EFFECT OF FEEDING DIFFERENT LEVELS OF CALCIUM SALTS OF FATTY ACIDS ON DIGESTIBILITY, BODY DIMENSION AND CARCASS CHARACTERISTICS OF FATTENING BUFFALO BULLS

F. M. Abo -Donia and S. A. Ibrahim

Animal Production Research Institute, Ministry of Agriculture, Dokki, Giza, Egypt

SUMMARY

Eighteen buffalo bulls were allotted into three similar groups. Three concentrate feed mixture were formulated to replace Calcium salts of fatty acids (Ca-SFA) instead of corn grain as 0, 25 and 50% on basis of energy content then distributed to three animal groups. All groups received berseem hay and rice straw. Acid ether extract (AEE) and total fatty acids (TFA's) were higher with high level of Ca-SFA. Adding Ca-SFA significantly (P<0.05) improved meat yield kg as level of fat intake was higher. Intake of DM, TDN and DCP kg per kg meat gain was slightly more efficient when feeding with different levels of Ca-SFA. Digestion coefficient of AEE was significantly higher (P<0.05) with supplemented Ca-SFA, while digestibilities of crude protein (CP), crude fiber (CF) and nitrogen free extract (NFE) didn't affected by fat supplemented. The values of TDN kg and DCP didn't significantly differ among the tested groups.

No significant (P>0.05) differences were found among treatments for body dimension. Both levels of Ca-SFA didn't significantly (P>0.05) affect fasting, empty body weight and carcass weight compared to the control one. Rump round, neck and hot carcass were significantly higher (P<0.05) with 50% level of Ca-SFA compared to the control one, while there was no significant difference (P>0.05) between both levels of Ca-SFA. No significant differences were observed for dressing values among treatments. Amount of meat for hind and fore right and hind left quarters were significantly higher (P<0.05) with feeding on Ca-SFA. Kidney fat and liver weight were significantly higher (P<0.05) when fed ration containing Ca-SFA than that on the control ration, except the average of liver weight for that group received ration containing 25% Ca-SFA level. Color intensity of fresh muscle, area, depth of longissimus dorsi muscle and fat content of muscles of 9, 10, and 11th ribs were significantly higher (P<0.05) with added 25 and 50% levels of Ca-SFA compared to the control. Chemical composition of CP, lipids, NFE and ash for longissimus dorsi muscle didn't significantly (P>0.05) affected with feeding Ca-SFA, while DM was significantly (P<0.05) higher with feed Ca-SFA compared to the control. There was a preferential deposition of more unsaturated fatty acids in the subcutaneous adipose tissues in groups fed on Ca-SFA and linoleic acid. The unsaturated fatty acid content of longissimus dorsi muscle was less than that in subcutaneous adipose tissues when fed on Ca-SFA diet. The correlations found between body weight and other traits of body dimensions were higher than these correlations between Hot carcass (HC) and Abdominal girth (AG), Hot carcass (HC) and Highet at withers (HW), Heart girth (HG) and Abdominal girth (AG) also Heart girth (HG) and Highet at withers (HW).

It is concluded that, adding Ca-SFA in finishing period of buffalo bulls might be improved carcass quality and meat gain efficiency.

Keywords: Buffalo bulls, calcium salts of fatty acids (Ca-SFA), digestibility, body dimensions and carcass traits

INTRODUCTION

A growing phase for cattle is usually imposed for a period between weaning and finishing in a feedlot. The growing phase allows body development before fattening, which in turn permits cattle to attain slaughter finish at desirable carcass weights. Commercial feed fats, usually supplemented at 2 to 5% of the diets dry matter, for growing and finishing cattle (Bauman *et al.*, 2003). Soap-stock as fatty acids has a higher inhibitory effect on ruminal microbes than the triglycerides form (Wu *et al.*, 1993). The negative effects of lipids on the digestion efficiency in the rumen are generally reduced by adding calcium supplementation to the diet (Jenkins and Palmquist, 1982 and El-Bedawy *et al.*, 2005).

In recent years awareness of the importance of diet in human health has increased. Many authorities have recommended that the contribution of fat especially saturated fatty acids to dietary energy intake should be reduced. In the UK recent recommendations were 35 % of energy for fat and 10 % of energy for saturated fatty acids (Henderson *et al.*, 2003). Within these general guidelines it is advised to reduce the intake of short- and medium-chain saturated fatty acids and the intake of n-6 polyunsaturates relative to n-3 (Gibney, 1993).

The objective of the present work is to incorporate different levels of calcium salts of fatty acids which produced from soap-stock (SS) as source of energy in fattening buffalo bull's rations at the finishing of fattening period. The effects of Ca-SFA supplementation in fattening buffalo bull's would be investigated on body dimensions, carcass traits, profile of fatty acids, intake, digestibility of nutrients and performance of meat production.

MATERIALS AND METHODS

This work has been conducted at Seds experimental station in Bani-souif Governorate and chemical analyses were conducted at Laboratory of By-Product Utilization Department belongs to Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt.

Calcium salts of fatty acids (Ca- SFA) was locally prepared in Soap & Oil Manufacture (Cairo Oil & Soap Co.,) according to El-Bedawy *et al.* (2005) from mixed of soybean and sunflower oil soapstock by 1:1 on DM basis.

