Growth Performance and Economic Evaluation of Fattening Male Egyptian Buffalo Calves

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Abstract: Data of 8235 male buffalo calves belong to a commercial farm covering the period from 2006 to 2014 were used in this study. Data were classified into 5 categories according to initial weights, 4 seasons, 9 years and 4 fattening period categories. All factors under study affected ($P< 0.05$) growth performance of fattening buffalo calves. Calves with initial weight 120-150 kg performed the best results as compared to other classes of initial weights. Additionally, the Autumn season had the heaviest marketing weight and the highest daily gain (454.14 ± 0.92 and 1.013 ± 0.003 kg, respectively) and the best feed conversion ratio (8.4 ± 0.10 kg DM/ kg gain). Also, the shortest fattening period (5-6 mo) showed the best fattening performance, the highest average daily gain (1.22 ± 0.007 kg /d) and the best feed conversion ratio (7.44 ± 0.19 kg DM / kg gain). In addition, average daily gain > 1 kg achieved the lowest cost of feed and total cost per kg gain (9.5 and 12.04 LE/kg gain, respectively), the best economic efficiency (1.67), the highest profit (2542.86 LE) and annual return of investment (52.99%) compared with the other average daily gain categories (< 1.00 kg).

Keywords: Buffalo calves, fattening calves performance, economic efficiency

INTRODUCTION

National demand of red meat in Egypt is more than the national production. To bridge this gap, the Egyptian government nowadays encourages the producers to fatten buffalo male calves instead of slaughtering them at young ages as veal (El-Asheeri and Ibrahim, 2012). Buffalo meat is regarded as a healthy red meat because of its lower fat and cholesterol content in comparison to beef and pork (Singh, 2016). Growth features of buffaloes were affected by genotype and age (Ashour *et al.,* 2000; Ahmed *et al.,* 2004), sex (El-Feel *et al.,* 1993), body conformation (Shahin, 2003) and feeding (Mehrez *et al.,* 1993). Previous studies indicated that average daily gain of buffaloes ranged between 0.433 and 0.780 kg (Omar *et al.,* 1993; Mehrez *et al.,* 1993; Afzal *et al.,* 2009).

The aim of this study was to evaluate the growth performance of fattening male buffalo calves under different environmental factors, and also, to evaluate of the economics of fattening buffalo calves.

MATERIALS AND METHODS

Data and management of studied animals

The present study was conducted on a commercial buffalo herd located in Nubaria – South of Alexandria, Egypt. A total of 160543 monthly body weight records relevant to 8235 male buffalo calves were collected to cover the period of 9 years from 2006 to 2014. The calves were housed free in semi-open shed yards and each yard contained a group of calves similar in body weight. Animals were fed on corn silage mixed with concentrate ration during the year (TMR) according to their body weight requirements (NRC, 2001). Water was offered in excess to animals all the times. Animals were free from the diseases, clinically normal and possess healthy appearance.

Traits and factors under study

Calves were weighed monthly after 16 hour fasting. Feed intake was recorded per yard and averaged for each calf in kilograms dry matter. Feed conversion was number of kilograms dry matter intake / 1 kilogram body gain. Data were classified into categories according to the factors studied which were 5 initial weights, 4 seasons, 9 years and 4 fattening periods.

Statistical analysis

All data sets were tested for normality with the Shapiro-Wilk test from the UNIVARIATE procedure (SAS, 2004) and were found normally distributed [Shapiro-Wilk test (W) ≥ 0.90]. The effects of initial body weight, season and year of fattening commencement and fattening period on marketing weight, body weight gain and feed conversion ratio were tested using the following model:

$$Y_{ijklm} = \mu + B_i + S_j + F_k + P_l + e_{ijklm}$$

In which Y_{ijklm} is calf marketing weight, body weight gain and feed conversion ratio, μ is the overall mean, B_i is the fixed effect of i^{th} initial body weight (i = 1- 5), S_j is the fixed effect of j^{th} season of fattening commencement (j = 1-4), F_k is the fixed effect of k^{th} year of fattening commencement (k = 1-9), P_l is the fixed effect of l^{th} fattening period (l = 1-4), and e_{ijklm} is the residual error.

