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Performance and Carcass Characteristics of Subtropical Calves Fed Untraditional Fattening Ration

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Abstract: The objective of this study was to investigate the effect of feeding two levels of corn silage on growth performance, carcass characteristics of subtropical calves. Fifteen Egyptian native calves (initially weighed 245.3±3.0 kg) were randomly divided into three equal groups as follows: group 1 (Control, C): fed Concentrate Fed Mixture (CFM) and rice straw; group 2 (50%): CFM was replaced with 50% corn and group 3 (75%); CFM was replaced with 75% corn silage on dry matter basis. Growth performance and carcass traits were investigated. Moreover, the economical partial budget analysis was calculated for feasibility. A significantly ($p<0.0001$) higher fattening period and lower Average Daily Gain (ADG) were found for 75% group but no significant adverse effects of this treatment on the DMI, feed conversion, final body weight and total gain. No significant effect ($p>0.05$) on the hot carcass weight, dressing percentage, full and empty digestive tract, non-edible parts, edible organs, boneless meat and visceral fat percentages were detected due to corn silage replacements. The partial budget analysis showed a significantly higher gross margin and benefit/cost ratio for calves from 75% when compared with the control group.

Key words: Native calves, corn silage, growth, carcass, profit

INTRODUCTION

Fattening calves on Concentrate Feed Mixture (CFM) *ad libitum* plus rice or wheat straw is a common practice of meat production from the native calves in Egypt and other developing countries. It was found that this practice represents the major variable of running costs (86-93%) as reported by Alsheikh *et al.* (2004) and El-Asheeri (2008). This higher percentage consider the main constrain for beef industry in countries that do not have pastures and depend only on concentrate feed mixture which most of its ingredients are imported. Minimizing feeding costs by using alternative feedstuffs may be the only way to keep feedlots running, under the global increase of grains price.

Corn silage has increased in popularity, particularly during the past decade (Mayne and O'Kiely, 2005; Arbabi *et al.*, 2008, 2009; Mafakher *et al.*, 2010) due to their potentially lower cost and to their perceived conservation and nutrition attributes. Keady (2005) concluded that corn silage increased forage intake by 1.5 kg DM day^{-1}, live-weight gain by 0.23 kg day^{-1} and carcass gain by 0.11 kg day^{-1}. A number of studies have reported positive effects on feed intakes when forage corn silage replaced grass silage either totally or as part of the forage base for beef cattle (O'Kiely and Moloney, 2000; Keady and Kilpatrick, 2004). However, improvements in forage intake, observed in many studies have not consistently resulted in improved levels of animal performance (O'Kiely and Moloney, 2000) such that the production and ultimately financial, implications of incorporating corn silage into the diet of beef cattle is not clear.

Also, Average Daily Gain (ADG), the important measure of animal performance, of Egyptian native calves which are the main source of beef production in Egypt, ranged between 600-1228 g day^{-1} as reported by Alsheikh *et al.* (2004), El-Bedawy *et al.* (2004) and El-Asheeri (2008). Trails of Sami *et al.* (2004), Kirkland *et al.* (2005) and Cozzi *et al.* (2005) who fed corn silage partially or completely to beef cattle reported ADG between 0.92 and 1.4 kg.

This range is close to values reported under feeding on grains or concentrate feed mixture but calves fed maize silage spent longer fattening period to reach the target weight.

Limited studies are available to determine the economic return of fattening native calves on maize silage. Therefore, the objectives of the present study were to

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investigate the effects of replacing concentrate feed mixture with 50 or 75% corn silage on the native calves' performance, carcass characteristics and economic indicators.

MATERIALS AND METHODS

Experimental animals and feeding system: Fifteen native calves were purchased from the local market and treated upon purchasing against internal and external parasites. Calves were divided into three equal groups (n = 5). The 1st group (Control, C) was fed on Concentrate Feed Mixture (CFM, yellow corn (50%), wheat bran (20%), cotton seed meal (15%), soybean meal (10%), additives (5, 14% crude protein, 60% TDN) plus rice straw, served as control. In the 2nd and the 3rd groups, CFM was replaced with 50 and 75% corn silage, respectively. Calves were around 12 months in age and 243±kg in weight. Required feedstuffs were purchased at the beginning of the experiment and random samples were selected for chemical analysis according to AOAC (2000). Chemical composition of utilized feedstuffs is shown in Table 1. They were fed individually twice daily according to NRC (1996) requirements. Offered and residues of CFM, rice straw and corn silage were recorded daily to calculate daily dry matter intake (DMI, kg day^{-1}) and feed conversion (FC, kg DM kg^{-1} gain) ratio. Animals were housed in a semi open yard and kept tied throughout the experimental period and offered water 3 times daily till slaughter.