Eighteen buffalo bulls about 295.0 ± 7.31 kg body weight at one year of age were randomly allotted into three similar groups. Bulls were housed in three shaded paddocks and adapted on the experimental rations for two weeks before experimental period which lasted to 120 days. During the experimental period, animals were weighted biweekly. Measurements of body dimensions were made at the beginning and the end of feeding trials according to the description of (El-Kholy, 1991).

Three concentrate feed mixtures (CFM's) were formulated to replace Ca-SFA instead of corn grain as 0, 25 and 50% on basis of energy content and randomly assumed on three animal groups. The CFM's had almost similar protein and energy content (chemical composition of different CFM's shown in Table 1). The three CFM's were randomly offered to the three animal groups. All groups received berseem hay (BH) and rice straw (RS). The tested rations were offered according to nutrient requirements of NRC (2000). Drinking water and minerals blocks were available all times daily.

Table 1. Chemical composition of the consumed concentrate feed mixtures, experimental rations, Ca-SFA and roughages (BH and RS)

Item	*CFM's*			*Ca-*	*Roughages*		*Experimental Rations **		
	CFM1	*CFM2*	*CFM3*	*SFA*	*BH*	*RS*	*Control*	*LFL*	*HFL*
Chemical compassion (%)									
DM	90.24	90.44	90.61	94.78	90.29	93.00	90.99	91.10	91.18
OM	90.52	89.19	88.16	78.22	87.50	87.20	88.99	88.30	87.77
CP	18.11	18.37	18.62	...	12.30	3.50	12.96	13.10	12.35
CF	9.42	9.95	10.62	...	28.50	40.50	21.78	22.05	21.80
AEE	4.12	7.27	10.34	78.22	1.60	0.93	2.74	4.38	5.79
NFE	58.87	53.60	48.58	...	45.10	42.27	51.51	48.78	47.82
Ash	9.48	10.81	11.84	21.78	12.50	12.80	11.01	11.70	12.23
TFA's	3.15	6.10	8.95	76.96	0.95	0.47	2.05	3.59	5.59
Cell wall constituent (%)									
NDF	20.08	20.58	21.31	...	62.99	71.89	43.01	43.25	43.51
ADF	14.69	15.41	16.26	...	46.34	55.47	32.30	32.65	33.00
ADL	1.61	1.60	1.61	...	7.90	10.37	5.29	5.28	5.26
Cell	13.09	13.81	14.65	...	38.44	45.40	27.01	27.38	27.74
HCell	5.39	5.17	5.04	...	16.65	16.11	10.72	10.60	10.51
GE**	4.025	4.136	4.245	7.402	3.982	4.101	4.036	4.094	4.147

CFM1= containing yellow corn (40%), soybean meal (14%), cotton seed meal (15%), wheat bran (19%), rice bran (4%), molasses (4%), ground limestone ((3%) and common salt (1%). CFM2 = 25% Ca-SFA was supplemented instead yellow corn on energy basis and CFM3 = 50% Ca-SFA was supplemented instead yellow corn on energy basis. Cell= cellulose and HCell= Hemicellulose. LFL=low fat level of 25% Ca-SFA and HFL= high fat level of 50% Ca-SFA

*Formulas of experimental rations were calculated from average feed consumed during experimental period

** Mcal/kg and CFM's= Concentrate feed mixture

Digestion trials was carried out at the end of the experimental period using three replicates applying the acid insoluble ash (AIA) technique suggested by Van Keulen and Young (1977). Chemical composition of feeds or residuals and feces were determined according to A.O.A.C. (2000). Acidified ether extract was determined as described by modified method Abo-Donia *et al.* (2003). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined according to Goering and Van Soest (1970). Hemi-cellulose and cellulose were calculated as the difference between NDF and ADF, ADL orderly. Total fatty acids (TFA's) in Ca-SFA and different ingredients were determined by A.O.C.S. (2000). Profile of fatty acids composition of Ca-SFA in Table (3) was analyzed by description of Sukhija and Palmquist (1988).

At the end of feeding trials, randomly three animals from each experimental group were fasted 18 hrs then slaughtered for carcass evaluation. Empty body weight (EBW) was calculated as the difference between fasted weight and gastrointestinal (GI) tract contents (Sainz *et al.*, 1995). The pH value of meat tissues was measured by pH meter as described by Aitken *et al.* (1962). The color intensity of meat water extract and drip were determined according to the method described by Hussaini *et al.* (1950). Tenderness and water holding capacity were determined according to the method described by Grau and Hamm (1957). Moisture, ash, crud protein and Lipids contents were analyzed according to the methods described by (A.O.A.C., 2000). Nitrogen free extract (NFE) in meat was calculated as the following equation 100 - (CP + Lipids + ash). The 9, 10 and 11^{th} rib sections of each carcass were separated into lean, fat and bone with each portion being weighed. The soft tissue from these sections and the *longissimus dorsi* muscle at the 12^{th} rib were subjected to proximate analysis. Three fat sample of each group from subcutaneous adipose tissues of each animal were integrated in one sample by 1:1:1 as well as samples of *longissimus dorsi* muscle then frozen and stored at -18 °C to be used for determining fatty acids as methyl esters by the gas-liquid chromatographic procedure of Gerhardt and Gehrke (1977). Gas liquid chromatography of the methyl esters was conducted on an F and M Model 402 gas liquid chromatograph with a hydrogen flame ionization detector. A U-shaped glass column, 1.8 m long and 3.5 mm in diameter, packed with 15% diethylene glycol succinate (DEGS) on 60-80 mesh Chromosorb W was used. The column oven was maintained at 180 °C isothermally. The flash heater and the detector were operated at an average temperature of 230 C and 240 °C, respectively. The hydrogen, nitrogen and air flow rates were 38, 70 and 625 ml per minute, respectively.

