PRODUCTIVE PERFORMANCE OF BUFFALO CALVES FED DIFFERENT LEVELS OF MILK REPLACER

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SUMMARY

The objective of the present study was to evaluate the productive performance and economic efficiency for pre- and post-weaning buffalo calves fed milk replacer (MR) at levels of 9, 10 and 11% of their body weight in the 1st, 2nd and 3rd groups, respectively. Fifteen buffalo calves of average live body weight (LBW) 38.59±1.55 kg were chosen and separated from their dams within 2 h of birth. Calves were fed twice daily at the rate of 10% of their LBW on dam colostrum for the first three days and then the whole buffalo milk for seven days. Consecutively, calves were divided depending on their body weight into three groups with average body weight of 41.89±1.46 kg at the beginning of the experimental period (10 day initial age). The obtained results showed that increasing the level of milk replacer in the daily meal of suckling calves from 9% up to 11% of their body weight led to in parallel way to significant (P<0.05) decrease in solid feeds of starter, berseem hay (BH) and rice straw (RS). Calves in all experimental groups reached LBW over a range (87.35-94.56 kg) at weaning age (15 wk), being the heaviest was occurred with G3, while calves in G1 showed the lightest ones, being significant differences among dietary treatments. Total and daily gain from initial-18 wk were significant higher (P<0.05) in G2 than those of G1, but being similar with those found with G3. The digestibility of all nutrients as well as the feeding values (TDN and DCP) did not significantly different among the dietary treatments (different levels of MR).   On the other hand, Values of PCV, Hb and RBCs were the highest (P<0.05), while WBCs was the lowest (P<0.05) in G2. Concentrations of IgG, IgM and IgA in blood serum were significant higher (P<0.05) with G2 than those of the other dietary treatments. Likewise, most blood metabolites were also markedly higher with G2 than those of G1 and G3 which have the low or high level of MR, respectively. Comparatively the values of liver enzymes and the concentration of thyroid hormones (T4) for low level-MR (G1) were mostly significant (P<0.001) higher than those of mid MR level (G2) and insignificant higher than those of the high MR level (G3). It could be concluded that, using milk replacer at 10% of their live body weight had the improved growth performances of suckling buffalo calves as well as recognized highest economic feed efficiency as compared to those reared on the same milk replacer at levels of 9 or 11%. This may help farmers to keep up and care of suckling buffalo calves and not sell it, and such regime could help to alleviate the problem of milk and beef shortage in Egypt.

Keywords: Buffalo calves, milk replacer, growth performance, blood biochemicals.

INTRODUCTION

Buffalo is playing a prominent role in rural livestock production providing milk and work draft force (Kumar *et al*., 2011). Egyptian buffalo represent about 1.8% of the world buffalo population (FAO, 1998), which is more than 170 million head (FAO, 2004). In Egypt, buffalo milk contributes about 70% of domestic milk production (Nigm, 1996). Nutritional cost of milk production is high at all times of the year and this drain may interfere with the ability of farmers to the continuation of rearing suckling buffalo calves till weaning (3 months of age) on the whole buffaloes milk (WBM). However, several researchers have recognized that averages daily gain of calves at all times of the growing period is less affected by milk replacer compared with the whole cow milk (Moms and Wilton, 1976).

In young calves, rumen development depends on animal age and feed quality that is provided from liquid and solid feeds (Weary *et al*., 2009). Farmers forced to sell male calves at 40 days of age or earlier to save milk and avoid calf mortality to increase their income. Researchers used several feeding strategies which aimed to reduce the period from birth to weaning and as soon as possible transitioning from liquid to solid feed (Baldwin *et al*., 2004). Feeding dairy calves on milk replacer led to save milk for human consumption

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(Abdullah *et al*., 2013). Several authors reported that calves can reach early weaning and age at puberty by feeding more milk replacer (Cowles *et al*., 2006).

