Journal of Animal and Veterinary Advances 11 (20): 3732-3737, 2012
ISSN: 1680-5593

Carcass Merits, Chemical Composition and Physical Properties of Beef under Unconventional Fattening Regimen

[1, 2]A.S. Sami, [2]Amal K. El-Asheeri and [2]M.A. Radwan
[1]Department of Animal Production, College of Food and Agricultural Sciences,
King Saud University, P.O. Box 2460, 11451 Riyadh, Saudi Arabia
[2]Department of Animal Production, Faculty of Agriculture, Cairo University,
Gamaa Street, 12613 Giza, Egypt

Abstract: This study aimed at studying the effect of replacing concentrates with corn silage on the carcass and meat quality traits of fattening calves. Twenty four calves of Egyptian Baladi cattle (local breed), 1 year of age and initially weighed 245±2.46 kg were randomly assigned to three equal groups (n = 8 each); Control (C) group that fed Concentrate Feed Mixture (CFM) and rice straw, the second and the third groups were fed CFM and corn silage at ratio of 50:50 (T1) and 25:75 (T2), respectively. After 7 months, five animals per each group were randomly selected for slaughtering. No significant differences among the three groups of carcass merits regarding the proportion of fore and hind quarters, eye muscle area, physical components of best ribs and meat/bone ratio. Also, lean contents of protein, intramuscular fat, moisture and collagen did not significantly differ. Shear force values, cooking loss percentage, expressible fluid percentage, color and pH after 3 and 24 h were not affected by silage replacements. This study indicated that utilizing corn silage instead of concentrate fed mixture either by 50 or 75% in the fattening ration of Baladi calves did not adversely affected the carcass and meat quality merits. These results may allow beef producers to produce meat with the same quality, low costs and consequently low prices compared to the existing traditional beef production systems.

Key words: Carcass, silage, chemical, physical, meat

INTRODUCTION

Baladi cattle (*Bos indicus*) are the local breed reared in Egypt. Their cows characterized with its low milk production. Therefore, the main utilization of Baladi cattle in Egyptian agriculture matrix is providing red meat at the local level. These cattle contribute with 60% of total production of red meat at the national level. The meat of Baladi bullocks is the most acceptable and demanded by the Egyptian consumers due to its tenderness and flavor.

It is calculated that feeding is the major and expensive (86-93%) variable factor of running costs in the feedlot enterprises (Alsheikh *et al*., 2004; El-Asheeri *et al*., 2008). This high percentage represents a considerable constrain for beef industry under the recent global trend in increasing grains price and economic crisis. Replacing concentrate feed mixture with other feedstuffs to minimize feeding costs, emphasizing on corn silage is recently adopted by beef producers. Several trials were conducted to feed beef cattle (completely or partially) on corn silage (Sami *et al*., 2004; Cozzi *et al*., 2005). However, such fattening practices of Baladi calves on corn silage are not common in Egypt. Therefore, the present study was designed to test the effect of replacing concentrate feed mixture with 50 or 75% corn silage on the carcass merits, chemical composition and physical properties of fattening Baladi calves.

MATERIALS AND METHODS

Animals and feeding system: Twenty four Baladi calves (*Bos indicus*), 1 year of age were purchased from the local market to be used in the present study. Animals treated upon purchasing against internal and external parasites. Animals were randomly divided into three equal groups (n = 8); first group was fed Concentrate Feed Mixture (CFM) plus rice straw and served as Control (C). Second and third groups were fed on CFM and corn silage at ratio of 50:50 (T1) and 25:75 (T2), respectively. They initially weighed 243±2.8, 248±2.8 and 245±3.3 for C,

Corresponding Author: A.S. Sami, Department of Animal Production, College of Food and Agricultural Sciences,
King Saud University, P.O. Box 2460, 11451 Riyadh, Saudi Arabia

T1 and T2 groups, respectively. Calves were fed individually according to NRC (1996) requirements twice daily for 7 months.