Statistical analysis was carried out using SAS (2000). Duncan's Multiple Range Test (Duncan, 1955) was used to separate the means when the main effect was significant.

RESULTS AND DISCUSSIONS

Chemical Composition

Chemical composition of the CFM's, experimental rations, Ca-SFA, BH and RS are presented in Table (2). It is showed that the three CFM's and rations were comparable in nutrient content except the AEE and TFA's they were higher with the high level of Ca-SFA in concentrate feed mixture or consumed rations. The content of AEE was much higher than that of ether extract, because fatty acids in Ca-SFA are incompletely extracted without acid treatment (Drackly *et al.*, 1985 and Abo-Donia *et al.*, 2003). As expected, total amount of total fatty acids were higher with rations containing Ca-SFA than the control and in reasonable agreement with acid ether extract analysis. The differences between values of AEE and TFA's 1.26% in Ca-SFA due to higher content of other lipids such glycerol, pigments, wax .etc, which almost reach to 12%. These results were nearly similar to those reported by Kim *et al.* (1993) and Aiad *et al.* (2005). The chemical compositions of the roughages (BH and RS) were within the normal published ranges for CP, CF, and CWC (CLFF, 2001). Unsaturated fatty acids (USF) in Ca-SFA reached to 75.5 vs. 25.5 for saturated fatty acids (SFA) and were enriched in C18:1 and C18:2 (see Table 2).

Table 2. Fatty acids composition of Ca-SFA

Items (%)	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	∑UNS	∑SA
Ca- SFA	6.00	11.50	3.00	8.00	37.50	24.50	9.50	75.5	25.5

∑UNS=Unsaturated fatty acids and ∑SA= Saturated fatty acids.

Feed Intake and performance of meat production

Intake of CFM's, berseem hay and rice straw kg/h/d were similar among all experimental groups (Table 3). Adding fat improved meat yield kg significantly (P<0.01 and 0.05) as level of fat intake was higher. There was improve in daily meat gain with increasing level of Ca-SFA in bull's rations compared to control, while differences weren't significant (P>0.01 and 0.05) among treatments. The same trained were observed for values of total dry matter intake (TDMI) kg/kg meat gain, kg total digestible nutrient intake (TDNI) /kg meat gain and kg digestible crud protein intake (DCPI) / kg meat gain among all experimental groups.

The intake of DM, TDN and DCP kg per kg meat gain were efficient when feeding different levels of Ca-SFA compared to the control ration. This could be attributed to high fat digestibility leading to increase fat efficiency as a source of energy. Improve conversion of TDN and protein intake might be due to proportion of fat deposited in the carcass as it directly related to energy intake during the finishing phase (Byers, 1982).

Table 3. Effect of feeding Ca-SFA level on FI and feed conversion of buffalo bulls

Item	Experimental Rations			±SE
	Control	LFL	HFL	
Feed intake (FI) kg/h /day on DM basis for slaughtered animals:				
CFM's	3.97	4.07	4.03	---
Berseem hay	1.60	1.63	1.61	---
Rice straw	2.05	2.10	2.05	---
Total DM intake	7.62	7.80	7.96	---
TDN intake	5.03	5.34	5.56	0.278
Meat yield (kg)	177.77[c]	190.33[b]	204.83[a]	2.560
Daily increase of meat (kg)	0.514	0.564	0.585	0.032
Feed conversion:				
Kg DMI/kg meat yield	14.82	13.83	13.61	1.320
Kg TDNI/kg meat yield	9.79	9.47	9.50	0.889
Kg DCPI/kg meat yield	1.418	1.328	1.222	0.126

Means of 3 animals in each treatment. LFL=low fat level of 25% Ca-SFA and HFL= high fat level of 50% Ca-SFA

a, b and c Means in the same row having different superscripts are significantly different at P<0.05.

Daily meat gain = ((final live body weight - meat quantaty in carcass) * avearage daily gain)/100

kg TDMI, TDN and DCP / kg meat yield calculated from (daily meat gain)

Digestibility and Nutritive Values

Nutrient digestibilities and nutritive values of the experimental rations are presented in Table (4). Digestion coefficient of AEE was significantly higher (P<0.05) with supplemented Ca-SFA compared to the unsupplemented one, and also was higher with high level of Ca-SFA. These results are in a good agreement with those obtained by EL-Bedawy *et al.* (2005), and Aiad *et al.* (2005) where attributed those results to the high digestibility of added dietary fat. Ruminant animals can digest fats with a high degree of efficiency ranged between 80% and 90% for a variety of fatty oils and fatty acids (Moore and Christie, 1984). Palmquist (1984) reported that, calcium soap was solubilized significantly as fatty acids, which increase the solubility of the acid-soap complex in the bile salt. This high efficiency was maintained even when the dietary intake of fatty acids was greatly increased.