Growth traits: The three groups were allowed to grow until reaching the target weight of slaughter (430 kg). Body weight was recorded bi-weekly throughout the experimental period to plot growth curve and to estimate average daily gain (ADG, kg day^{-1}), total gain and fattening period.

Slaughtering and carcass traits: After 16 h fasting, final body weight was recorded and animals were slaughtered according to Halal rules. After bleeding and removing skin, head and four feet, animals were eviscerated. Hot carcass weight was recorded to calculate the dressing percentage. Weights of edible organs (lungs, heart, liver, kidneys, midriff, spleen, testis and tail) were taken to calculate their percentage to the carcass weight. The same procedure was done with non-edible parts (skin, head, legs, esophagus, rumen, intestine and penis). Visceral fat weights (omental, heart, kidneys, mesenteric and cod) were recorded too. All carcasses were divided into two halves. The boneless meat of the left side was separated and weighted to calculate its ratio to the hot carcass.

Table 1: Chemical composition of the experimental feedstuffs

Item (%)	Concentrate feed mixture	Corn silage	Rice straw
Dry matter	92.0	34.0	90.0
Crude protein	15.0	8.0	3.5
Ether extract	4.4	6.1	1.0
Crude fiber	9.2	16.0	40.0
NFE	62.1	60.9	50.0
Ash	9.3	9.0	6.0

Economical evaluation: The partial budgeting evaluation was carried out to show the economic impact of replacing 50 and 75% CFM with corn silage in fattening native calves' rations. The assumptions of budget were as follow: fixed costs were similar for the three treatments therefore, researchers did not added it in the evaluation; variable costs and income sources were concentrate feed mixture = US$268 ton^{-1}; corn silage = US$36.4 ton^{-1}; rice straw = US$20 ton^{-1}; Purchasing price = US$2.6 kg^{-1} live body weight; animal selling price = US$2.5 kg^{-1} live body weight; manure price = US$2.7 m^{-3}; manure yield (m^3) = 10 m^3/animal/fattening cycle; Veterinary care cost = US$5.5/animal and Labor cost = 3.6/50 head/day. The assumed economical indices were: Total running costs = Total feeding+Labor+Veterinary care; Total variable costs = Total running costs+Purchasing price; Total income = Selling price+Manure price; Gross margin = Total income - Total variable costs; Cost of producing 1 kg gain = Total running cost/Total gain; Benefit/Cost ratio = Total income/Total variable cost.

Statistical analysis: The collected data were statistically analyzed according to the GLM procedure of SAS (2001). One way analysis of variance was used to analyse the effect of feeding type (C, 50 and 75% corn silage). Differences were considered significant at $p \leq 0.05$. All values expressed as percentages were transformed with arcsin before statistical processing.

RESULTS

Corn silage is widely used as forage to support high energy requirements by replace part of the concentrates feedstuffs for ruminant animals at different physiological status. Corn silage is relatively cheap when compared with other energy feed resources such as corn and other grains. So, corn silage can probably replace part of the concentrate feeds for growing calves to reduce the feeding costs and increase profit. This study was designed to investigate the effect of replacing Concentrate Feed Mixture (CFM) with 50 or 75% of Corn Silage (CS) on the performance and carcass characteristics of growing native calves.