Solids intake by suckling calves is influenced by amount of suckled milk (Baker and Barker, 1978) and by availability and quality of solids intake (Wright and Russel, 1987). The range of correlation between level of milk consumption and weight gain among calves varies from 0.4 to 0.88 (Wyatt *et al*., 1977). Solids intake by suckling calves increases as lactation declines, and subsequently, applies greater pressure on the solids program (Fox *et al*., 1988). It has also been shown that solids intake per unit of BW before weaning is consistently increased for calves receiving low quantities of milk (Broesder *et al*., 1990) and that the consumption of milk decreases different solids intake (Baker *et al*., 1976). Few experiments have evaluated the performance of suckling calves when controlled amounts of milk with consuming solids, and the subsequent effect on the feedlot finishing phase. There were positive impact between reared dairy calves on milk replacer (MR) during the pre-weaning period and the long-term productivity of these calves (Soberon and Van Amburgh, 2012). In this respect, Bascom *et al*. (2007) reported that milk replacer had no effect on calf performance at weaning or post-weaning, while Kuehn *et al*., (1994) demonstrated a negative relationship between MR and starter consumption by calves. Weaning buffalo calves on solids intake at level of 2% (on dry matter basis) of their birth weight would be performed more efficient and economic (Salama and Mohy El-Deen, 1999). Using milk replacer in suckling buffalo calves resulted in lower feed cost per weight gain by 18.91% as compared to those fed whole milk (Aquino *et al*., 2008), without any effect on growth rate (Lorenz *et al*., 2011). Therefore, the objective of the present study was to evaluate digestibility, growth performance, hematological and blood biochemical parameters, immune response and economic efficiency pre- and post-weaning of buffalo calves fed milk replacer at different levels of their live body weight (9, 10 and 11%).

MATERIALS AND METHODS

This study was conducted at El-Gemmeza, Animal Production Research Station, belonging to Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt.

Animals:

Fifteen suckling male buffalo calves with an average live body weight (LBW) of 38.59±1.55 kg were chosen and separated from their dams within 2 h of birth and it were kept in an individual pens (1.0 × 1.5 m) bedded with rice straw. Pens were designed to allow calves fed free access of their starter and berseem hay (BH) as well as provided free access of water.

Feeding system:

Calves were fed twice daily at the rate of 10% of LBW on dam colostrum for the first three days and the whole buffalo milk daily for seven days. Consecutively, calves were divided depending on their weight into three groups with average body weight of 41.89±1.46 kg at the beginning of the experimental period. Calves in the experimental groups were fed milk replacer (MR) at levels of 9, 10 and 11% of their weight in the 1st, 2nd and 3rd groups, respectively. Liquid milk replacer was prepared at each meal in steel buckets by mixing 0.18 kg of milk replacer in powder form with one liter of warm water (60±2°C), then decreased to 38°C at feeding time. Calves were daily suckled the milk replacer 4 times at 8:00, 11:00, 18:00, and 23:00 h and given starter, 3rd cut BH and rice straw (RS) at free choice. Ingredients of milk replacer and starter as well as chemical composition on dry matter of feedstuffs are given in Tables (1 and 2).

At 12 wk of age, calves were gradually weaned by reducing the quarter amount of milk replacer every five days up to complete weaning at 15 wk of age, while taking into account the presence of free access of starter and good BH as well as provided free access of drinking water. After weaning, all nutritional allowance of all groups was calculated according to the standard of Kearl (1982).

Experimental procedures:

Growth performance parameters:

Live body weight (LBW) and feed intake (milk replacer, starter, BH and RS) of calves were recorded at 10-d initial age, 12 - wk beginning of weaning, 15 - wk weaning age, and 18 - wk post-weaning, then total gain and daily weight gain as well as feed conversion were calculated at different phases of the experiment.

Table (1): Ingredients of milk replacer powder and starter based on DM.

Ingredients of milk replacer	%	Ingredients of starter	%
Milk powder	40	Corn	48
Sweet whey powder	17	Wheat bran	15
Corn gluten meal (60%)	12	Soybean meal (44%)	23
Coconut oil	8	Sunflower meal	10
Vegetable fat	7	Limestone	2
Soybean meal powder (48%)	6	Salt	1
Feed additives	3.48	Premix[1,2]	1
Corn starch	3		
Corn flour	3		
Butyl hydroxyl toluene	0.02		
Premix[1,2]	0.5		

[1]*Provided (DM basis): 5 mg/kg of Co, 25 mg/kg of Cu, 0.01% I, 400 mg/kg of Fe, 1% K, 0.60% Na, 0.15% Mg, 90 mg/kg of Mn, 0.40% S, 0.02% Se, 125 mg/kg of Zn.*

[2] *Provided per kilogram of MR (DM basis), 55,000 IU vitamin A, 5,600 IU vitamin D, 350 IU vitamin E, 15 mg/kg of vitamin B1, 35mg/kg of vitamin B2, 25 mg/kg of vitamin B6, 100 mg/kg of vitamin C, 75 mg/kg of pantothenate.*

Table (2): Chemical analysis (% on DM basis) of milk replacer, starters, berseem hay and rice straw fed to calves.