Slaughter and carcass traits: At the end of the experiment, five calves per group were randomly chosen to be slaughtered according the Islamic rules. Final body weights (436±2.8, 432±4.9 and 431±3.1 kg) and hot carcasses weights (248±3.6, 244±4.4 and 240±4.0 kg) for C, T1 and T2 groups, respectively (Sami *et al*., 2012). The left side of each carcass was cut between the 8th and 9th rib into two quarters, fore and hind and weighed to calculate their proportion to the carcass. Best ribs (9, 10 and 11th ribs) were separated from the left side and weighed fresh. Best ribs were chilled at 4°C for 24 h afterwards, they were weighed again before dissecting into bone, lean and fat tissues. Eye muscle (Longissimus Dorsi, LD) area (cm^2) between the 9th and 10th rib was estimated by planimeter.

Lean chemical composition: Moisture, protein, fat and collagen contents of the LD muscle were estimated using Food Scan Pro meat analyzer (Foss Analytical A/S, Model 78810, Denmark). According to the manufacturer's instructions about 50-100 g of raw meat (obtained from the 9th rib) were minced and put in the meat analyzer cup. The cup was inserted into the meat analyzer for scanning sample with infra red to determine the chemical components.

Physical properties: Meat pH value was measured after 3 h postmortem and 24 h postmortem using 5 g from the LD muscle of meat according to the following methodology described by Abdel-Aziz (2006). Samples were minced and put in graduated glass beaker before filling the beaker with distilled water up to 50 mL. The mixture (meat and water) was shacked. The pH value of the obtained suspension was measured by pen pH meter (pH ep, HI 96107, Hanna instruments, Italy). Expressible fluid percentage was measured by placing about 0.3 g of lean (W1) on a filter study (Whatman No. 1) and then subjected to a pressure of 1000 g for 10 min. The sample was reweighed (W2) and the expressible fluid was estimated as the difference between the two weights divided by W1 multiplied by 100.

Cooking loss percentage was determined using 2 cubes of meat (about 100 g, W1). The samples were boiled in saline (0.09% NaCl) for 45 min and then were left to be cool at room temperature. Sample was reweighed (W2) to calculate the cooking loss percentage as the difference between W1 and W2 divided by W1 multiplied by 100.

The cooked samples were used for determining the shear force (kg/cm^3). Samples were kept in refrigerator (4-5°C) for about 12 h before estimating shear force using Instron Universal Testing Machine (Model 2519-105, USA). Six cores from each sample were taken using cylinder of 0.5 inch in diameter. Cores were removed parallel to the longitudinal orientation of muscle fibers. The shear force machine was adjusted at crosshead speed of 200 mm min^{-1} according to the procedure outlined by Shackelford *et al*. (2004).

Meat color was measured using croma meter (Konica Minolta, Model CR 410, Japan) calibrated with a white plate and light trap supplied by the manufacturer. Color was expressed using the CIE L*, a* and b* Color System (CIE, 1976). A total of three spectral readings were taken for each sample on three locations of the muscle. The L* (brightness) values measure (higher L* value indicates a white color while lower L* value indicates a black color); a* values measure redness (positive a* value indicates a reddish color while negative value measures greenish) and b* values measure yellowness (positive b* value indicates a more yellowish color while negative value measures bluish).

Statistical analysis: Data were analyzed using the General Linear Model of SAS (2002) as a one way analysis of variance. Duncan's multiple range was used to determine the significant differences among means ($p<0.05$).

RESULTS AND DISCUSSION

Carcass traits

Fore and hind quarters, eye muscle area and best ribs components: Results presented in Table 1, indicated that there is no significant difference among the studied groups regarding fore and hind quarters proportions, eye muscle area, percentages of physical components of best ribs (lean, bone and fat) and meat/bone ratio. Fore-quarters represented about 49% while the hind one

Table 1: Percentage of Fore (FQ) and Hind Quarter (HQ), eye muscle area, physical components of best ribs (9, 10 and 11th ribs) and meat to bone ratio of Baladi calves fattened on concentrate feed mixture (C), concentrate feed mixture and corn silage at 50:50 (T1) and 25:75 (T2)

