EVALUATING THE IMPACT OF VARYING CONCENTRATE RATION LEVELS ON THE PERFORMANCE OF SAHIWAL HEIFERS DURING THE PRE-PUBERTAL PERIOD

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ABSTRACT: This study aimed to investigate the effects of varying levels of concentrate ration on the performance of Sahiwal heifers during the pre-pubertal period. The study examined several key parameters, including dry matter intake (DMI), daily weight gain (DWG), feed efficiency (FE), onset of puberty, body measurements (BM), and nutrient digestibility. The findings demonstrated significant differences among the different treatments and provided valuable insights into the impact of concentrate supplementation. Regarding DMI, the results indicated a variation ranging from 3.66±0.08 to 5.59±0.03 kg/heifer, which could be attributed to factors such as age, size, and weight of the heifers. In terms of DWG, heifers fed on a diet consisting of green fodder and 1% concentrate exhibited a higher average daily weight gain of 0.49±0.01 kg/calf compared to other treatments. FE was also influenced by the level of concentrate supplementation, with higher concentrations leading to improved efficiency. The provision of additional dietary protein was found to enhance feed efficiency by converting feed into available protein. The onset of puberty was significantly affected by the supplementation of green fodder with varying levels of concentrate. Delayed puberty was observed in Sahiwal heifers fed solely on ad-*libitum* fodder, indicating the importance of sufficient nutrient intake to meet the heifers' nutritional requirements. Body measurements (BM), including body length (BL), wither height (WL), and heart girth (HG), showed improvement in heifers fed on varying levels of concentrate. The digestibility of nutrients, including dry matter (DM), crude protein (CP), ether extract (EE), and ash, varied significantly among the different treatments. Overall, this study provides important insights into the effects of concentrate ration levels on the performance of Sahiwal heifers during the pre-pubertal period. These findings contribute to existing knowledge and can serve as a valuable resource for researchers, farmers, and stakeholders interested in optimizing the growth and development of Sahiwal heifers.

Keywords: concentrate ration, pre-pubertal period, dry matter intake.

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INTRODUCTION

Replacement heifers are potential assets for dairy farms, as they can replace older unproductive and uneconomical animals. If their potential is positive, they can contribute to genetic gain. However, heifer production is the costliest aspect of dairy farm operations, requiring significant inputs over a long period without immediate returns (Heinrichs *et al*., 1993). Cady and Smith (1996) reported that the growth rate of replacement heifers significantly impacts the economics of dairy farms, accounting for 60-70% of feed costs. Protein and energy are crucial nutrients that influence growth rate and early puberty in heifers. Additionally, minerals and vitamins are essential for accelerating growth and promoting early puberty in heifers. Implementing balanced feeding, improved management practices, and reducing disease incidence can help reduce the age at maturity and the age at first calving (Heinrichss and Heinrichs, 2005).

Studies conducted by Bashir (2006) and Rehman (2006) have shown that the age of puberty in local cows is 34 months, which is considerably higher than in exotic breeds such as Friesian, Jersey, and crossbred cows. Underfeeding and imbalanced feeding can lead to decreased growth at an early age, resulting in lower weight at puberty and increased age at calving. Nutrition plays a significant role in achieving appropriate body weight and reducing the age at puberty, showing a negative correlation with nutrition (Chaudhry *et al*.,

1988; Marston *et al*., 1995; Patterson *et al*., 1992; Schillo *et al*., 1992).

Bhatti *et al*. (2007) reported that Sahiwal heifers can attain puberty at 18 months with an average growth rate of 380 g/day. In Pakistan, heifers are typically raised on fodder with limited amounts of concentrate ration, which is low in protein and energy and high in fiber. This practice can hinder growth and have a negative effect on the age at puberty. Akayezu *et al*. (1994) observed a growth rate of 860 g/day in Holstein heifers when they were fed a ration containing 20% crude protein. Similarly, a study conducted by Chaudhry *et al*. (1988) revealed that the age at puberty was reduced by 8 months in buffalo heifers fed a ration with 15.4% crude protein. Another study by Rafiq and Chaudhry (2002) confirmed that supplementing concentrate with green fodder reduces the age at puberty in heifers and influences blood biochemistry, which serves as an indication of adaptability, clinical interpretation, and stress. Additionally, an increase in body measurements influenced by diet has a positive effect on achieving early puberty (Yanar *et al*., 1992).

The main objective of this experiment was to evaluate the effect of different levels of concentrate on the growth and puberty of Sahiwal heifers.