Item	Milk replacer	Starter	Berseem hay (BH)	Rice straw (RS)
DM	97.50	88.98	87.39	88..25
Chemical composition (%):				
OM	93.19	92.55	87.19	81.87
CP	28.00	19.24	13.22	2.68
CF	1.22	5.63	27.18	38.72
EE	8.50	2.97	0.67	1.32
NFE	55.47	64.71	46.12	39.15
Ash	6.81	7.45	12.81	18.13

Body measurements:

Body length (distance between the points of shoulder and point of pin bone), heart girth (circumference of the chest measured directly behind the front leg), withers height (distance from base of the front feet to the withers), and hip height (distance from base of the rear feet to hook bones) as body measurements of calves were estimated at initial, 12, 15 and 18 wk of age.

Digestibility trails:

Digestibility trials were conducted at the end of the experiment using three calves from each group. Fecal grape samples were taken from each calf at three successive days and composted for each animal to determine total tract apparent nutrients digestibilities using silica (McDonald *et al*., 2010) as an internal marker.

Analytical procedures:

Chemical analyses of feedstuffs and feces:

Representative samples of used feedstuffs, milk replacer and feces were analyzed for DM, CP, EE, CF and ash contents according to the AOAC (1995), while nitrogen free extract (NFE) was calculated by difference.

Blood sampling:

Blood samples were taken from all experimental calves from the jugular vein after three hours of morning feeding at initial, 12, 15 and 18 wk of age in two test tubes (without and with anticoagulant). Hematological parameters, including packed cell volume (PCV), hemoglobin concentration (Hb), and count

of red (RBCs) and white (WBCs) blood cells, were determined immediately in the whole blood of the 1st blood portion (with heparin). The 2nd blood portion (without heparin) was allowed to clot and centrifuged at 3000 rpm for 20 min., then serum samples were separated and stored at -20°C till analysis. Blood serum samples were analyzed for concentrations of total proteins (Henry, 1964), albumin (Doumas *et al*., 1971), glucose (Trinder, 1969), triglycerides (Mc Gowan *et al*., 1983), total cholesterol (Richmond, 1973), LDL and HDL density lipoproteins (Friedewald *et al*., 1972), total lipids (Zollner and Kirsch, 1962), urea (Bull *et al*., 1991), and creatinine (Bartles *et al*., 1972), while, globulin concentration was calculated by subtraction of serum albumin from total proteins concentration. Immunoglobulins (IgG, IgM and IgA) concentrations in blood serum were determined with the quantitative ELISA (Bovine IgG, IgM, and IgA ELISA Quantitative kit, Bethyl laboratories, UK) according to Killingsworth and Savory (1972). Also, activity of asprtate (AST) and alanine (ALT) transaminases (Reitman and Frankel, 1957) and alkaline phosphatase (ALP, Young, 1995) were determined in blood serum. Lactate dehydrogenase (LDH) was determined colorimeterically according to Cabaud *et al*. (1958). The concentration of triiodothyronine (T3) and thyroxin (T4) in blood serum were estimated using radioimmunoassay (RIA) commercial kits (Coat-A-Count®-TKT31) by Automatic Mini-Gamma Counter (LKB-1275) according to Saunders (1995).

Statistical analysis:

Data were analyzed according to SPSS (2010). The detected significant differences were performed at (P<0.05) by Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCSSION

Feed intake:

Data in Table (3) showed that daily total dry matter intake (TDMI) of calves did not significantly affected by dietary treatments over the first 12 wk-stage. It was clearly that as a results of increasing level of milk replacer in the daily meal of suckling calves from 9% up to 11% of their body weight, both DM intake from starter and BH significant (P<0.05) decreased gradually up to 11% milk replacer (G3), that recorded the lowest quantities of both solid feeds. Likewise, over at 12-15 wk of age, TDMI was significantly (P<0.05) decreased with increasing level of milk replacer in the daily meal also, that corresponding by the significant decreased in solid feeds of starter, BH and RS. It could be observed that the increases in milk replacer rate over the experimental groups during the first two stages of growth corresponded significantly for being reduction of the solid feed in the daily meal of suckling calves (starter, BH and RS). These results greatly might be due to that calves attained up to nearly physiological satisfaction of their nutritional requirements from milk replacer in particular with the highest level on the expense of solid feeds. Over the last period post weaning (15-18 wks), the total DM intake was significant (P<0.05) lower for calves in G2 and G3 than in G1. In fact, it is well known that CF content in the pre-weaning diet for suckling calves is potentially considering a key limiting factor to reach the right time for weaning calves. Considerably, the recommended content of CF in the starter could be greatly assistance of rapid development of the rumen which in turn reflected on the post-weaning growth rate. It is of interest to note that increasing level of milk replacer intake was associated with decreasing starter, berseem hay and rice straw intakes. It is well known that energy level is the main factor affecting feed intake. Based on the obtained results of feed intake from different feedstuffs, the high level of milk replacer (G3) had high nutritional values to meet energy requirements of suckling calves. Generally, solids feed intake is a limited factor affecting weaning period. Zicarelli (2006) reported that weaning of buffalo calves reached later due to lower intake capability that delays the intake of dry matter that in turn did not ensure adequate energy for calve growth. The utilization of starter diets for young calves at an early age is the best approach for improving both rumen papillae development and subsequent performance to attain a favorable growth rate (Bach *et al*., 2007). Also, NRC (2001) announced that calf starter showed be comparatively high in readily fermentable carbohydrates to support the fermentation required for suitable ruminal tissue growth. Experimental evidence indicates that intake of roughage, especially leguminous hay stimulates the development of the reticulo-rumen as well as increasing the weight, size and thickness of tissues and the growth of normal papillae (Warner and Flatt, 1965).