Traits	C	T1	T2	p-value
n	5	5	5	-
FQ (%)	49.2±0.3	49.3±0.6	49.5±0.7	0.99
HQ (%)	50.8±0.3	50.7±0.6	50.5±0.7	0.99
Eye muscle area (cm^2)	71.1±5.0	65.8±4.7	70.0±3.8	0.70
Best ribs physical component (%)				
Lean	61.5±1.6	61.9±1.3	64.6±1.5	0.56
Bone	18.3±1.7	17.4±1.5	18.2±1.2	0.25
Fat	20.2±2.6	20.7±0.7	17.2±2.0	0.39
Meat/bone ratio	4.6±0.4	4.9±0.5	4.6±0.4	0.83

represented 51%. The obtained results of fore and hind quarters agreed with findings of Sami (2001) and El-Asheeri (2009) on Baladi bullocks slaughtered between 400 and 450 kg. They reported a range of 49.1-50.7 and 49.3-50.9% for fore and hind quarters, respectively. Results obtained from the studies on Friesian calves reared under Egyptian conditions indicated higher proportion of fore than hind quarters (Soroor, 1993) with a difference of about 10%.

Eye muscle area of T1 was smaller than the two other groups. It was less than C and T2 groups by 5.3 and 4.2%, respectively. Insignificant difference in eye muscle area of the three groups agreed with the findings of Loerch and Fluharty (1998), Rossi and Loerch (2001) and El-Asheeri *et al.* (2008) who reported that feeding system has no effect on eye muscle area. The present range of eye muscle area (65.8-71.1 cm^2) is close to that reported by Sami (2001) and El-Asheeri (2009) (62.9-72.9 cm^3) in their studies on Baladi calves while less than that reported for bullocks of beef breeds (77.3-98.7 cm^2) as reported by Page *et al.* (2001) and Punchas *et al.* (2002). The difference in eye muscle area of Baladi bullocks compared to beef breeds is due to age and weight at slaughtering and/or animal genotype (Owens and Gardner, 2000; Page *et al.*, 2001; Punchas *et al.*, 2002).

Comparing the physical components of best rib of the three groups showed that the percentage of bone was similar in the three groups meanwhile lean percentage was higher compared to C group. A reverse trend was observed in fat percentage where it was higher in C group. The insignificant difference between the two groups (C vs. T2) in lean and fat percentages was 3.1%. The higher percentage of the dissected fat in the best ribs of C group may be due to high energy intake per day of C group and reaching the descending phase of growth curve earlier than T2 group. The insignificant difference in best ribs physical components agree with the findings of Partida *et al.* (2007) and El-Asheeri *et al.* (2008) reporting no effect of feeding type physical component best ribs.

The obtained results of lean percentage of the three groups are in agreement with that reported by Sami (2001), Partida *et al.* (2007) and El-Asheeri (2009) (61.0-64.5%) while lower than that reported by disagree with these reported by Nour *et al.* (1994) (55.2-57.8%). The obtained results of fat percentage of the three groups are in agreement with that reported by Sami (2001) and El-Asheeri (2009) (17.1-22.4%) on Baladi bullocks while disagree with these reported by Nour *et al.* (1994) (23.7-28.1%) and Partida *et al.* (2007) (13.4-13.9%) on (Egyptian Baladi and Simmental). The obtained results of bone percentage of the three groups (about 18%) are in agreement with that reported by Sami (2001) and El-Asheeri (2009) (18.3-19.7%) while higher than that reported by Partida *et al.* (2007) (13.4-13.9%). Meat/bone ratio as measured in best ribs in the three groups are so close to the corresponding values measured on carcass. This finding is less than the results of Sadek *et al.* (1993).

Meat quality

Chemical composition: Differences in percentages of moisture, protein, fat and collagen in the meat of the three groups were non-significant (Table 2). These findings in accordance with the results of Skelley *et al.* (1978) who found that chemical composition (moisture, protein and fat%) of Longissimus dorsi muscle was not affected by feeding animals on corn grain or corn silage.

