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Effect of age on feed efficiency and carcass yield characteristics of indigenous bull

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Abstract

The study was conducted with the objectives to understand the effect of age of native Pabna bulls on feed conversion ratio (FCR), digestibility and carcass yield characteristics. Fifteen Pabna bulls having five in each age groups of 6 to12, 13 to 24 and 25 to 36 months were fed *ad libitum* mix silages of Splendida (*Setaria splendida*) and Andrpogan (*Andropogon gyunus*) grasses (1:1 fresh) and supplemented with a concentrate mixture at 1% of live weight (LW) for a period of 72 days. With the increase of age, and subsequently LW (initial LW: 98.2, 182.6 and 288 kg, respectively), there was significant decrease in dry matter (DM) intake as % LW (<0.05; 2.94, 2.61 and 2.36, respectively) and increased daily gain (<0.01; 294, 519 and 597 g/d, respectively). However, the feed conversion ratio (FCR) (>0.05; 10.88, 10.10 and 12.24, respectively) and DM digestibility (>0.05; 51.0, 48.1 and 49.1 %, respectively) of bulls were remained unchanged. In case of carcass yield characteristics, significantly lower yield grade (<0.01; 1.79, 1.27 and 0.20, respectively) of bulls of 25 to 36 years produced higher closely trimmed boneless retail cuts (CTBRC) (<0.01; 50.47, 51.64 and 54.14 %, respectively), retail cut (<0.01; 76.14, 78.55 and 83.48 %, respectively) and meat quality index (MQI) (<0.01; 67.28, 67.89 and 69.07, respectively) compared to younger bulls. It may, therefore, be recommended that beef cattle farming with native Pabna bulls of 24 to 36 months will give more daily LW gain and produce more CTBRC at a similar FCR compared to younger ones.

Key words: Pabna bulls, age, feed conversion ratio, yield grade, meat quality index

Introduction

Beef cattle fattening in Bangladesh is a growing business and contributing to fight the rising demand for high-protein foods of the country. It also plays a significant role in enhancing food security, providing households with employment, investment opportunity, and manure for sustainable agriculture. About 24.5 million cattle heads are distributed throughout the country which ranks 12th in the world and 3rd in Asian countries (FAO, 2010). Although the growth of livestock production is the second highest among all other sub-sectors of agriculture in Bangladesh (BER, 2012), the consumption of meat and other livestock products is still lower than requirement. The daily per caput requirement of meat is 120 gm, whereas the availability is 102 gm (BER, 2013). The demand for beef cattle increases several times higher during the holy Eidul-Azha festival. In that time, about 1.8 million of cattle are slaughtered to meet the demand (Sujan *et. al.,* 2011). To satisfy this requirement, beef fattening enterprise is still growing up in the country. However, the profitability of a beef cattle fattening enterprise is not only determined by the cost of feed, market price and demand of meat but also the yield and quality of beef carcass produced.

The yield and quality of beef carcass are two important determinants of profitability of beef cattle farming. The United States Department of Agriculture (USDA, 1996) yield grade (YG) of beef carcass is a tool to predict sub-primal yields, closely trimmed boneless retail cuts (CTBRC), and meat quality index (MQI) of cattle. The lower the YG, the higher the expected yield of CTBRC, and consequently the higher the profitability. Therefore, YG is an important marketing tool of beef cattle farmers. The YG is assessed on a scale of 1 to 5, with YG 1 considering the best because there is more muscle relative to fat. The YG of beef cattle depends on the longssimus muscle area (LMA), back fat thickness (BFT, fat thickness

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in LMA), fat contents in or around kidney pelvic and heart regions (KPH), and hot carcass weight (HCW) of cattle. The age, live weight (LW), breed, sex and plane of nutrition of cattle are the factors determining the proportions of muscle, fat and bone of a carcass. It was reported by Steen and Kilpatrick (1995) that with the increase of slaughter weight due to age, carcass fatness increases which reduce meat and bone ratio and meat proportion in high-priced joints of bulls and heifers. The dietary intake, daily gain, and feed conversion ratio (FCR) are also affected with the increase of age. It was reported that calves (8 months) had daily live weight (LW) gains of 1090 g with FCR of 9.20 with YG of 2.47, while the same for the yearling bulls (13 months) were 1266 g, 10.1 and 2.54, respectively (Neumann and Lusby, 1986) under the same plane of feeding and management. The paucity of all those information on native cattle of Bangladesh often confuses farmers for the selection of a suitable age group of animals for fattening. Keeping all those factors in consideration the present study was undertaken with the following objectives:

1) To determine the differences in intake, digestibility and growth performances of indigenous bulls of different age.
2) To determine their carcass yield characteristics and meat quality index (MQI) at different age.

Materials and methods

Selection of bulls

Three age groups of bulls of Pabna cattle, a native genotype of cattle in Bangladesh, such as 6 to 12, 13 to 24 and 25 to 36 months, having five bulls in each were selected and housed individually in cattle research station of Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka. Bulls were dewormed by drenching according to prescribed doses of Endex (NOVARTIS), a commercial anthelmentic drug containing Levamisole Hydrochloride and Triclabendazole by 7.5 mg and 12 g, respectively in 100 g bolus, kept 15 days for adaptation. Initial weights of the bulls were taken, and dividing them into three age groups feed were supplied and refusals were collected individually.

Feeding management of bulls and collection of samples

Mixed grass silage, at an equal ratio on fresh basis, of mature Splendida (*Setaria splendida*) and Andropogan (*Andropogon gyunus*) was fed *ad libitum* to the native bulls. All the animals were supplemented with a conventionally mixed concentrate mixture at the rate of 1.0% of LW. The composition of concentrate mixture and the chemical composition of mixed silage and concentrate mixture are presented in Table 1. The daily allowance of mixed silage and concentrate were divided into equal two parts and supplied at 08:00 and 16:00 coordinated universal time (UTC). Fresh and clean water was available at all times. The supply and refusals of silage were weighed daily throughout the growth period and representative samples of them were collected and stored in deep freeze (-20°C) for the determination of chemical composition. The bulls were weighed fortnightly for a total growth period of 72 days and at the end a 7 days digestibility trial was conducted while offered and refused feed, dung production and the representative samples of feed, refusals, and dung were collected and stored in deep freeze (-20°C) for chemical analyses. The dry matter and protein of fresh samples of feed, refusals and feces were determined at least in three out of 7 days' collection period. Feces and refusal samples, collected and kept frozen for 7 days, were thawed, and seven days samples of each bull were mixed thoroughly and a composite sample was taken for analyses of the chemical composition.

Analysis of samples

The dry matter (DM), organic matter (OM) and crude protein (CP) was determined according to AOAC (2004); and acid detergent fiber (ADF) was determined according to van Soest (1991) and results were expressed inclusive of ash.

Slaughtering and carcass yield characteristics of bulls

Three bulls from each of three age groups were randomly selected for slaughtering to determine the carcass yield characteristics and primal cuts. Bulls were fed for three days more to allow slaughtering and carcass evaluation of three bulls daily having one from each group. They were

kept 24 hours fasting and slaughtering according to halal method and fasted body weight were taken. The weight of body organs (blood, head, skin, spleen, heart with and without fat, kidney and kidney knob, pelvic fat, visceral fat, lung, liver, digestive tract with content, rumen with and without its contents) were weighed using digital scale and recorded. Hot carcass weight (HCW) of bulls was recorded immediately after dressing and removal of offal parts. The internal fat contents in or around kidney, pelvic and heart regions (KPH) were weighed and expressed as % HCW. The longssimus muscle area (LMA) was measured by splitting the carcass between 12^{th} and 13^{th} ribs and using a grid calibrated in square cm. Back fat thickness (BFT) was measured in mm using a caliper by averaging three points between the 12th and 13^{th} ribs over the LMA. The yield grade (YG) of carcass was calculated according to United States Department of Agriculture (USDA, 1996) using the following equation:

YG = 2.5 + (2.5 x BFT) + (0.20 x KPH) – (0.32 x LMA) + (.0038 x HCW)