Recently, researchers have shown that enhancements in growth and feed efficiency can be acquired by feeding greater quantities of milk replacer or augmented concentration of nutrients in milk replacer (Brown

et al., 2005). Moreover, ZHAO Heng-bo *et al.* (2007) indicated that the length, width of rumen papilla and its surface were significant increased in kids fed an alfalfa hay from 20 day old.

Table (3): Daily dry matter intake from different feedstuffs for buffalo calves during pre and post-weaning intervals.

Daily DM intake, kg/h	G1	G2	G3
Initial to 12 wk:			
Milk replacer	0.83	0.98	1.14
Starter	0.43[a]	0.31[b]	0.25[c]
BH	0.34[a]	0.26[b]	0.18[c]
RS	-	-	-
Total	1.60	1.55	1.57
12 to 15 wk:			
Milk replacer	0.372	0.495	0.504
Starter	0.78[a]	0.64[b]	0.56[c]
BH	0.51[a]	0.38[b]	0.25[c]
RS	0.22[a]	0.17[b]	0.11[c]
Total	1.882[a]	1.685[b]	1.424[c]
15 to 18 wk:			
Starter	1.26[a]	1.14[b]	1.12[ab]
BH	0.68[a]	0.64[b]	0.58[c]
RS	0.31[a]	0.28[b]	0.22[c]
Total	2.25[a]	2.06[b]	1.92[c]
Total DM intake	1.755[a]	1.658[b]	1.604[b]

Means denoted within the same row with different superscripts are significantly different at P<0.05.

Growth performance:

Data concerning growth performance parameters of calves pre and post-weaning stages are presented in Table (4). Results of LBW at 12, 15 and 18 wk of age were significant (P<0.05) higher with the moderate MR- meal level (G2) and the high MR level (G3) than that of low MR level one (G1). These results are in consistent with the previous studies which was demonstrated greater growth for calves fed larger amounts of whole milk (Jasper and Weary, 2002) or milk replacers based on skim milk (Gerrits *et al.*, 1996) or whey proteins (Diaz *et al.*, 2001 and Brown *et al.*, 2005). In addition, there was no significant differences between the moderate (G2) level of MR and the high (G3) level of MR regarding LBW at 18 wk of age, while at 12 and 15 wk of age, calves in G3 was (P<0.05) significant higher than those of G2. Likewise both total gain and daily gain over either initial to 12 wk of age or the whole experimental periods (Initial to 18 wk) were significant (P<0.05) higher with G2 and G3 than G1 one. Otherwise, over 12-15 wk of age and 15-18 wk of age the values of total weight gain and daily gain were significant (P<0.05) decreased. Regarding feed conversion, it was significant (P<0.05) better over the main suckling period that continued up to 12 wk of age as well as the whole experimental period (0-18 wk), with greatest efficiencies observed for calves fed higher level of milk replacer (G3). On the other hand, over 12-15 wks of age, the high level of milk replacer (G3) seemed to be lesser in feed efficiency than the other treatments (G1 and G2). Such results might be due to the higher level of milk replacer (11%) in the third experimental group that could be affect inversely on the intake of solid feeds (starter, BH and RS) and in turn affected unfavorably on growth of young calves and as well as on feed conversion as shown in Table (4). In relation to this point, high milk or milk replacer allocation to pre-ruminants retards rumen development. Therefore the recommended feeding strategy is to restrict milk or milk replacer feeding to promote early start on solid feeds. Moreover, earlier Huber *et al.* (1984) indicted that excess milk or milk replacer feeding delays starter intake and weaning age. Therefore, restricting milk or milk replacer to 8 to 10 percent of birth weight is recommended (NRC, 2001). Generally, Krishnamoorthy and Moran (2011) concluded that free access to clean drinking water and providing coarsely ground, fresh and palatable starter feed are the ways by which early intake of dry feeds can be promoted and thereby transition of pre-ruminants from milk replacers to solid feeds can be hastened. They were added that the transition of pre-ruminant feeding management from liquid milk to a diet based entirely on solid starter feeds (plus limited roughage) is one of the key management skills in rearing of young ruminants and this manual provides a good insight into how this can