Table 4. Effect of feeding of Ca-SFA on nutrient digestibility, cell wall constituent and nutritive values of the experimental rations

Item	Experimental Rations			P<
	Control	LFL	HFL	
Nutrient digestibility % :				
DM	69.04±0.56	69.91±0.78	70.04±2.20	ns
OM	71.61±0.42	72.11±1.28	71.99±2.38	ns
CP	56.88±1.01	57.19±1.56	57.15±2.37	ns
CF	66.12±0.16	66.04±1.47	65.80±1.88	ns
AEE	68.56±0.72[c]	87.90±0.92[b]	91.57±0.70[a]	*
NFE	77.96±0.49	76.60±2.99	74.90±3.98	ns
DE	68.57±0.33[b]	72.71±1.31[ab]	75.95±2.11[a]	*
Cell wall constituent %:				
NDF	64.89±1.33	61.85±1.63	61.78±2.24	ns
ADF	63.08±1.64	59.04±2.15	59.07±2.51	ns
Nutritive value % :				
TDN	66.07±0.38	68.49±1.24	69.81±1.11	ns
DCP	7.37±0.11	7.49±0.48	7.06±0.45	ns

Means of 3 animals in each treatment. LFL=low fat level of 25% Ca-SFA and HFL= high fat level of 50% Ca-SFA

a, b and c Means in the same row having different superscripts are significantly different at (P< 0.05).

Digestibilities of CP, CF, NFE and cell wall constituent (NDF, ADF, cellulose and hemi-cellulose) weren't affected significantly (P>0.05) by supplemented Ca-SFA compared with control group. Weren't affected fiber digestibility could indicated that, added protected fat didn't affect on the cellulotic activity in the rumen. Although adding Ca-SFA improved the energy values of the diets expressed as TDN, but the differences were not significant. The values of DCP didn't significantly differ among the tested groups. The herein results agreed with those obtained by Aiad *et al.* (2005) and El-Bedawy *et al.* (2005).

Body dimensions:

The averages of body dimensions measurement are present of Table (5). Although there are slightly higher values of body dimensions with feeding Ca-SFA diets, there were no significant differences (P>0.05) among treatments. These findings are in agreement with that reported by (Park *et al.*, 1993) who reported that, plane of nutrition had little effect on hip height and wither, whereas nutritional restrictions on growth involving body length, heart girth and hip width. The values of Body weight (BW), Heart girth (HG), Body length (BL), Highet at withers (HW), Highet at hook (HH), Width at pin bone (WP), Width at hook (WH) and Chest depth (CD) are in agreement with that reported by Sadek (1980). While heart girth (HG), abdominal girth (AG), abdominal height (AH), rump length (RL), width at shoulder (WS) and width at pin bone (WP) are nearest to that obtained by (Khalil, 1981 and Mohi El-Din, 1992) on Egyptian buffalo calves. On the contrary, our results of body weight (BW), heart girth (HG), abdominal depth (AD), abdominal height (AH), highet at withers (HW) and width at shoulder (WS) were higher than those recorded by (Mangurkar and Desai, 1978) on Nili-grade she-buffaloes.

Table 5. Effect of supplementing Ca-FAS on body dimensions (cm)

Item	Experimental Rations			±SE
	Control	LFL	HFL	
Body weight (BW)	351.00	357.33	359.25	19.61
Heart girth (HG)	202.75	209.08	206.33	10.88
Abdominal girth (AG)	224.50	225.83	226.50	11.90
Abdominal depth (AD)	126.42	127.00	131.33	6.92
Abdominal height (AH)	36.83	37.17	36.17	2.04
Body length (BL)	148.08	157.33	157.33	8.10
Rump length (RL)	151.17	157.17	159.83	8.30
Highet at withers (HW)	76.00	80.33	82.25	4.38
Highet at hook (HH)	77.17	81.00	79.08	4.19
Width at shoulder (WS)	76.17	77.42	78.58	4.33
Width at pin bone (WP)	44.25	46.50	47.00	2.53
Width at hook (WH)	52.25	54.75	58.50	2.91
Chest depth (CD)	15.83	13.75	15.33	0.97
General type (GT)	3.33	3.33	3.50	0.22

Means of 6 animals in each treatment. LFL=low fat level of 25% Ca-SFA and HFL= high fat level of 50% Ca-SFA

a, b, c Means with different superscripts in the same row are significantly difference P<0.05

Carcass characteristics and average weight of organs:

The slaughter measurements and carcass evaluation are presented in Tables (6 and 7). Feed rations containing different levels of Ca-SFA didn't significantly affect fasting, empty body weight and carcass weight compared to the control one. Rump round, neck and hot carcass were significantly (P<0.05) higher with the 50% level of Ca-SFA compared to the control, while there was no significant difference (P>0.05) between both levels of Ca-SFA. No significant differences were observed for dressing values between different levels of Ca-SFA and the control. Similar response was observed on Egyptian buffalo sire (Sadek, 1980) and on swamp buffalo calves (Shamsudin *et al.*, 1994). Hind right and left quarters were significantly (P<0.05) higher with 50% level of Ca-SFA, while no significant differences were found between the level of 25% Ca-SFA and the control. Adding fat didn't improve fore right and left quarters compared to the control one. Amount of meat for hind and fore right quarter were significantly (P<0.05) higher with high levels of Ca-SFA compared to low level and the control. Meat of hind left quarter was significantly (P<0.05) higher with both levels of Ca-SFA compared to the control. Adding dietary fat didn't significantly affect the meat of fore lift quarter compared to the control. Protein conversion to gain was better in the fat supplemented group than the unsupplemented one. Dietary fat might a role compensates and save dietary protein (Wu *et al.*, 1993).