YG: Yield grade (%)

BFT: back fat thickness (inch)

KPH: fat contents in or around kidney, pelvic and heart regions (%)

LMA: longssimus muscle area (square inch)

HCW: hot carcass weight (lb)

The MQI was determined according to MAF (1996) by using the following equation:

MQI = 65.834 - (0.393 x BFT) + (0.088 x LMA) - (0.008 x HCW)

MQI = Meat quality index (%)

BFT: back fat thickness (mm)

LMA: longssimus muscle area (square cm)

HCW: hot carcass weight (kg)

Statistical analysis

Data of different age groups on feed utilization, growth efficiency or carcass characteristics were analyzed for determining significant differences in treatment responses with a simple design using computer software of General Linear Model of SPSS-11.5.

Results and Discussion

Intake of nutrients and live weight gain of bulls

The intake of dietary nutrients and LW gain of bulls are presented in Table 2. The daily DM intake of different age groups either from mixed silage or from concentrate increased significantly ($p<0.01$) with the increase of age of bulls, and total DM intake varied from 3.20 kg in the youngest to 7.31 kg in the oldest group. However, dietary DM intake in % LW decreased significantly ($P<0.05$) with the increase of age or LW. The dietary DM intake per kg metabolic LW of bulls in different groups did not differ ($p>0.05$). The intake of CP, ADF and ME was increased significantly from the youngest to the oldest group as a consequence of increased DM intake with the increase of age or LW. The daily gain of bulls was found to increase from 294 to 597 g/d in the youngest to the oldest group and the difference due to increase of age was significant (<0.01). However, the FCR of the three age groups did not differ ($P>0.05$).

Table 1. Composition of mixed silage and concentrate mixture

Ingredients of concentrate mixture (% fresh)	**Mixed silage**	**Concentrate mixture**
Wheat bran	-	57
Khesari bran	-	24
Til oil cake	-	12
Soybean meal	-	3
Fish meal	-	1
Oyster shell powder	-	2
Dicalcium phosphate	-	0.5
Common salt	-	0.5
Chemical composition (%DM)		
DM (% fresh)	22.2	90.5
OM	93.8	92.4
CP	8.3	15.5
ADF	59.39	28.4

According to BSTI (2008), the daily DM requirement of a bull of 100 kg LW with 250 to 750 g/d gain may range from 2.6 to 3.2 kg/d, and a bull of 300 kg with similar gain may range from 6 to 7.4 kg/d. Therefore, the daily dietary DM intake of bulls of different age groups (3.2 to 7.31) was sufficient. With the increase of age or LW, feed intake increases to satisfy the nutrient requirements of different metabolic sizes of animals. Neumann and Lusby (1986) reported that animals of higher LW due to age differences required a higher amount of feed, even to attain at constant weight gain. It was also reported in BSTI (2008) that DM intake of a bull on % LW decreases with the increase of LW: the DM requirement of a bull of 100 kg LW with 0 to 0.75 kg/g gain may range from 2.4 to 3.2 % of LW while that of a bull of 300 kg LW may range from 1.7 to 2.4 % of LW. No significant difference (>0.05) in DM intake per kg metabolic LW if bulls of different age groups indicates that the biological capacity of animals for feed intake was similar for all age groups and LW. Huque and Sultana (2005) in their review report on feeding of feedlot beef cattle found a linear relation (r^2=0.565) between daily DM intake and live weight of animals when other factors related to feeding systems or types and quality of feeds, composition of diets, and physiological stages and genotypes of feedlot beef cattle were ignored, and the equation derived gave an average DM intake of 2.06 Kg for 100Kg live weight. Similar to DM intake, the daily intake of CP of bulls of all age groups were sufficient to support their maintenance and production requirements. According to BSTI (2008), the daily CP requirement of a bull of 100 kg LW with 250 to 750 g/d gain may range from 306 to 448 g/d, and that of a bull of 300 kg with similar gain may range from 588 to 753/d. Therefore, it may be said that the CP intake of bulls of all age groups was sufficient for their maintenance and production. The FCR of feedlot beef cattle did not depend on LW of cattle, and it varied from 5.93 to 10.1 (Neumann & Lusby, 1986; Kim *et al*., 2004; Milton *et al.*, 1994a and 1994b; Rush *et al.*, 1994; Reinhardt *et al*., 1993; Vieselmeyer *et al*., 1996). Huque and Sultana (2005) found a logarithmic relation with a coefficient (r) of 0.88 between the LW of indigenous bulls and their daily gain without considering the possible effects due to variations in dietary composition and age, management or genetics of the animals of feedlot beef cattle in the temperate regions.