be best undertaken. These results are agreement with those reported by Brown *et al.* (2005) who showed that calves fed milk replacer (30% CP and 16% fat on DM basis) at 2% their body weight was significant higher in their LBW (12 kg) more than those fed at 1% (21% CP and 21% fat) of body weight at 8 wk of age. Diaz *et al.* (2001) determined that calf growth was directly related to intake of milk replacer. Blome *et al.* (2003) demonstrated that increasing of milk replacers fed at 1.5% of BW daily (DM basis) linearly increased LBW, total gain and daily gain.

Table (4): Productive performance of calves fed different levels of milk replacer at pre and post-weaning intervals.

Item	G1	G2	G3
Live body weight (kg):			
Initial	36.40±2.12	35.80±1.90	35.30±1.35
At 12 wk of age[1]	75.80±4.17[c]	81.20±2.70[b]	87.40±3.11[a]
At 15 wk of age[2]	87.35±4.23[c]	91.82±5.12[b]	94.56±5.46[a]
At 18 wk of age[3]	99.70±3.71[b]	107.62±5.25[a]	105.55±3.11[a]
Total weight gain (kg):			
Initial ~12 wk of age	39.40±1.60[c]	45.40±2.12[b]	52.10±2.32[a]
12 ~ 15 wk of age	11.55±1.22[a]	10.62±1.26[b]	7.16±0.89[c]
15 ~ 18 wk of age	12.35±2.33[b]	15.80±3.55[a]	10.99±2.44[c]
Initial ~ 18 wk of age	63.30±4.87[b]	71.82±5.65[a]	70.25±6.11[a]
Daily gain (kg/d):			
Initial ~12 wk of age	0.469±0.04[c]	0.540±0.07[b]	0.620±0.08[a]
12 ~ 15 wk of age	0.550±0.07[a]	0.506±0.08[b]	0.341±0.09[c]
15 ~ 18 wk of age	0.588±0.08[b]	0.752±0.08[a]	0.523±0.07[c]
Initial ~ 18 wk of age	0.502±0.04[b]	0.570±0.06[a]	0.558±0.06[a]
Feed conversion (kg DM intake/kg gain):			
Initial ~12 wk of age	3.410[a]	2.870[b]	2.500[c]
12~15 wk of age	3.422[b]	3.330[b]	4.176[a]
15~18 wk of age	3.827[a]	2.739[b]	3.671[a]
0~18 wk of age	3.496[a]	2.909[b]	2.875[b]

Means denoted within the same row with different superscripts are significantly different at P<0.05.

(1): Beginning of weaning. (2): End of weaning. (3): Post-weaning.

Body measurements:

Results in Table (5) showed that heart girth was significantly (P<0.05) recorded the highest values in G3, followed by G2 and the lowest values being associated with G1. Also, body length, wither height and hip height were significant higher for G2 and G3 compared with G1. It is of interest to note that all body measurements are in harmony with LBW of buffalo calves in experimental groups. Similar to the present results in buffalo calves, Bartlett *et al.* (2006) noted that body length, heart girth, wither height were greater for Holstein calves fed at 1.75% of BW than those fed 1.25% of BW of milk replacer.

Also, Brown *et al.* (2005) found that calves fed milk replacer at 10% of their body weight increased body length, withers height and hip height compared with those fed low level (8% of body weight).