Table 2: Performance of native calves fattened on concentrate feed mixture (C), concentrate feed mixture and corn silage at 50 or 75%

Traits	C	50 (%)	75 (%)	SE	p-value
n	5.00	5.00	5.00	-	-
Initial body weight (kg)	242.00	243.00	243.00	5.29	0.9882
Final body weight (kg)	437.00	433.00	429.00	5.13	0.5137
Total weight gain (kg)	195.00	190.00	186.00	8.52	0.7778
Fattening period (day)	201.00^{b}	208.00^{b}	252.00^{a}	5.88	<0.0001
ADG (kg)	0.97^{a}	0.91^{a}	0.74^{b}	0.04	0.0043
DMI (kg day^{-1})	9.18^{a}	7.29^{b}	7.08^{b}	0.12	<0.0001
Feed conversion (kg DM kg^{-1} gain)	9.52^{a}	8.05^{b}	9.68^{a}	0.41	0.0301

^{ab}Means with no common superscript in the same row significantly differ ($p<0.05$)

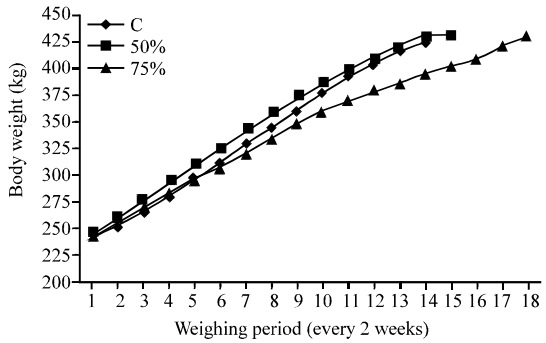

Fig. 1: Growth curve of control (C), 50 and 75% corn silage groups

Feed intake, conversion and growth rate: This experiment was lasted for approximately 8.5 months for a period range from 201-252 days to reach a maximum body weight of 437 kg. Feed intake of CFM, rice straw and corn silage for the three treatments is shown in Fig. 1. As expected, the C group consumed more CFM compared to 50 and 75% groups. Also, 50% consumed more CFM than 75% group. The differences among the three groups were significant. The opposite trend was found in the roughage consumption where the 75% group was >50% group which was higher than C group. Significant differences among the three groups were also detected.

Growth performance of the native calves is shown in Table 2. A significant increase in fattening period was found for 75% group which received high level of corn silage to reach the target final body weight (430 kg) late compared to the C and 50% groups. The growth curve of the three groups (Fig. 2) supported the obtained result. Meanwhile, the total weight gain did not significantly affected by the treatments. A significantly lower ($p<0.01$) Average Daily Gain (ADG) of 75% group was detected when compared with C and 50% groups (0.74 vs. 9.18 and 0.91 kg, respectively). While no significant differences were recorded between C and 50% treatments. Furthermore, a significantly lower daily Dry Matter Intake

Table 3: Carcass characteristics of native calves fattened on concentrate feed mixture (C), concentrate feed mixture and corn silage at 50 and 75%

Traits	C	50 (%)	75 (%)	SE	p-value
n	5.0	5.0	5.0	-	-
Hot carcass weight (kg)	248.0	244.0	240.0	4.05	0.4082
Dressing (%)	57.0	56.0	56.0	0.95	0.8810
Boneless meat (%)	84.0	83.0	83.0	0.73	0.6778
Visceral fat (%)*	6.0	5.0	5.4	0.67	0.5445
Total full digestive tract (%)	24.0	27.0	28.0	1.74	0.2467
Total empty digestive tract (%)	10.4	10.2	9.8	0.50	0.6929
Total edible organs (%)**	7.4	6.8	6.8	0.22	0.1176
Total non-edible parts (%)***	36.0	35.0	34.0	1.21	0.7776

*Visceral fat: omental fat, heart, kidney, mesenteric and cod.; **Edible organs: Lung, heart, kidneys, liver, midriff, spleen, testis and tail; ***Non-edible parts: skin, head, legs, esophagus, rumen empty, small intestine empty, large intestine empty and penis

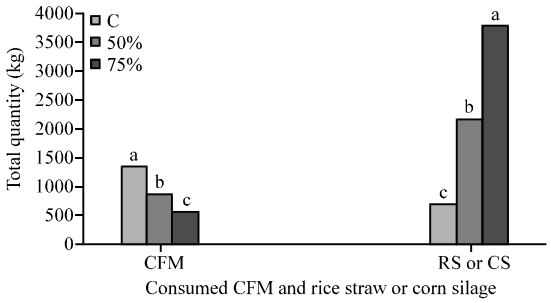

Fig. 2: Total quantity of CFM and rice straw or corn silage of control (C), 50 and 75% corn silage groups

(DMI, kg day^{-1}) was found for calves from 50 and 75% groups which fed corn silage compared with the C group. Calves of 50% group were significantly more efficient in converting feeds to gain (lower feed conversion ratio kg DM kg^{-1} gain) compared to C and 75% groups. The 75% group was the same as C group in feed conversion ratio.