MATERIALS AND METHODS

Experimental Animals/Treatments: Sixty-three Sahiwal heifers, approximately 12-15 months old, were raised until they reached maturity. During the first 15 days, all animals underwent an adjustment period during which they were fed ad-libitum green fodder (maize, sada bahar, sorghum, millet, sarson, bersem oat) along with a concentrate ration fed at a rate of 0.5% of their body weight. The concentrate ration was formulated according to NRC (2001) guidelines, with a CP content of 14%, total digestible nutrients (TDN) of 65%, and metabolizable energy (ME) of 2810 Kcal. At the end of the adjustment period, the animals were regrouped and randomly assigned to one of three different treatments using a completely randomized design.

The three treatments were as follows:

I. Ad-*libitum* green fodder (GF) (control)
II. Ad-*libitum* green fodder + Concentrate mix (GF+CR@0.5%) fed at 0.5% of body weight
III. Ad-*libitum* green fodder + Concentrate mix (GF+CR@1%) fed at 1.0% of body weight

This trial continued until the heifer's reached puberty and conceived.

Health Control: A vaccination schedule (Table 4) was followed, and deworming was conducted at three-month intervals for each animal. All animals were kept under the same environmental conditions, provided with 36 sq. ft of space, and observed for any signs of abnormality or disease behavior, which were then treated accordingly.

Experimental Parameters

Dry Matter Intake (DMI): The feed (green fodder) offered and consumed was monitored daily. The leftover feed was collected the following morning and weighed to determine daily intake. The groups receiving the concentrate ration (GF+CR@0.5% and GF+CR@1%) were given the ration according to their body weight. Samples were collected and dried to calculate dry matter intake (DMI).

Feed Analysis: Samples of both concentrate and fodder were collected monthly for laboratory analysis of DM, CP, and ash content.

Daily Weight Gain: The animals were weighed at fortnightly intervals in all treatments, and weight gain was calculated accordingly.

Nutrient Digestibility: Digestibility studies were conducted after three months of the experiment. Fecal samples were collected over a period of three days at 6-hour intervals. Fifty grams of each sample were weighed and composited to form one sample per animal. The feed and fecal samples were oven dried at 60°C and stored at room temperature until further analysis (Ajmal *et al*., 2003).

Nutrient digestibility (%) = (Nutrient intake - Nutrient in feces) / Nutrient intake x 100

Feed Efficiency (FE): FE of each animal was calculated at the end of the experiment using the formula described by Tayeb *et al*. (1992):

Feed efficiency (FE) = weight gain (WG) / feed intake (FI)

Body Condition Score (BCS): BCS were monitored to observe the health and body condition of the heifers, following the method described by Heinrichs and Heinrichs (2005).

Body Measurements (BM): The following body measurements were recorded fortnightly:

a) **Wither Height (WH):** Measured (cm) from the top of the withers to the ground while the heifers were in a squarely standing position.

b) **Body Length (BL):** Measured (cm) from the shoulder to the pin bone.

c) **Heart Girth (HG):** Measured (cm) by taking the circumference of the chest area.

Statistical Analysis: The recorded data was subjected to statistical analysis using the analysis of variance technique (Steel *et al*., 1997). The differences between treatment means were tested using the Least Significant

Difference (LSD) method, employing appropriate statistical analysis software (SAS 9.1.3).

RESULTS

The effect of ad *libitum* green fodder with varying levels of concentrate on the performance of Sahiwal heifers during the pre-pubertal stage is presented in the following parameters.

The mean DMI of Sahiwal heifers fed GF, GF+0.5% CR, and GF+1% CR was 3.66±0.08, 4.67±0.09, and 5.59±0.03 kg/heifer, respectively (Table 4.3). The highest mean DMI was observed in heifers fed GF+1% CR, while the lowest DMI (3.66±0.08 kg) was observed in heifers fed GF. A significant difference (P<0.01) in DMI was found between heifers.

The ADG of heifers fed on GF, GF+0.5% CR, and GF+1% CR was 0.24±0.01, 0.35±0.01, and 0.49±0.01 kg/heifer, respectively. The highest WG was observed in heifers fed GF+1% CR (0.49±0.01 kg), while the lowest weight gain (0.24±0.01 kg) was observed in heifers fed GF (Table 4.3).

The BCS of heifers fed on green fodder and different levels of concentrate is presented in Table 4.3. The lowest BCS was observed in heifers fed GF (1.15±0.15), while better BCS were observed in the GF+1% CR treatment. There was no significant difference (P>0.05) in BCS among the different treatments.

Feed Efficiency (FE): The FE of Sahiwal heifers in the GF, GF+0.5% CR, and GF+1% CR treatments was 0.065, 0.083, and 0.087, respectively. A significant difference was observed among the different treatments (Table 4.3).

Digestibility of Nutrients: The digestibilities of nutrients (DM, CP, EE, and ash) are presented in Table 4.4. The dry matter digestibility was significantly different among Sahiwal heifers in the different treatments. The highest DM digestibility was observed in the GF+1% CR treatment, while the lowest was observed in the GF treatment.