Digestibility and feeding values:

Data in Table (6) showed that the differences respecting all nutrients digestibilities and feeding values as TDN and DCP among the experimental groups, were not significant. The digestibility values of most nutrients for G1 were slightly higher than those of G2 and G3, while the slightly lower values were recorded with G3- diet. These results might be due to somewhat differences in feed intake during pre-weaning period where animal groups given different MR levels. In more explanation probably due to that animals on G1 received the low level MR- meal that also corresponding by the significant increased in solid feeds of starter, BH and RS and therefore increased of CF% content, being enhancement of rapid development of the rumen, which is reflected positively on the post-weaning ruminal function and consequently significant growth performance for calves. Additionally, calves received solid feeds at the second week of calving enhanced progressively its acceptability to consume the solid feeds offered during the whole suckling periods. This

suggests that the solid feed may have a long retention time in the rumen, and thereby small quantity of feed entering the rumen at each meal (Bhatti *et al.*, 2008), allowing for a more complete degradation by microorganisms. Importantly, the duration and the rate of ingested milk or milk replacer by suckling calves during the early stage after calving considerably can be affect on the degree of rumen development at weaning time and in turn being affect positively or negatively on nutrients digestibilities of the solid feed meal, throughout what well known as carry over effect at after weaning phases. Concerning feeding values which expressed as TDN, it could be noticed that animals in G1 recorded insignificant higher values than that of G2 and G3. While the lowest one was recorded for G2, with no significant difference. This may be due to the relatively differences in development of rumen and this is reflected on all nutrients digestibilities in the post-weaning stage.

Table (5): Some body measurements of buffalo calves fed different experimental rations at pre and post-weaning intervals.

Item	G1	G2	G3
Body length, cm			
Initial age	57.5±1.82	59.4±2.48	58.2±1.28
At 12 wk of age	69.8±1.16[b]	76.2±2.47[a]	77.8±1.16[a]
At 15 wk of age	73.8±1.53[b]	80.8±1.66[a]	80.2±1.71[a]
At 18 wk of age	79.7±1.41[b]	86.9±2.33[a]	84.5±2.22[a]
Heart girth, cm			
Initial age	78.8±1.39	79.2±2.56	79.6±1.96
At 12 wk of age	85.8±1.63[c]	92.1±2.10[b]	98.4±2.84[a]
At 15 wk of age	89.4±1.86[c]	95.4±2.36[b]	100.9±2.44[a]
At 18 wk of age	93.2±2.44[c]	99.5±5.65[b]	103.5±2.41[a]
Wither height, cm			
Initial age	62.4±1.03	64.0±1.73	63.3±1.68
At 12 wk of age	71.2±1.20[b]	68.6±1.36[b]	76.2±1.58[a]
At 15 wk of age	74.6±1.42[b]	76.0±1.58[ab]	79.4±2.11[a]
At 18 wk of age	78.3±2.40[b]	82.4±1.93[a]	83.0±1.86[a]
Hip height, cm			
Initial age	66.6±1.03	66.8±1.28	67.4±1.43
At 12 wk of age	67.2±1.20[b]	81.4±1.21[a]	82.8±1.58[a]
At 15 wk of age	79.9±2.12[b]	84.8±2.11[a]	86.1±2.10[a]
At 18 wk of age	83.8±3.24[b]	88.6±2.33[a]	89.7±1.86[a]

Means denoted within the same row with different superscripts are significantly different at P<0.05.

Table (6): Effect of milk replacer levels in daily meal of suckling calves on nutrients digestibilities at 18 weeks of age.

Item	G1	G2	G3
Nutrient digestibility (%)			
DM	66.33±2.46	65.91±3.11	65.14±2.88
CP	67.98±1.96	68.26±2.34	67.67±2.27
CF	52.59±1.34	51.02±1.11	50.39±1.22
EE	69.83±2.33	69.51±1.96	68.72±2.07
NFE	74.88±2.76	73.66±2.59	73.59±2.31
Feeding values (%)			
TDN	63.74	62.93	63.05
DCP	10.30	10.33	10.50

Concerning feeding values which expressed as DCP, it showed that no significant difference among treatments. These results are in good agreement with the findings of Bhatti *et al.* (2012) who reported that animals fed high level of milk, skim or milk replacer were not affected of all nutrients digestibilities.