Carcass characteristics: Results of carcass characteristics are shown in Table 3. Results illustrated that no significant effect ($p>0.05$) of feeding corn silage together with CFM, either by 50 or 75%, on the hot carcass weight, dressing percentage, boneless meat, visceral fat, total full and empty digestive tract, total edible and non-edible parts percentages (carcass basis) when compared with the C group. These insignificant differences could means that feeding corn silage up to 75% doesn't cause negative effect on carcass characteristics, meat yield and fat quantity.

Economical evaluation: The total running cost for reaching the targeted final body weight for growing calves was significantly lower for calves from 50 and 75% groups compared with the C group (982.3 and 958.9 vs.

Table 4: Economic indicators of feeding C, 50 and 75% corn silage diets to native calves

Economic indicators (US$)	C	50 (%)	75 (%)	SE	p-value
Source of variable costs					
Purchasing price	640.10	651.10	654.90	10.24	0.584
Running cost					
CFM cost	358.70^{a}	228.70^{b}	146.80^{c}	8.01	<0.0001
RS or CS cost	13.70^{c}	78.20^{b}	137.20^{a}	2.90	<0.0001
Total feeding costs	372.40^{a}	306.90^{b}	284.00^{b}	9.98	0.0001
Labor costs	14.65^{b}	15.11^{b}	18.33^{a}	0.43	<0.0001
Veterinary care	5.50	5.50	5.50		
Total running costs*	392.50^{a}	327.40^{b}	307.80^{b}	10.37	0.0002
Total variable costs**	1032.60^{a}	982.30^{b}	958.90^{b}	14.60	0.0114
Source of income					
Selling price	1093.50	1083.50	1072.00	12.82	0.5137
Manure price	30.52^{b}	31.48^{b}	38.18^{a}	0.89	<0.0001
Total income	1124.00	1115.00	1110.20	12.95	0.7504
Gross margin	91.50^{b}	132.70^{ab}	151.20^{a}	15.15	0.0445
Cost of producing 1 kg gain	11.00^{a}	9.60^{b}	9.20^{b}	0.44	0.0191
Benefit/Cost ratio	1.09^{b}	1.14^{ab}	1.16^{a}	0.02	0.0317

$^{a-c}$Means with no common superscript in the same row significantly differ ($p<0.05$); *Total running costs = Total feeding+Labor+Veterinary care; **Total variable costs = Total running costs+Purchasing price; Total income = Selling price+Manure price; Gross margin = Total income−Total variable costs; Cost of producing 1 kg gain = Total running cost/total gain; Benefit/Cost ratio = Total income/Total variable cost

1032 US$, respectively). This means that using corn silage instead of CFM up to 75% of daily feed intake reduced the total feeding costs and consequently the running cost which led to increase the gross margin as shown in Table 4. Significant difference was found between 75% and C groups in gross margin but this difference was not existed when compared 50% with either C or 75% groups. The cost of producing 1 kg body gain was significantly lower ($p<0.01$) for calves from 50 and 75% groups (9.6 and 9.2 US$, respectively) compared to C group (11.1 US$). Furthermore, the benefit to cost ratio was the lowest for C group and highest for 75% group. No significant difference was detected when 50% group was compared with C and 75% groups.