The average weight of organs, offals and fat of some organs of finishing buffalo bulls are shown in Table (8). Head, front leg full rumen, empty rumen, lung, spleen, testes, kidney, heart, intestinal fat and skin weight were not affected with feed Ca-SFA. These results are in agreement with those reported by (Abdallah *et al.*, 1982). Kidney fat and liver weight were significantly higher (P<0.05) with fed ration containing Ca-SFA than that control ration, except average of liver weight for group received ration containing low Ca-SFA level.

Table 6. Effect of supplementing Ca-SFA on carcass traits of finishing buffalo bull's diet

Item	*Treatments*			*±SE*
	Control	*LFL*	*HFL*	
Fasting body weight, kg	400.67	409.00	423.33	11.37
Empty body weight, kg	349.13	359.25	374.48	12.38
Carcass weight, kg	144.33	159.00	165.00	6.91
Rump round, cm	71.00^{b}	77.67^{a}	78.33^{a}	1.28
Neck, kg	8.33^{b}	9.33^{ab}	9.67^{a}	0.33
Hot carcass, kg	224.33^{b}	233.67^{ab}	248.00^{a}	5.76
Dressing (%):				
A	56.05	57.12	58.61	1.00
B	64.38	65.03	66.30	1.30
C	59.15	60.53	61.93	1.02
D	67.93	68.91	70.05	1.34
Fore right quarter	56.00	57.67	62.83	2.18
Hind right quarter	55.25^{b}	58.33^{ab}	61.17^{a}	1.47
Fore lift quarter	57.50	58.67	62.00	1.72
Hind lift quarter	55.58^{b}	59.00^{ab}	62.00^{a}	1.28
Meat of fore right quarter	42.00^{b}	44.50^{b}	49.50^{a}	0.91
Meat of hind right quarter	44.75^{c}	48.00^{b}	51.50^{a}	0.84
Meat of fore lift quarter	45.50	46.33	49.50	1.28
Meat of hind lift quarter	45.50^{b}	51.50^{a}	54.33^{a}	1.10
Back fat thickness	0.39	0.40	0.41	

Means of 3 animals in each treatment. LFL=low fat level of 25% Ca-SFA and HFL= high fat level of 50% Ca-SFA

a, b, c Means with different superscripts in the same row are significantly difference P<0.05. A= (hot carcass/fasting body weight)*100, B= (hot carcass/empty body weight)*100, C= [((hot carcass + (liver +heart+ kidney with fat+ spleen)/fasting body weight]*100 and D= [((hot carcass + (liver +heart+ kidney with fat+ spleen)/empty body weight]*100

Table 7. Effect of supplementing Ca-SFA on carcass traits of the finished buffalo bull's diet

Item	*Treatments*			±SE
	Control	*LFL*	*HFL*	
Head	25.25	25.75	25.00	0.35
Tail	0.50^{b}	0.80^{a}	0.80^{a}	0.06
Hind legs	5.80^{b}	6.45^{a}	6.30^{ab}	0.18
Front legs	5.90	6.50	6.30	0.18
Full rumen	62.00	58.33	59.00	1.81
Empty rumen	15.60	16.05	16.45	0.34
Lung	5.50	5.70	5.85	0.19
Liver	5.85^{b}	5.65^{b}	6.30a	0.10
Spleen	0.95	1.00	0.95	0.08
Testes	0.25	0.25	0.30	0.04
Kidney	1.25	1.35	1.25	0.09
Heart	2.25	2.65	2.25	0.13
Kidney fat	1.85^{b}	2.95^{a}	3.00^{a}	0.10
Intestinal fat	2.90	3.90	3.80	0.34
Skin weight	46.50	47.00	45.50	1.03

Means of 3 animals in each treatment. ±SE: Standard error. LFL=low fat level of 25% Ca-SFA and HFL= high fat level of 50% Ca-SFA. a, b, c Means with different superscripts in the same row, differ significantly (P<0.05).

Physical and chemical characteristics of Longissimus dorsi muscle

The overall means of physical and chemical traits of *longissimus dorsi* muscle are reported in Table (8). It was observed that area and depth of *longissimus dorsi* muscle were significantly higher (P<0.05) with addition of both level of Ca-SFA compared to the control.

Table 8. Effect of adding fat in bull's rations on physical and chemical characteristic of *Longissimus dorsi* muscle

Item	Control	*LFL*	*HFL*	*±SE*
Composition of 9, 10, 11th ribs (%):				
Lean	61.42	62.25	63.12	1.10
Fat	22.48^{b}	23.65^{a}	23.66^{a}	0.27
Bone	16.10	14.10	13.22	1.22
Eye muscle traits:				
Eye muscle	56.73^{b}	61.15^{a}	61.99^{a}	1.09
Fat depth over	0.93	0.97	0.97	0.06
Width of *Longissimus dorsi*	15.64	16.23	16.79	0.36
Depth of *Longissimus dorsi*	9.22^{b}	10.13^{a}	10.35^{a}	0.22
Index of *Longissimus dorsi*	60.42	61.69	61.88	0.43
Physical characteristics:				
pH	5.69	5.68	5.74	0.10
Color density	0.310^{a}	0.293^{b}	0.297^{b}	0.003
Meat tenderness	3.29	3.71	3.53	0.13
Water holding capacity	7.20	7.21	7.21	0.11
Chemical composition (%):				
DM	25.00^{b}	28.00^{a}	29.10^{a}	0.49
CP	76.99	78.10	78.64	1.01
Lipids	13.25	13.33	13.67	0.35
NFE	5.74	4.87	3.79	0.96
Ash	4.00	3.70	3.90	0.15

a and b: Means in the same row with different superscripts differ (P<0.05). ±SE- Standard error
LFL=low fat level of 25% Ca-SFA and HFL= high fat level of 50% Ca-SFA