Blood parameters:

Hematological parameters and immunoglobulin concentrations:

Hematological parameters including packed cell volume (PCV), hemoglobin concentration (Hb) and count of red blood cells (RBCs) were significantly (P<0.05) higher, while white blood cells (WBCs) count was significantly (P<0.05) lower in calves of G2 as compared with those of G3 and G1. It is of interest to note that all hematological parameter values of calves in all experimental groups fed different levels of milk replacer seemed to be in normal range that reported for buffalo calves by Niaz *et al.* (2000) who indicated good health status of buffalo calves fed 8 or 10 % of live body weight of milk replacer. Mostly all hematological parameters significantly (P<0.05) increased by advancing calf age up to weaning at 15 wks of age, then showed insignificant change till 18 wk of age. Analysis of variance revealed that the effect of interaction between dietary treatments and age of calves were significant (P<0.05) for PCV and WBCs count (P<0.001). On the other hand, values of PCV, Hb and RBCs were increase in G2 and slightly increase in G3 versus slight reduction in G1 and the values of these items also almost significant increased with advancing calve age. However, the count of WBCs seemed to be significant lower in G2, than that of G3 and G1 and mostly un affected by calve age (Table 7). These results are in good agreement with those obtained by Harvey (1997) who reported clear reduction in hematological parameters in first days of life, which may be attributed to feeding calves on colostrum, which increase the plasma volume by its osmotic effect. In this respect, Hulbert *et al.* (2014) showed increase in concentration of Hb, hematocrit value and count of WBCs from birth till 7 weeks of age for Holstein calves fed on milk replacer compared with natural milk or pasteurized milk.

Immunoglobulins concentration, including IgG, IgM and IgA, in blood serum of buffalo calves were significantly (P<0.05) higher in G2 than those in G3 or G1, but only IgG concentration was significantly (P<0.05) higher in G3 than that in G1. As affected by calf age, IgG concentration gradually reduced by age progress, being significantly (P<0.05) the highest at initial age, moderate at weaning (15 wk of age) and the lowest at 18 wk of age (post-weaning). On the other hand, concentration of both IgM and IgA showed almost insignificant differences among different ages of calves, being the values at weaning age (15 wk) were significant higher than those of most other ages. It is of interest to note that the effect of interaction between level of milk replacer and calf age was significant for IgG (P<0.01) and IgM (P<0.05). According to immunoglobulin concentration in Table (7), feeding calves on milk replacer at a level of 10% of LBW (G2) enhanced calf immunity, in term of increasing I IgG, gM and IgA. In this way, Foote *et al.* (2004) suggested that the quantity and quality of milk replacer fed to dairy calves may have limited improvement in immune response compared with natural milk. Overall, the high immunoglobulin concentrations in buffalo calves of G2, this might be due to increasing concentration of total proteins and its fractions and good healthy condition of calves.

The observed remarkable reduction in IgG concentration by age progressing might be attributed to that calves are born without fully mature immune system and some authors indicated that presence of ≥10 mg IgG/ml in blood of calves is necessary for successful immunity response in the first few days of age (Logue and Mayne, 2014). In good agreement with the present results, Ježek *et al.* (2012) found marked reduction in concentrations of IgG blood for calves starting immediately after birth up to four weeks of age. In contrast to the present results, the same author observed decrease in IgM and IgA concentrations in blood of dairy calves from birth till one month of age.

Concentration of some blood metabolites:

Data in Table (8) revealed significant (P<0.05) effect of milk replacer level on concentrations of total proteins (TP), globulin (GL), glucose (Glu), triglycerides (TG), LDL, HDL and total lipids (TL) in blood serum of buffalo calves, being higher (P<0.05) in G2 as compared to those of G1 and G3. However, albumin (AL), total cholesterol (TCH), urea (U) and creatinine (Cr) concentrations did not affected.

Blood TP and AL concentrations showed gradually significant (P<0.05) increase with advancing calve age, while Glu, TG, TCH, LDL, HDL and TL concentrations significantly (P<0.05) higher at initial age compared with other ages. However, Gl, U and Cr concentrations were not affected by calf age. It is worth noting that the effect of interaction between milk replacer level and calf age was significant only for lipid profile, including LDL, HDL and TL concentrations. In this respect, concentration of LDL, HDL and TL showed higher rate of increase in G2 than those of G1 and G3 (Table 8).

Table (7).

Table (8).

The presented results are in agreement with the findings obtained by Quigley *et al.* (2006) who indicated positive correlation between milk replacer level and blood total proteins and glucose in bovine calves. Also, the present results of AL and lipid profile are in agreement with those reported by Lee *et al.* (2008) for calves fed milk replacers. On the other hand, Blome *et al.* (2003) reported that plasma urea N concentration increased linearly with increasing of CP in the diets.