DISCUSSION

It is truly remarkable that the growth response of growing calves is as uniform as it is when different variable components that result in growth carefully considered. The nutritional variations in feedstuffs are acknowledged for uniformity especially roughages. Corn silage well known to provide less crude protein per unit of forage but excels in energy contents due to high corn seeds starch and digestible dry matter and Neutral Detergent Fiber (NDF). The concentration of NDF in corn silage can vary greatly from 46-52.5% (NRC, 1996). The NDF or crude fiber concentration is well known to play an important role in affecting feed intake, especially when corn silage fed in high levels. In this study, a significantly lower daily Dry Matter Intake (DMI, kg day^{-1}) was found for calves for 50 and 75% which fed corn silage compared with the C group. This result agreed with Tjardes *et al.* (2002a, b) and Nichols *et al.* (1998) who reported a depression in feed intake by growing steers fed high levels of corn silage with high NDF contents. Furthermore, Dado (1993) reviewed several studies and clearly concluded that high levels of corn silage cause a significant drop down in daily dry matter intake resulting from physical fill in the form of inert bulk of the digestive system. Other justification of low feed intake by high level of corn silage intake suggested by Tauqir *et al.* (2009) who assumed the presence of products resulting from fermentation in the silo that had a negative effect on palatability and consequently low feed intake by growing steers.

Concerning the ADG, many field experiments were conducted to study the effect of replacing part of CFM with corn silage in rations of fattened animals (Schrage *et al.*, 1991; Loerch and Fluharty, 1998). They concluded that increasing the proportion of corn silage in rations of fattening animals reduces ADG by 7.7-33%. Sex, genotype as well as ratio of CFM:corn silage were causes of variation in ADG among the previous studies. The findings of the experiment is partially agreed with others as the replacing level up to 50% corn silage didn't cause any significant effect on ADG but increasing corn silage up to 75% caused a significant reduction in the ADG compared to control 50% groups.

On the other hand, Feed Conversion (FC) of growing native calves is reported to be between 7.4 and 9.5 kg DM kg^{-1} gain in general (Alsheikh *et al.*, 2004; El-Bedawy *et al.*, 2004). Also, comparing with other beef breeds, Hereford, Angus, Limousine and Simmental breeds had a range of feed conversion from 5.4-9.95 kg DM kg^{-1} gain (Sami *et al.*, 2004; Cozzi *et al.*, 2005; Pyatt *et al.*, 2005). The FC ratio fall within the range of previous studies. The reported wide variation in feed conversion may probably attribute to age, body weight of experimental animals and type of feed offered. Most of the previous studies reported a decrease in feed conversion with increasing the proportion of corn silage in the ration of fattened calves. Muhamed *et al.* (1983) reported decreasing FC when the proportion of corn silage increased from 15-75% by about 20% (7.9 kg DM kg^{-1} gain vs. 8.4 kg DM kg^{-1} gain). The findings partially agreed with the previous studies in term of decreasing FC up to 50% corn silage when compared to the control group but increasing corn silage up to 75% increased the FC compared with 50% and control groups.

Regarding dressing percentage, studies of Schrage *et al.* (1991) indicated that dressing percentage is

not affected by type of feed. Feeding animals on rations containing 20-70% corn silage resulted in dressing percentage between 59.9-64.6%. This result is supported by the findings of Nour *et al.* (1994) and Rossi *et al.* (2001) who found that feeding on concentrate or corn silage rations had no effect on dressing percent (59.7-63.5%) of animals slaughtered between 427 and 569 kg.

Feeding large amount of silage to the growing calves is economically recommended since, the cost of metabolizable energy from silage is approximately half of the energy from other energy feedstuffs. To facilitate the level of silage administration we must evaluate their effect on growing calves performance thus to find a balance between the economic and calves performance (Steen, 1995; Paterson *et al.*, 1995). The economical evaluation of this study showed that increasing the level of corn silage up to 75% reduced the cost of producing 1 kg body gain and increased the gross margins and benefits to cost ratio.

According to the particular cost and the economical evaluation of this study, to achieve a maximum profit without negative effect on growing calves performance, carcass merits, health and meat productivity producers are recommended to increase dietary corn silage up to 75% of daily feed intake and 25% concentrate.

Using concentrate feed mixture with 50 or 75% corn silage for native calves reduce daily dry matter intake as a result of high fiber contents and rumen inert bulk and improve feed efficiency without adverse effects on carcass merits or meat yield. Moreover, a higher profit can be obtained as a result of lower cost of corn silage compared with the concentrate feed mixture. Further research is needed to determine the effect of using high levels of corn silage on meat taste, tenderness and other quality measurements.

CONCLUSION

In this study using 50 or 75% corn silage in the fattening diet had no adverse effects on the DMI, FC and carcass characteristics. Also, more profits could be attained when CFM replaced with 50 or 75% corn silage.

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