Moisture: Insignificant differences among the three groups agrees with the findings of French *et al.* (2000) Revilla and Vivar-Quintana (2006), Jenschke *et al.* (2008) and Serra *et al.* (2008) who reported no effect of feeding on corn grains (72.4-74.4%) and corn silage (72.9-74.8%) on moisture percentage. Studies on Baladi calves reported close moisture percentage to those obtained in C group ranging from 71.5-73.45% as reported by El-Bedawy *et al.* (1996), Badr (1997) and Sami (2001). Reported average of moisture percent in meat of Baladi bullocks is less than that reported for Baladi crosses with Red Angler (76.7%), Braunvieh (77.5%) and Deutsches Braunvieh (76.8%) (Nigm *et al.*, 1983).

Protein: Percentages of protein were in the range of protein percentage (21.7-23.9%) reported by French *et al.* (2000) and Serra *et al.* (2008). Insignificant difference between C and T1 and T2 groups concerning protein percentage disagree with the findings of Nour *et al.* (1994) who reported lower protein percentage in the meat of animals fed corn grains (18.7%) compared to those fed corn silage (22.8%). The obtained percentage of protein is less than that reported for Baladi and their crosses with Red Angler, Braunvieh, Deutsches Braunvieh, Grauvieh and Friesian (19.94-21.9%) (Nigm *et al.*, 1983) while it was within the range reported by Badr (1997) and Sami (2001) (21.8-22.9%).

Table 2: Meat chemical composition of Baladi calves fattened on concentrate feed mixture (C), concentrate feed mixture and corn silage at 50:50 (T1) and 25:75 (T2)

Traits	C	T1	T2	p-value
n	5	5	5	-
Moisture (%)	72.3±0.5	72.0±0.5	71.6±0.8	0.71
Protein (%)	22.3±0.4	21.3±0.4	22.4±0.5	0.21
Fat (%)	2.6±0.3	3.0±0.6	2.9±0.5	0.34
Collagen (%)	1.4±0.1	1.2±0.1	1.2±0.1	0.39

Intramuscular fat: Obtained results of fat in the three groups are close to that reported by Badr (1997) (2.8-3.9%) on Baladi calves. While it is higher than that reported by Nigm *et al.* (1983) of Baladi crosses with exotic breeds (1.54-2.22). Revilla and Vivar-Quintana (2006), Jenschke *et al.* (2008) and Serra *et al.* (2008) found that there was no effect of the type of feed on fat percent in bovine meat. Opposite to that results of Nour *et al.* (1994) and Jenschke *et al.* (2008) who showed an increase in fat percentage in muscles of animals fed corn grains (2.95-5.4%) compared to those fed on corn silage (2.5-5.2%).

Collagen: The total collagen percentage in meat is not affected by feeding type (Aberle *et al.*, 1981) which agrees with the present results. On the contrary, Faucitano *et al.* (2008) indicated a decrease in collagen content in meat of cattle fed on grass silage compared to those fed on concentrates which is in contrast with the present results.

Physical properties: Values of pH after 3 and 24 h, expressible fluid percentage, cooking loss percentage, shear force value and meat color are presented in Table 3.

pH: Measuring pH after 3 h postmortem indicated that there was no significant difference (6.1-6.3) among the three groups. After 24 h of chilling, pH tended to decrease in the three groups but in different magnitude. While pH of T1 decreased by 0.6, the pH of C and T2 decreased only by 0.3 and 0.2, respectively. It is worth to note that pH of T2 group after 24 h was still over 6.0 while the other two groups went down to <6.0 value. The present results agreed with the findings of Faucitano *et al.* (2008). On the other hand, it is in the opposite of the findings of Jenschke *et al.* (2008). They reported that higher pH value for animals fed on corn silage was higher (6.17) than those fed on corn grains (5.75). Also, they added that pH was higher in meat of animals fed on corn grain (5.7) than those fed on corn silage (5.6). Decreasing pH values after 24 h postmortem agreed with the findings of El-Asheeri (1984). She reported values of pH >6.0 in meat of Baladi and Baladi crosses when measured 2 h post-slaughter. Her corresponding values measured after 18 h postmortem decreased to 5.6-5.8.