Least significant difference ($LSD_{0.05}$) was used to test the differences among means. Besides, the economic analysis was performed to find out the best average daily gain which achieved the highest economic efficiency and profit. The economic indicators were calculated as following:

a) Total cost, LE = cost of (feed + labor + veterinary care + miscellaneous) + calf purchased price.
b) Cost of producing 1 kg gain, LE = (Total cost - calf purchased price) / total body weight gain.

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c) Economic efficiency, % = Price of kg gain / Total cost / kg gain.

d) Profit, LE = Total income – Total cost = selling price + manure price – Total cost.

e) Expected fattening cycle per year = 12 / fattening period, mo.

f) Annual return of investment (ROI, %) = Profit per cycle x no. of cycles per year.

RESULTS AND DISCUSSION

As evident from Table (1) the averages of initial and final (marketing) weights of male Egyptian buffalo calves were 177.46 and 456.64 kg with total body weight gain 279.19 kg in 10.57 mo fattening period. Each calf consumed 8.30 kg dry matter daily and gained 0.91 kg per day to record a feed conversion of 9.12 kg dry matter intake for each one kg body weight gain. The obtained results were higher than those reported by Abd El-Aziz (2002) and Zeidan *et al.* (2003) who obtained growth rates of 0.778 and 0.866 Kg/day, respectively for male buffalo calves. In contrast, Tiwari *et al.* (2000) reported that average daily gain was 484 g/day with a feed conversion ratio of 11.0 kg dry matter intake/kg gain, when raising buffalo calves fed urea treated wheat straw-based rations 58% supplemented with 42% concentrate mixtures. Basra (1992) reported that growth rate in buffalo calves ranging from 549 to 728 g per day when fattened on medium-protein high-energy diets.

Table (1): Overall means and standard deviation (Mean ± SD) of some economic traits for male Egyptian buffalo calves

Item	Mean ± SD
No.	8235
Initial Weight, kg	177.46 ± 39.79
Final Weight, kg	456.64 ± 45.29
Total Gain, kg	279.19 ± 52.95
Fattening Period, mo	10.57 ± 2.80
Average Daily Gain, kg/d	0.91 ± 0.17
Feed Intake, kg DM/d	8.30 ± 1.86
Feed Conversion, kg DM/kg gain	9.12 ± 3.55

The analysis of variance for some factors affecting growth performance of male buffalo calves is presented in Table (2). All factors under the study affected ($P< 0.05$) growth performance of fattening male buffalo calves. Initial body weight affected ($P< 0.01$) marketing weight, average daily gain and feed conversion. Similar results were obtained by Tiwari *et al.* (2000) who found that feed efficiency is affected by the age, breed, body weight, fattening period, and nutrient concentration of the diet. Also, Seth (2005) recorded that the live weight and gain of buffalo male calves may be affected by the type and breed of the animal, environmental factors, and feeding management. The average daily gain could be affected by genetic resources, initial body weight and age as reported by Keshab *et al.* (2005).

Table (3) shows the least square means and standard errors of growth performance of male buffalo calves affected by initial body weights. Calves with an initial weight of 120-150 kg performed the best results as compared to other initial weight classes, although they recorded the lightest final weight (437.28 kg), they achieved the highest average daily gain (1.077 kg/d) and the best feed conversion ratio (7.77 kg dry matter intake per one kg gain). Whereas, calves with heavy initial weights (> 240 kg) had the worst performance for all studied traits. According to the growth curve, the body weight of calves tended to increase with increasing rate hence with decreasing rate by age and weight (Lawrence *et al.,* 2012) and that may explain the obtained results, so the lightest initial weight category achieved the highest daily gain because its calves mainly benefited from increasing by increasing rate but the heavy initial weight categories passed through the stage of increasing with decreasing rate. Thus, the highest average daily gain resulted in the best feed conversion. Horn *et al.* (1981) indicated that daily gains of light weight steers (*e.g.*, 300 lb) were greater than those of heavier steers (*e.g.*, 500 lb). Also, Brazle and Higgins (1999) obtained that light weight yearling steers yielded the greatest daily gain.