Fat content of muscles of 9, 10, and 11th ribs were significantly (P<0.05) higher with high and low levels of Ca-SFA compared to the control, while no significant differences were found between both levels of Ca-SFA. Carcass measurements such as backfat depth, lean cut percentage and *longissimus* muscle area were relatively easy to obtain and have been used as general indices of fatness and (or) leanness in cattle (Swatland *et al.*, 1994). Color intensity of fresh muscle was significantly lower (P<0.05) with both levels of Ca-SFA compared to the control. Several studies on cattle have shown that the bright color associated with oxymyoglobin is retained longer after grass feeding compared with that after grain feeding i.e. shelf life is increased (Wood *et al.*, 2004). No significant different was found when bulls feed diet containing Ca-SFA on pH, meat tenderness and water holding capacity. Chemical composition of CP, lipids, NFE and ash for *Longissimus dorsi* muscle didn't significantly affected with feeding Ca-SFA, while DM was significantly higher (P<0.05) with feed Ca-SFA compared to the control. These results are within the values obtained on buffalo calves by Etman (1985) and Khalifa *et al.* (2001) and on growing sheep by (Khattab *et al.*, 2003).

The compositions of subcutaneous and *longissimus dorsi* fatty acids for those finished buffalo bulls are presented in Tables (9 and 10). There was a preferential deposition of more unsaturated fatty acids in the subcutaneous adipose tissues in groups feed Ca-SFA compared to the control, and the linoleic acid was the most responsive to diet. When the levels of linoleic acid in the diet have been compared with the resulting depot fat, dietary linoleic acid was found to be preferentially deposited (Dahl and Persson, 1965).

Table 9. Effect of supplementing Ca-SFA on fraction of FA's (%) of carcass lipid Inter muscular eye muscle (*Longissimus dorsi* at the 10th rib)

Fatty acids profile	Treatments		
	Control	LFL	HFL
C14:0	1.97	2.91	2.08
C15:0	1.02	0.92	0.87
C16:0	30.75	26.02	25.68
C16:1	3.26	2.40	1.87
C17:0	2.79	2.13	2.54
C18:0	15.28	14.04	14.99
C18:1	39.19	39.92	39.00
C18:2	2.53	3.86	4.95
C18:3	1.89	4.52	4.40
C20:0	0.97	1.45	1.78
C20:1	0.35	1.83	1.84
∑ saturated fatty acids	52.78	47.47	47.94
∑ total unsaturated fatty acids	47.22	52.53	52.06
∑ mono-unsaturated fatty acids	42.80	44.15	42.71

LFL=low fat level of 25% Ca-SFA and HFL= high fat level of 50% Ca-SFA

The degree of unsaturation slightly increased as the level of Ca-SFA in the diet was increased, the greatest increase was found with high content of linoleic acid. These results pointed out that, the fatty acid profile of buffalo bull's adipose tissue reflects that of the diet and feeding Ca-SFA which produced from oils would achieve an ideal (UNS/SA) fatty acid ratio. It appeared from these data that dietary linoleic acid was preferentially deposited in the subcutaneous adipose tissues and *longissimus dorsi* muscle of the buffalo bulls. Sawosz *et al.* (1999) reported that feed lecithin and oils rich in n-3 polyunsaturated fatty acids increased α-linolenic acid and eicosapentaenoic acid (EPA) in the tissues. At the same time, preliminary studies indicated that conjugated linoleic acid is a powerful anticancer in the rat breast tumor model with an effective range of 0.01 – 1% in the diet (Voorrips *et al.*, 2002). Huerta-Leidinz *et al.* (1991) reported that whole cottonseed in steers diets were raised the linoleic acid level in all depot fats.

Results in Tables (9 and 10) showed that, *longissimus dorsi* muscle fatty acids contained a higher proportion of saturated fatty acids than those of subcutaneous adipose tissues. The unsaturated fatty acid composition of *longissimus dorsi* muscle was less than subcutaneous adipose tissues when fed Ca-SFA diet. Comparing results from animals in those groups feed 25 and 50% levels of Ca-SFA showed that mono-unsaturated fatty acid levels didn't differ for subcutaneous adipose tissues and *longissimus dorsi* muscle.