Table 3: Physical traits of Baladi calves meat fattened on concentrate feed mixture (C), concentrate feed mixture and corn silage at 50:50 (T1) and 25:75 (T2)

Traits	C	T1	T2	p-value
n	5	5	5	-
pH				
3 h	6.08±0.04	6.06±0.06	6.26±0.12	0.15
24 h	5.74±0.10	5.70±0.13	6.10±0.14	0.06
Expressible fluid (%)	30.00±0.80	30.20±1.60	32.40±2.20	0.52
Cooking loss (%)	43.20±1.00	43.40±1.00	43.80±1.30	0.93
Shear force (kg cm^{-2})	4.90±0.40	4.80±0.40	4.10±0.20	0.25
Color[+]				
L*	41.90±1.00	40.10±1.20	43.70±0.90	0.09
a*	18.30±1.30	18.40±0.20	17.40±1.80	0.85
b*	8.00±0.90	7.50±0.80	8.00±0.50	0.82

[+]L* brightness (0 = black, 100 = white); a* redness/greenness (positive values = red, negative values = green); b* yellowness/blueness; (positive values = yellow, negative values = blue)

Expressible fluid percentage: Results indicated that expressible fluid percentage in meat of Baladi bullocks slaughtered around 430 kg BW is between 30.0 and 32.4% without significant effect of feed type. Obtained expressible fluid percentage of C group is less than that reported for Baladi bullocks feed on concentrate feed mixture (34.3%) as reported by Sami (2001).

Cooking loss percentage: Type of feeding had no effect on cooking loss percentage. Cooking loss percentage in the three groups ranged between 43.2 and 43.8%. The present results is in alignment with the results of Mills *et al.* (1992) and French *et al.* (2000) who found that there was no effect of feed types on cooking loss percentage while disagree with the findings of Faucitano *et al.* (2008) who found that cooking loss was higher for meat of cattle fed on grass silage versus those fed on a combination of grass silage and concentrate by about 12.5%. Cooking loss is not easy to be compared with the earlier researches since, it is affected mainly by breed, ultimate pH and intramuscular fat (Chambaz *et al.*, 2003). Obtained cooking loss percentage in Baladi calves are close to that reported by Badr (1997) and Sami (2001) who showed values from 42.23-44.5% while higher than that reported for Angus (31.6%) and Charolais (7.6%) (Chambaz *et al.*, 2003).

Shear force: Similar to expressible fluid percentage and cooking loss percentage, results of shear force value (kg/cm^3) indicated no significant difference among the three groups however, T2 showed lower value compared to C and T1 groups by about 0.6%. The trend of the present results was in line with the findings of French *et al.* (2000) and Gill *et al.* (2008) who reported that shear force value was not affected by feed type. On the other hand, it is in contrast with the findings of Radunz *et al.* (2003) who stated that type of feed affect tenderness significantly by about 15.9%.

Meat color: Analysis of meat color of C, T1 and T2 revealed that there were no significant differences concerning brightness, redness and yellowness among the three groups. The present trend of meat color among the three groups is in agreement with the findings of French *et al.* (2000, 2001) and O'Sullivan *et al.* (2003)

who reported no effect of feeding grains and silage on muscle color. The present results are on the contrary of the findings of Crouse *et al.* (1984) who reported that feeding forge to beef cattle resulted in darker meat compared to those fed on grains. The obtained values of brightness (40.1-43.7) is close to that reported by Page *et al.* (2001) and Kim *et al.* (2008). But the redness values (17.4-18.4) is higher than that reported by Page *et al.* (2001) and less than that reported by Kim *et al.* (2008).

CONCLUSION

This study indicated that utilizing corn silage instead of concentrate fed mixture either by 50 or 75% in the fattening ration of Baladi calves did not adversely affected the carcass and meat quality merits. These results may allow beef producers to produce meat with the same quality, low costs and consequently low prices compared to the existing traditional beef production systems.

ACKNOWLEDGEMENT

The researchers extend their appreciation to the Deanship of Scientific Research at King Saud University for funding the work through the research group project No. RGP-VPP-127.

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