The calves bought in Autumn season had the heaviest marketing weights and the highest average daily gain (454.14 and 1.013 kg, respectively) and the best feed conversion (8.4 kg DM/ kg gain) as shown in Table (4). This finding could be due to the favorable climate conditions (Bayou *et al.,* 2015) in Autumn than other seasons. Hassan (1999) found that the best growth performance was for calves bought and fattened in Spring.

Table (2): Analysis of variance for factors (initial weight; IW, season and year of bought and fattening period length; FP) affecting growth performance of male buffalo calves

Source of variance	DF	Final weight, kg	Total gain, kg	Daily gain, Kg/d	Feed conversion, Kg DM/kg gain
IW	4	94176**	661153**	4.20**	422.15**
Season	3	50669**	30736**	0.28**	30.30*
Year	8	230720**	200108**	1.06**	120.00**
FP	3	646063**	750810**	21.68**	1586.80**

* : $P < 0.05$ & ** : $P < 0.01$

Table (3): Least squares means of performance traits for fattening male buffalo calves by initial weights categories

Initial weight, kg	n	Final weight, kg	Total gain, kg	ADG, kg/d	FC, kg DM/kg gain
120-150	**2272**	437.28^{e}±1.09	294.67^{a}±1.12	1.077^{a}±0.004	7.77^{e}±0.12
-180	**2331**	443.99^{d}±0.86	273.35^{b}±0.88	1.043^{b}±0.003	8.18^{d}±0.09
-210	**2075**	450.36^{c}±0.81	252.67^{c}±0.83	0.995^{c}±0.003	8.59^{c}±0.09
-240	**1180**	460.32^{b}±0.99	235.12^{d}±1.01	0.946^{d}±0.004	9.09^{b}±0.11
>240	**377**	470.00^{a}±1.68	208.35^{e}±1.72	0.847^{e}±0.006	10.12^{a}±0.18

$^{a-e}$: means with different superscripts in the same column are significant ($P< 0.05$)

Table (4): Least squares means and standard error (LSM±SE) of growth performance traits affected by season and year of brought for fattening male buffalo calves

Factor		n	Final weight, kg	Total gain, kg	ADG, kg/d	FC, kg DM/kg gain
Season	**Winter**	**1424**	439.94^{d}±0.98	257.81^{c}±1.01	0.982^{d}±0.004	8.80^{c}±0.11
	Spring	**2111**	446.74^{c}±0.93	262.50^{b}±0.95	0.984^{c}±0.003	8.64^{b}±0.10
	Summer	**2132**	452.69^{b}±0.95	267.59^{a}±0.98	1.000^{b}±0.004	8.57^{b}±0.10
	Autumn	**2568**	454.14^{a}±0.92	267.48^{a}±0.94	1.013^{a}±0.003	8.40^{a}±0.10
Year	**2006**	**749**	429.51^{g}±1.31	251.14^{g}±1.34	1.007^{d}±0.005	8.61^{f}±0.14
	2007	**1379**	427.80^{h}±0.95	243.63^{h}±0.98	0.966^{f}±0.004	8.77^{d}±0.10
	2008	**1228**	413.49^{i}±1.05	232.02^{i}±1.08	0.935^{h}±0.004	9.25^{a}±0.11
	2009	**1567**	445.17^{f}±0.91	259.56^{f}±0.93	0.980^{e}±0.003	8.68^{e}±0.10
	2010	**1218**	454.47^{e}±1.16	267.38^{e}±1.19	0.980^{e}±0.004	8.80^{c}±0.13
	2011	**519**	477.18^{a}±1.63	290.05^{a}±1.67	0.962^{g}±0.006	9.08^{b}±0.18
	2012	**357**	464.03^{b}±1.84	279.14^{b}±1.89	1.047^{a}±0.007	8.08^{g}±0.20
	2013	**1046**	461.44^{d}±1.16	276.25^{c}±1.19	1.040^{b}±0.004	8.09^{g}±0.13
	2014	172	462.32^{c}±2.55	275.45^{d}±2.62	1.038^{c}±0.010	8.08^{g}±0.28