Figuer 1. Body condition of heifers on treatment I, II and III, respectively (left to right).

Puberty

Age at Puberty: Sahiwal heifers fed on green fodder and 1% of concentrate ration reached puberty at 320 days of the experimental period, while those fed on 0.5% concentrate ration reached puberty at 400 days. The heifers fed green fodder (control) did not show signs of heat, except 33.3% of heifers showed estrus behavior at 450 days of the experimental period. In all treatments, heifers exhibited signs of estrus, including swollen vulva, mucous discharge, mounting activity, and acceptance by castrated bulls.

Body Weight at Puberty: Heifers fed on GF+1% CR attained a mature body weight of 290.5±15.2 kg, while those in the GF+0.5% CR treatment attained 286.5±16.7 kg of body weight. Heifers in the GF treatment had an average body weight of 270±18.9 kg. A statistically significant difference was observed among the treatments (Table 4.5).

Table 4.1: Composition of Concentrate Ration.

Ingredients	% Inclusion
Rapeseed Meal	17
Cottonseed cake	5
Maize gluten 30%	16
Maize grain	16
Wheat Bran	16
Rice polishing	13
Molasses	16
Mineral Mixture	1
Total	**100**
CP %	16.57
ME (Kcal/ Kg)	2810

Body Measurements (BM): The mean increase in WH of Sahiwal heifers in the GF, GF+0.5% CR, and GF+1% CR treatments was 12.83±0.27, 15.03±0.13, and 16.20±0.45 cm, respectively (Table 4.6). The total increase in body length was 15.97±0.27, 22.65±0.30, and 25.22±0.29 cm, while the mean increase in HG was

18.64±2.38, 40.41±1.34, and 41.17±2.20 cm in the GF, GF+0.5% CR, and GF+1% CR treatments, respectively. The mean BM showed a statistically significant difference ($P<0.05$) among the different treatments.

Table 4.2: Chemical composition of fodder and concentrate supplement fed to heifers on varying levels of concentrate.

	Composition %				
Particulars	**DM**	**CP**	**EE**	**CF**	**Ash**
Fodder	26.04 ±2.08	8.95±2.08	2.14±1.93	23.54±2.08	1.37± 1.94
Concentrate	93.05 ± 1.41	14.04± 0 .97	2.51± 0.78	21.91 ± 1.73	1.98 ± 0.88

Table 4.3: Mean dry matter intake, weight gain, feed efficiency and body condition score .

Treatments	DMI (Kg)	WG (Kg)	FE	BCS
GF	3.66^{a}±0.08	0.24^{a}±0.01	0.065^{a}	1.15^{a}±0.15
GF+0.5%CR	4.67^{b}±0.09	0.35^{b}±0.01	0.074^{b}	2.17^{b}±0.12
GF+1%CR	5.59^{c}±0.03	0.49^{c}±0.01	0.087^{c}	2.98^{c}±0.10

Green fodder=GF, CR=Concentrate ration
Mean having different superscripts in a column are significantly different

Table 4.4: Effect of different level of concentrate on nutrient digestibility (Mean ± SE).

	DM	CP	EE	Ash
GF	53.67^{a}±0.19	67.09^{a}±0.22	78.34^{a}±0.45	65.23^{a}±0.27
GF+0.5%CR	63.42^{b}±0.41	72.45^{b}±0.17	70.23^{b}±0.26	69.03^{b}±0.36
GF+1%CR	65.28^{b}±0.27	73.21^{b}±0.12	72.19^{b}±0.32	71.02^{b}±0.44

Green fodder=GF, CR=Concentrate ration
Mean having different superscripts in a column are significantly different

Table 4.5: Attainment of puberty and Estrus symptoms in Sahiwal heifers.

Parameter	GF	GF+0.5%CR	GF+1%CR
No. Of animals	23	23	23
No. Of experimental days	450^{c}	400^{b}	320^{a}
Heifers got pregnant	7	21	19
Weight at puberty (60-70 % of mature BW)	260^{a}±17.4	286.5^{b}±16.7	290.5^{b}±15.2
Conception %	35	91.30	82.60
Heifer attaining puberty early then control	-	50 days	130 days
Body weight at first breeding	273^{a}±18.9	298^{b}±17.9	300^{b}±15.8
Service per conception	1.87^{a}±0.13	2.05^{b}±0.17	2.11^{b}±0.19
Estrus Sign			
Swollen vulva	Yes	Yes	Yes
Mucous discharge	Yes	Yes	Yes
Bellowing	Yes	Yes	Yes
Mounting activity	Yes	Yes	Yes
Reduce intake	Yes	Yes	Yes
Castrated bull	Yes	Yes	Yes

Green fodder=GF, CR=Concentrate ration
Mean having different superscripts in a row are significantly different

Table 4.6: Mean Increase in body measurements (cm) of Sahiwal heifers.