Digestibility of nutrients

The digestibility of nutrients in different age groups is presented in Table 3. There was no effect of age on the digestibility of DM, OM, CP or ADF of the diet. The range of DM digestibility of the diet of this study (48.1 to 51.0 %) was found lower than that of a Napier silage (*Pennisetum purpureum*) based diet supplemented with a concentrate mixture of similar level (52.3 to 60.3 %), as reported by Islam et *al.* (2002).

Table 2. Intake of nutrients and LW gain of bulls of different age groups

Items	Age of bulls (months)			SED	*P* values
	6 to 12	13 to 24	25 to 36		
Initial LW, kg	98.2[a]	182.6[b]	288.0[c]	17.96	<0.01
Final LW, kg	119.4[a]	220.0[b]	331.0[c]	4.52	<0.01
DM intake from silage, kg/d	1.97[a]	3.140[b]	4.13[c]	0.47	<0.05
DM intake from concentrate, kg/d	1.23 [a]	2.1 [b]	3.17 [c]	0.21	<0.01
Total DM intake, kg/d	3.20[a]	5.24[b]	7.31[c]	0.64	<0.01
Total DM intake, % LW	2.94 [b]	2.61 [b]	2.36 [a]	0.14	<0.05
Total DM intake, g/kg $W^{0.75}$	95.0	98.1	99.1	6.14	NS
CP intake, g/d	353.8[a]	584.4[b]	832.1[c]	69.9	<0.01
ADF intake, kg/d	1.52[a]	2.46[b]	3.35[c]	0.33	<0.01
LW gain, g/d	294[a]	519[b]	597[c]	69.99	<0.01
FCR	10.88	10.10	12.24	0.94	NS

SED, standard error difference; *P* >0.05, not significant (NS); DM, dry matter; LW, live weight; CP, crude protein; ADF, acid detergent fiber; FCR, feed conversion ratio.

Table 3. Digestibility of nutrients (%)

Parameters	Age of bulls (months)			SED	*P* values
	6 to 12	13 to 24	25 to 36		
DM	51.0	48.1	49.1	3.55	>0.05
OM	54.4	52.6	53.5	3.97	>0.05
CP	63.9	65.4	66.86	3.89	>0.05
ADF	46.3	43.9	44.7	4.46	>0.05

SED, standard error difference; *P* >0.05, not significant (NS); DM, dry matter; OM, organic matter; CP, crude protein; ADF, acid detergent fiber.