$^{a-i}$: means with different superscripts in the same column under the same factor are significant ($P< 0.05$)

Apparent year to year variations were observed for all studied traits (Table 4). The years 2012, 2013 and 2014 achieved the highest averages daily gain and the best feed conversions compared to other years. The variations from year to year may be due to the management of herd which was improved from year to year so the last three years had the best performance. The same result was obtained by Krupa *et al.* (2005). Also, Přibyl *et al.* (2000) reported that among environmental effects, the most frequently used herd-year-season effect, which represents especially management practices, accounts for the highest proportion of variability of beef growth traits.

As evident from Table (5), the shortest fattening period (5-6 mo) showed the best fattening performance was reflected in the highest average daily gain (1.22 kg/d) and the best feed conversion ratio (7.44 kg DM/kg gain). This obtained result may be due to calves of this category were of younger ages and lighter initial weights and benefited from stage of increasing by increasing rate and the lightest final weight (415.78 kg) emphasis this view. On the other hand, the longest fattening period (10 -12 mo) had the worst performance compared to the other groups. Hassan (1999) reported that, the average growth rate of Baladi calves was over 1 Kg/day during the first four months of fattening then a sharp decrease in growth rate occurred during the following months. Punia and Singh (2001) reported that, in a short fattening period of about 4 months, river buffalo male calves may reach 350 kg of body weight with an initial weight of 200 kg. Also, Kwon *et al.* (2009) found that the daily gain of Hanwoo calves during the fattening period was higher for shorter period than longer one ($P < 0.05$).

Table (5): Effect of fattening periods on fattening buffalo calves performance

Fattening period, mo	n	Final weight, kg	Total gain, kg	ADG, kg/d	FC, kg DM/kg gain
5-6	**376**	415.78^{d}±1.76	226.99^{d}±1.80	1.228^{a}±0.007	7.44^{d}±0.19
-8	**1548**	438.67^{c}±0.94	253.89^{c}±0.96	1.042^{b}±0.003	7.83^{c}±0.10
-10	**2571**	456.74^{b}±0.76	273.00^{b}±0.78	0.924^{c}±0.003	8.82^{b}±0.08
-12	**3740**	482.34^{a}±0.72	301.50^{a}±0.74	0.786^{d}±0.003	10.34^{a}±0.08

$^{a-d}$: means with different superscripts in the same column are significant ($P< 0.05$)

The economic efficiency of fattening buffalo calves under three averages daily gain was summarized in Table (6). Average daily gain > 1 kg achieved the lowest cost of both feed and total cost per kg gain (9.5 and 12.04 LE /kg gain, respectively), the best economic efficiency (1.67), the highest profit (2542.86 LE) and annual return of investment (52.99 %) compared to the other categories (< 1.00 kg). Increasing net profit with increasing average daily gain in our study agree with the findings of Kopeček *et al.* (2009) who reported that the break-even point between cost of producing one kg gain and average daily gain is between 0.9 and one kg. El-Asheeri and Ibrahim (2012) recorded that increasing daily gain of fattening Baladi calves from 0.550 to 1.150 kg was associated with exponential increase in gross margin, output / input ratio, net profit per cycle (%) and annual return of investment (ROI, %), meanwhile decreasing in cost of producing 1 kg gain by 55.4%.

