds was reached at 220 to 286 kg body weight at 400 to 488 days (approximately 13 to 16 months). This finding aligns with Schillo (2011), who reported that heifers fed an appropriate diet typically reach puberty between 9 and 15 months.

Table 3. Means of initial age, age at first estrus, and number of days of heat occurrence in dairy heifers fed COMP and TMR feeding

Parameters	Treatments		SEM	P-VALUE
	COMP	TMR		
Initial age, d	367	356.2	12.6	0.5383
Age at first estrus, d	438	413.5	26.2	0.6011
NDHA, d	85.7	59.5	19.3	0.4849

COMP= component, TMR= total mixed ration, NDHA= Number of days of heat occurrence after feeding

Table 4. Pearson Correlation Coefficient (r^2) of the BWG, Nutrient Intake with the Onset of Estrus and NDHA in Dairy Heifers During the Feeding Trial

Parameter	AE, d	DMI, kg	CPI, kg	NDHA, d	BWG, kg
AE, d	0				
DMI, kg	-0.57	0			
CPI, kg	-0.67	0.98	0.		
NDHA, d	0.87	-0.57	-0.60	0	
BWG, kg	-0.36	0.80	0.73	-0.46	0

AE= Age at first estrous, DMI= Dry matter intake, CPI= Crude protein intake, BWG= Body weight gain, NDHA= Number of days of heat occurrence after feeding

However, it should be noted that there is considerable variation in the average age at puberty, with figures ranging from approximately 8 to 24 months. For heifers to reach early puberty, it is essential that they receive an adequate nutritional intake, as once this stage is reached, the heifer must be able to maintain a level of nutrition that allows for the continuation of the estrus cycle; this is by Bindari et al. (2013) that nutrition plays a major role in enhancing reproductive efficiency in all animals. Energy and protein are the major nutrients required in the greatest amounts and should be the topmost priority to optimize reproduction efficiency in dairy cattle.

CONCLUSION

According to the study's findings, the TMR feeding system did not affect the growth performance of BWG, ADG, and FCR, except for DMI, CPI, NDFI, and ADFI, which were more significant in the TMR feeding group. The occurrence of the estrus was not affected by the TMR feeding system. However, there was a moderately negative correlation between DMI and CPI with the onset of estrus and the number of heat occurrences after feeding the ration.

Overall, TMR performed a better feeding system. Growing dairy cattle consumed more TMR because they had no choice among the feeds offered. As a result, each feed consumed was uniform, definable, and as close as one can make a nutritionally complete diet. The TMR feeding is expected to be beneficial in raising growing dairy cattle.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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