Carcass yield characteristics and quality of meat

The carcass yield characteristics and MQI of bulls of different age groups are presented in Table 4. With the increase of age or LW the HCW, LMA, BFT, CTBRC and MQI were increased significantly (<0.01) with a decrease in YG (<0.01) while there was no change in DP and KPH of bulls. The dressing percent (DP) of bulls was 45.7, 46.6 and 49.4 %, respectively in the youngest to the oldest group; and it, even at the oldest group, was lower than that of the feedlot beef cattle (55.1 to 65.5; Coleman *et al.*, 1995; Neumann & Lusby, 1986; Kim *et al*., 2004). Huque and Sultana (2005) reported an average DP of 58.53 of feedlot beef cattle fed with high quality roughage and grain based concentrate at a minimum ratio of 1:1. The bulls of the present trial were fed with a diet of low quality mixed silage of mature grasses and concentrate mostly based on grain by-products at a ratio of 3:2. LMA is a good predictor of carcass growth. Huque and Sultana (2005) in their review on feedlot cattle showed that LMA of indigenous bulls was more linearly related with the rate of gain (r^2=0.9246) than the LW (r^2=0.4168). Purchas *et al*. (2002) showed that LMA of feedlot Angus beef cattle increased from 48.4 cm^2 at weaning to 80.6 cm^2 at yearling age; and the rate of increase, however, declined as bulls increased in weight. The BFT and KPH represent the external and internal fat contents of a carcass. Higher BFT and KPH increase the YG (USDA) and subsequently reduce the expected amount of retail cuts from a carcass. It was reported that KPH of feedlot bulls increased linearly with the increase of LW (Lunt *et al*., 1985; Coleman *et al*., 1995; Crouse *et al*.; 1989). Preston (1971), Reid (1971) and Coleman *et al*. (1995) reported LW as one of the most important factors that affect body composition in cattle. However, types of fat (BFT or KPH) grow independently (Rouse *et al.*, 2003), and intramuscular fat are more dependent on age than weight. BFT, The LMA, HCW; and KPH determine USDA YG of a carcass. Of these, fat thickness has the largest effect followed by LMA. The calculated YG of the three age groups was 1.79, 1.27 and 0.20, respectively, and the oldest bulls yielded significantly (<0.01) lower value.

Table 4. Carcass characteristics of bulls of different age groups

Parameters	Age of bulls (months)			SED	*P* values
	6 to 12	13 to 24	25 to 36		
LW at slaughter, Kg	126.0 [a]	206.3[b]	328.3[c]	20.32	<0.01
HCW, Kg	57.4 [a]	96.5 [b]	162.0 [c]	10.97	<0.01
DP, %	45.7	46.6	49.4	2.99	NS
LMA, cm^2	28.5 [a]	46.6 [b]	78.53 [c]	3.63	<0.01
BFT, mm	1.52 [a]	3.22 [b]	6.06 [c]	0.22	<0.01
KPH%	1.71	1.99	1.92	0.18	NS
YG	1.79 [c]	1.27 [b]	0.20 [a]	0.09	<0.01
CTBRC, %	50.47 [a]	51.68 [b]	54.14 [c]	0.21	<0.01
Retail cut, %	76.14 [a]	78.55 [b]	83.48 [c]	0.43	<0.01
MQI	67.28 [a]	67.89 [b]	69.07 [c]	0.16	<0.01

SED, standard error difference; *P* >0.05, not significant (NS); LW, live weight; HCW, hot carcass weight; DP, dressing percent; LMA, longssimus muscle area; BFT, back fat thickness; KPH, kidney pelvic and heart fat; YG, yield grade; CTBRC, closely trimmed boneless retail cuts; and MQI, meat quality index.

The USDA yield grade ranges from 1.0 to 5.0; and the reason for significant (<0.01) decrease of YG with the increase of LW was due to increase (<0.01) of LMA without proportional development of BFT, KPH and HCW. The plane of nutrition might not favor fat deposition. The diets of bulls irrespective of age were composed of mixed silage of mature grasses (56 to 62 % of diets; Table 2) and concentrate mixture of mostly brans (81 %) without grain (Table 1). Geay and Robelin, (1979), and Price *et al*. (1984) showed that diets influence fat deposition independent of the effects of LW, causing cattle fed different diets to vary in carcass fatness even at similar degrees of maturity. The tendency for fat deposition in cattle with tropical inheritance was found lower than that with the temperate ones (Crouse *et al.*,1989). Significantly lower YG (<0.01) and higher CTBRC and MQI (<0.01) in the oldest group of bulls indicate that bulls of 25 to 36 years old might give better carcass yield under same feeding and management condition.

Conclusion

It was found that the Pabna bulls of 25 to 36 months old had a higher daily LW gain in a similar FCR and digestibility compared to younger groups. In case of carcass yield characteristics, bulls of 25 to 36 years group produced significantly lower YG (P<0.01), higher CTBRC, retail cuts and MQI compared to younger ones. It may, therefore, be recommended that beef cattle farming with indigenous Pabna bulls of 24 to 36 months may be more profitable compared to younger ones.

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