CONCLUSION

From the obtained results, we can conclude that the lightest initial weight (120 – 150 kg), the best fattening performance was obtained. Also, the calves of average daily gain over 1 kg per day achieved the best economic efficiency and the highest profit. So that we recommended to start fattening process with lower weights after weaning immediately to achieve high profitable rate.

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Table (6): Economic evaluation for fattening buffalo calves under three values of daily gain with almost the same initial weights

Item	ADG, kg/d		
	0.75	**1.00**	**> 1.00**
Number of calves	471	2798	946
Total gain of calf, kg	266	280	270
Total cost of feed /calf, LE	4178.86[a]	3535.16[b]	2572.61[c]
Cost of feed /kg gain, LE	15.71[a]	12.63[b]	9.53[c]
Total cost / calf (without calf price), LE	5086.31[a]	4348.11[b]	3250.26[c]
Total cost / calf (with calf price), LE	9258.28[a]	8322.92[b]	7386.48[c]
Total cost /kg gain, LE	19.12[a]	15.53[b]	12.04[c]
Price of kg gain, LE	20.72	20.90	20.16
Economic efficiency (8/7)	1.08[c]	1.35[b]	1.67[a]
Economic efficiency (%)	108.35[c]	134.57[b]	167.47[a]
Profit, LE	774.91[c]	1853.20[b]	2542.86[a]
Fattening period, mo	12.71[a]	10.64[b]	7.70[c]
Number of cycle / year	0.94	1.13	1.56
Profit / year, LE	731.62	2090.08	3962.90
Annual return of investment (ROI, %)	7.55	24.81	52.99

[a-c] : means with different superscripts in the same raw are significant ($P< 0.05$)

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تقييم أداء عجول الجاموس المصري خلال مرحلة التسمين من حيث النمو والكفاءة الاقتصادية

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تم استخدام بيانات 8235 عجل جاموس تابعة لمزرعة تجارية خلال مرحلة التسمين وتغطي الفترة من ٢٠٠٦ إلي ٢٠١٤م. قسمت البيانات إلي أقسام حسب العوامل موضع الدراسة وهي ٥ أقسام وزن ابتدائي و ٤ مواسم و ٩ سنوات و ٤ فترات تسمين. إتضح من النتائج أن كل العوامل موضع الدراسة كان لها تأثير معنوي علي أداء العجول. العجول التي كان وزنها عند بداية التسمين يتراوح من ١٢٠ إلي ١٥٠ كجم أعطت أفضل أداء مقارنة بباقي المجاميع لنفس العامل. أيضا حققت العجول التي تم تسمينها خلال فصل الخريف أعلي وزن بيع ومعدل نمو يومي (٤٥٤.١٤ و ١.٠١٣ كجم ، علي الترتيب) وأفضل كفاءة تحويل غذائي (٨.٤ كجم مادة جافة مأكولة/كجم نمو). كما ظهر أيضا أن العجول المسمنة لفترات قصيرة (٥-٦ شهور) أعطت أفضل أداء من حيث معدل النمو اليومي (١.٢٢ كجم/يوم) وكفاءة التحويل الغذائي (٧.٤٤ كجم مادة جافة مأكولة/كجم نمو). بالإضافة لذلك فإن معدل النمو أكبر من ١ كجم يوميا حقق أقل تكاليف تغذية وتكاليف كلية (٩.٥ و ١٢.٠٤ جنيه/كجم نمو، علي الترتيب) وأعلي كفاءة اقتصادية (١.٦٧) وأعلي عائد صافي (٢٥٤٢.٨٦ جنيه). كما حققت نفس المجموعة (أكبر من ١ كجم نمو يومي) أعلي عائد سنوي علي الاستثمارات (٥٢.٩٩٪) مقارنة بباقي المجاميع.