Table 10. Effect of supplementing growing sheep rations with fat on fraction of FA's (%) of carcass lipid (Subcutaneous fatty acids in Brisket)

Fatty acids profile	Treatments		
	Control	LFL	HFL
C14:0	3.09	3.13	3.49
C15:0	0.86	0.82	0.95
C16:0	30.05	25.01	23.00
C16:1	2.87	3.58	4.48
C17:0	2.31	2.22	2.22
C18:0	13.29	12.91	13.25
C18:1	42.01	43.59	42.11
C18:2	3.61	5.02	5.87
C18:3	1.26	3.20	4.00
C20:0	0.30	0.23	0.30
C20:1	0.35	0.29	0.33
∑ saturated fatty acids	49.90	44.32	43.21
∑ total unsaturated fatty acids	50.10	55.68	56.79
∑ mono-unsaturated fatty acids	45.23	47.46	46.92

LFL=low fat level of 25% Ca-SFA and HFL= high fat level of 50% Ca-SFA

Correlation coefficients between body weight and some studied traits are included in Table (11). It interesting to note that the correlations between body weight and some traits of body dimensions were high while those between HC and AG, HC and HW, HG and AG also HG and HW were poor (Table 11). This indicated that the HG, AG, AD, AH and HW are better indicators for body weight. Almost all these correlations were highly significant (P<0.01). These results confirm those reported by Omar (1984), El-Kholy (1991) and Gilbert (1993) on cattle and Salama and Schalles (1991) on water buffalo. At the same time there are high correlations among weight, meat and hot carcass as well as between meat and HC.

The regression equation used for predicting body weight (WP), eye muscle (EMP), hot carcass and values of coefficient of determination for the prediction (r^2) of WP, EMP and HC are presented in Table (12). Results indicated that the differences in the accuracy of predicting body weight, eye muscle and hot carcass got larger values with WP but was smaller with HC and WP. These results are close to that obtained by Omar (1984), El-Kholy (1991) and Gilbert (1993)

Economics of feeding on Ca-SFA:

The nutrition cost to produce 1kg meat reduced with feeding fat by 12.79 and 12.18% for 25% Ca-SFA (LFL) and 50% Ca-SFA (HFL), respectively, compared with the control ration (Table 13). Revenue, after nutrition cost only, was shown to be higher with feeding Ca-SFA (9.63 and 10.35 LE/h/d for LF and HF, respectively) vs. 8.24 and 4.37 LE/h/d for the control ration. These biological and economical results indicate that using Ca-SFA as a source of energy in finishing buffalo bull's rations would improve the revenue and meat production efficiency.

Table 11. Correlation coefficients among body weight and some traits for body dimensions and carcass characteristics of buffalo fattening bulls feed different levels of Ca-SFA

Traits	HG	AG	AD	AH	HW
Correlations between body weight and some traits of body dimensions:					
Weight	0.92**	0.93**	0.89**	0.86**	0.89**
HG		0.99**	0.96**	0.95**	0.95**
AG			0.97**	0.95**	0.94**
AD				0.95**	0.92**
AH					0.89**
Traits	**Meat**	**HC**	**HG**	**AG**	**AD**
Correlations between body weight and carcass characteristics with some traits of body dimensions:					
Weight	0.69**	0.82**	0.92**	0.92**	0.89**
Meat		0.86**	0.39**	0.03	0.18
HC			0.24	0.10	0.18
HG				0.99**	0.96**
AG					0.97**

Table 12. Regression equations for predicting weight prediction (WP), eye muscle prediction (EMP) and hot carcass prediction (HCP) using some body dimensions and carcass traits in different experimental groups

Regression equation	R2	P<	CV*
Prediction of body weight from some body dimension traits:			
WP= 15.868x +1.650HG	0.841	0.0001	7.511
WP= 10.598x - 0.423HG + 1.917AG	0.864	0.0001	7.038
WP= 10.737x - 0.788HG + 1.958AG + 0.827HW	0.868	0.0001	7.055
WP= 11.180x - 0.499HG + 2.356AG - 0.655AD	0.868	0.0001	7.056
WP= 10.854x - 0.326HG + 2.286AG - 0.432AD – 1.310AH	0.869	0.0001	7.130
WP= 11.213x - 0.793HG + 2.424AG - 0.615AD - 0.841 AH + 0.892HW	0.873	0.0001	7.143
Prediction of Eye muscle by body dimension and some carcass traits:			
EMP= 26.858x +0.081FBW	0.291	0.1340	4.423
EMP= 5.883x +0.027FBW+ 0.567RL	0.756	0.0145	2.803
EMP= 7.876x + 0.0001FBW+0.505RL+0.059HC	0.774	0.0453	2.954
EMP= 51.0870x+ 0.221 fat intake	0.569	0.0188	3.448
EMP=-63.800x + 5.042 HC	0.346	0.4117	6.967
EMP= 403.646x – 2.749 HG	0.071	0.7327	9.725
Prediction of hot carcass by HG or TDN intake:			
HCP= 182.841x + 0.218HG	0.0578	0.5734	5.937
HCP= 186.997x + 9.347 TDNI	0.1075	0.3890	5.778
Prediction of weight by fat intake:			
WP= 0.871x + 0.004 fat intake	0.082	0.2501	12.847

HG= heart girth, AG= Abdominal girth, HW= Height at withers, AD= Abdominal depth, AH= Abdominal height, FBW= fasting body weight and RL= Rump length. * Coefficient of variance

Table 13. Economical evaluation for using of Ca-SFA in different experimental groups

Item	Experimental Rations		
	Control	LFL	HFL
Feed consumed as fresh (kg /h/d)	8.37	8.56	8.73
Cost of feed consumed (LE /h/d)	7.18	7.29	7.20
Price of meat gain (LE /h/d)	15.42	16.92	17.55
Nutrition cost of kg meat produced, (LE)	13.97	12.93	12.32
Revenue, (LE)	8.24	9.63	10.35