Treatments	Wither Height (WH)	Body Length (BL)	Heart Girth (HG)
GF	12.83^{a}±0.27	15.97^{a}±0.27	18.64^{a}± 2.38
GF+0.5%CR	15.03^{b}±0.13	22.65^{b}±0.30	40.41^{b}± 1.34
GF+1%CR	16.20^{c}±0.45	25.22^{c}±0.29	41.17^{c}± 2.20

Green fodder=GF, CR=Concentrate ration
Mean having different superscripts in a column are significantly different

DISCUSSION

The discussion focuses on the effect of varying levels of concentrate ration on the performance of Sahiwal heifers during the pre-pubertal period. Several previous studies are referenced to support the findings of the current study.

The study found a significant difference in DMI among the different treatments. The variation in DMI could be attributed to factors such as age, size, and weight of the heifers. Similar findings were reported by Baruah *et al*. (1993) and Ahmad *et al*. (2004) in buffalo heifers, where an increase in body weight was associated with increased CP intake and improved growth rates.

Heifers in the GF+1% CR treatment showed a higher DWG compared to the other treatments. The improved growth rate in heifers supplemented with concentrate is consistent with findings from previous studies by Choi *et al*. (1997), Jin *et al*. (2004), Yambayamba and Price (1997), Peri *et al*. (1993), Park *et al*. (1998), Ford and Park (2001), and others. These studies also reported that dietary treatments have an impact on growth and the onset of puberty.

The study observed that FE improved as more concentrate was provided to the heifers. This improvement in FE could be attributed to the availability of surplus protein and nutrients, which are converted into available protein and enhance FE. Similar findings were reported by Tayeb *et al*. (1992) and other studies, which found that supplementation with a high level of concentrate improves feed efficiency.

The study found that green fodder with varying levels of concentrate significantly influenced the onset of puberty in Sahiwal heifers. Delayed puberty in heifers fed ad *libitum* fodder could be attributed to inadequate nutrient intake. Similar findings were reported by Saleem and Rehman (1989) and NRC (2001), which highlighted the influence of nutrient intake on the weight at puberty in local cattle. Concentrate feeding before the onset of puberty was found to reduce the age at puberty in Nili-Ravi buffalo heifers (Chaudhry *et al*., 1988).

The study observed improvements in BM, such as BL, WH, and HG, in heifers fed varying levels of concentrate. This improvement could be attributed to the supply of nutrients from the concentrate ration, which contributed to both the maintenance of body requirements and structural development. While the findings of the current study align with those of Tayeb *et al*. (1992) and Yanar *et al*. (2002a), contrasting results were reported by Zanton and Heinrichs (2007) and Bascom and James (2007), suggesting that the effects on body measurements can vary depending on dietary treatments and other factors.

The study found significant differences in the digestibility of DM, CP, EE, and ash among the different treatments. The higher digestibility observed in the present study could be attributed to the adaptability of Sahiwal heifers to utilize a high-concentrate ration. This finding contrasts with the results reported by Jabbar *et al*. (2000) in Sahiwal heifers, where no significant differences were observed in nutrient digestibility among different energy diets.

Overall, the discussion provides a comprehensive analysis of the study's findings in relation to previous literature. It highlights the positive effects of concentrate supplementation on DMI, DWG, FE, onset of puberty, BM and nutrient digestibility in Sahiwal heifers during the pre-pubertal period. The findings of the current study are consistent with previous research, indicating that concentrate supplementation can lead to improved performance and growth in heifers.

However, it is important to note that there were also some contrasting results reported in the literature. For example, some studies did not find significant effects of concentrate intake on certain parameters, such as feed efficiency or body measurements. These discrepancies could be attributed to variations in dietary treatments, ingredient composition, and feed formulations across different studies.

The discussion emphasizes the relevance of the current study's findings and their alignment with existing knowledge. It highlights the potential benefits of concentrate supplementation in enhancing dry matter intake, weight gain, feed efficiency, onset of puberty, body measurements, and nutrient digestibility in Sahiwal heifers. The inclusion of references to previous studies adds credibility to the discussion and allows readers to further explore the topic.

In conclusion, the discussion provides a comprehensive overview of the effect of varying levels of concentrate ration on the performance of Sahiwal heifers during the pre-pubertal period. It presents the findings of the current study in the context of previous literature, highlighting the similarities and differences observed. This discussion contributes to the existing body of knowledge on the topic and can serve as a valuable resource for researchers, farmers, and other stakeholders interested in optimizing the growth and development of Sahiwal heifers.

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