LFL=low fat level of 25% Ca-SFA and HFL= high fat level of 50% Ca-SFA
The price of yellow corn, calcium salts of fatty acids, soybean meal, and cotton seed meal, wheat bran, rice bran, molasses, ground limestone and common salts, were LE 1250, 1650, 1650, 1050, 950, 750, 800, 95 and 120, respectively.
The price of one ton of berseem hay and rice straw were 750 and 150 L.E, respectively.
Price of meat gain/h/d, LE = price kg meat * daily meat gain (price of kg meat = 30LE)
Revenue, LE = price of feed consumed/h/d, LE - Price of meat gain/h/d, LE
Daily increase of meat/h/d kg See Table (4)

CONCLUSION

These results indicated that addition Ca-SFA as a source of energy must be taken into account in finishing period of buffalo bulls to improve meat production and quality as well as total revenue.

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تأثير تغذية مستويات مختلفة من الدهن الكالسيومى على المهضوم وأبعاد الجسم ومواصفات الذبيحة لعجول التسمين الجاموسى

فوزى محمد أبو دنيا، سمير على إبراهيم

معهد بحوث الإنتاج الحيواني، مركز البحوث الزراعية، الجيزة، مصر

تم توزيع 18 عجل جاموسى على ثلاث مجموعات. وتم تكوين ثلاثة أعلاف مركزة بحيث يتم استبدال الدهن الكالسيومى بحبوب الذرة على أساس الطاقة بنسبة صفر او25 او50% ثم وزعت هذه المركزات على المجموعات عشوائيا. كما غذيت كل هذه المجاميع غذيت على دريس برسيم وقش الأرز.وقد أوضحت النتائج مايلى: أن قيم مستخلص الأثير المحمض والأحماض الدهنية كانت مرتفعة مع المستوى العالى من الدهن الكالسيومى فى العلائق. كما ان إضافة الدهون قد حسن معنويا من إنتاج اللحم. المأكول من المادة الجافة والمركبات الكلية المهضومة والبروتين المهضوم لكل كجم لحم زيادة كان أكفأ عند التغذية على علائق تحتوى الدهن الكالسيومى. معاملات هضم مستخلص الأثير المحمض كانت مرتفعة معنويا مع إضافة الدهن الكالسيومى، بينما معاملات هضم البروتين والألياف الخام والمستخلص الخالى من الازوت لم تتأثر بإضافة الدهن. أشارت نتائج قيم المركبات الكلية المهضومة بعدم وجود تأثير معنوى لإضافة الدهون لوزيادة مستواها. لا توجد اختلافات معنوية بين المجاميع بالنسبة لقياسات أبعاد الجسم. مستويات الدهن الكالسيومى المضافة لم تؤثر على الوزن الصائم أو الفارغ لوزن الذبيحة مقارنة بالعليقة الشاهد. محيط الفخذ وكذا وزن العنق والذبيحة الساخنة ارتفعت معنويا مع إضافة الدهن الكالسيومى فى العلائق مقارنة بالعليقة الشاهد بينما لا يوجد اختلافات معنوية بين مستويات الدهن. لا توجد اختلافات معنوية بين المعاملات بالنسبة لقسيم التصافى. كمية اللحوم بالنسبة للأرباع الأمامية والخلفية للجزء الأيمن والربع الخلفى الأيسر ارتفعت معنويا مع التغذية على الدهن الكالسيومى. وزن الكبد ودهن الكلية ارتفعا معنويا مع التغذية على الدهن الكالسيومى مقارنة بالعليقة الشاهد فيما عدا وزن الكبد للمجموعة التى تناولت مستوى منخفض فى مستوى الدهن الكالسيومى. تركيز اللون ومساحة وعمق العضلة العينية ومحتوى الدهن فى العضلات عند الضلوع 9,10,11 كانت مرتفعة معنويا مع إضافة الدهن الكالسيومى مقارنة بالعليقة الشاهد. التركيب الكيماوى للبروتين والدهون ومستخلص الخالى من الازوت والرماد للعضلة العينية لم تتغير معنويا عند التغذية على الدهن الكالسيومى بينما كانت المادة الجافة أعلى معنويا عن التغذية على الدهن الكالسيومى مقارنة بالعليقة الشاهد. مكونات الأحماض الدهنية غير المشبعة فى أنسجة الدهن تحت الجلد فى المجموعة المغذاة على الدهن الكالسيومى كانت اعلى، كما إن الأحماض الدهنية غير المشبعة زادت فى الدهون الموجودة فى العضلة العينية عند التغذية على الدهن الكالسيومى. وجد ان معامل الارتباط بين وزن الجسم وبعض الموصفات الخاصة بإبعاد الجسم كانت مرتفعة إلا انه سجل ارتباط منخفض مابين الذبيحة وكل من محيط الصدر وارتفاع الجسم وكذا محيط الصدر ومحيط البطن وكذا محيط الصدر وارتفاع الجسم.

بشكل عام يمكن القول أن إضافة الدهن الكالسيومى فى علائق التهيئة لعجول التسمين الجاموسى من الممكن أن تحسن من جودة اللحوم وزيادة كفاءة إنتاجها.