It is of interest to note that, increasing concentration of GLU, triglycerides, total cholesterol, LDL, HDL and total lipids in blood of buffalo at 15 wks of age was attributed to the reduce in milk replacer supply during weaning period, then its concentrations being less by advancing age up to 18 wks. These results are in agreement with those obtained by Lee *et al.* (2008). Contrary, Smith *et al.* (2002) observed that calves blood urea concentration was decline with advancing age to post-weaning. Concerning Glu concentration, it could be noticed that slight decreased of its value with advancing age up to 18-wks after weaning and such status may be due to the shift into glucose as primary source of energy replacing to lactose in milk replacer. Also, the reduction in blood glucose concentration from birth till 18 wk. are an agree with Lee *et al.*, (2008) who found that serum glucose was reduced with advancing age of calves.

Enzyme activities and thyroid hormones:

Data in Table (9) revealed that activities of aspartate transaminase (AST) and alkaline phosphatase (ALP) in blood serum of calves was significantly ($P<0.05$) higher with G1 compared with the other treatments. However, activities of alanine transaminase (ALT) and lactate-dehydrogenase (LDH) was significantly ($P<0.05$) lower in G2 than those of the other treatments. It was observed significant ($P<0.05$) reduction in AST and ALP activities with advancing age, while ALT and LDH activities did not significantly affected by calf age. The interaction effect between dietary treatments and age of calves were significant for activities of AST, ALT ($P<0.05$) and ALP ($P<0.001$), reflecting the highest rate of decrease in activities of AST and ALP in G2 as well as slight decrease in ALT activity as compared with other treatments by advancing calves age.

Despite the differences in enzyme activities as affected by dietary treatments and age of calves, its values are within the normal range of buffalo calves (Abd Ellah *et al.*, 2014), reflecting normal liver function of calves in all groups. Similar results of AST and ALT activities were obtained on lambs fed different levels of milk replacer (Yang *et al.*, 2015). Concentration of T_3 was not significantly affected by dietary treatments and calf age or their interaction. However, T_4 concentration was significantly ($P<0.05$) lower in G2 than that of other treatments, but, showing insignificant changes by advancing calve age. The effect of interaction between dietary treatments and calf age was significant ($P<0.001$) respecting T4 concentration, reflecting marked decrease in G2 (Table 9). These results are in agreement with those obtained by Hammon and Blum (1998) who concluded that calves (Simmental Red Holstein, Braunvieh Brown Swiss, and Holstein Friesian) fed different amounts (fed twice daily at the rate of 5 or 10% body weight/meal) of colostrums or a commercial milk replacer appeared to be the concentration of T_3 was not affected by dietary treatments.

Table (9): Some enzyme activities and concentration of thyroid hormones in blood serum of calves as affected by dietary treatments and its age.

Item	Enzyme activity				Thyroid hormones	
	AST (U/l)	ALT (U/l)	ALP (U/l)	LDH (g/l)	T_3 nmol/l)	T_4 (µg/dl)
Effect of milk replacer level (L):						
G1	50.80±0.50[a]	16.86±0.20[a]	95.90±1.53[a]	715.05±23.61[a]	3.03±0.04	4.38±0.04[a]
G2	46.40±0.80[c]	15.30±0.26[b]	83.96±2.92[c]	626.50±25.63[b]	2.95±0.04	4.13±0.03[b]
G3	49.05±0.55[b]	16.37±0.19[a]	89.82±2.04[b]	712.80±19.14[a]	2.94±0.03	4.35±0.03[a]
Effect of calf age (A):						
Initial	49.80±0.52[a]	16.46±0.23	100.84±1.45[a]	698.33±27.51	3.05±0.06	4.23±0.03
At 12 wk	50.40±0.70[a]	16.28±0.27	93.16±2.07[b]	707.00±24.84	3.01±0.05	4.34±0.06
At 15 wk	48.00±0.94[b]	15.87±0.29	83.33±2.72[c]	667.53±29.72	2.92±0.04	4.32±0.05
At 18 wk	46.80±0.94[b]	16.11±0.41	82.29±1.95[c]	666.27±31.54	2.90±0.03	4.23±0.06
Effect of interaction (L x A):						
P-value	0.038*	0.033*	0.000***	0.852	0.064	0.001***

Means denoted within the same column for each effect with different superscripts are significantly different at P<0.05.

Economic feed efficiency:

Although the reduction in starter, BH and RS intakes, daily feed cost increased by increasing milk replacer intake in G2 and G3 as compared to G1. On the other hand, increasing daily gain of calves in G2 and G3 as compared to G1 resulted in increasing the return of G2 and G3 compared with G1. These results indicated that economic feed efficiency of calves was the highest for G2 compared with other treatments (Table 10).

Accordingly, rearing buffalo calves on milk replacer at a level of 10% of their live body weight had the highest economic feed efficiency as compared to those reared 9 or 11% where this finding could be reflecting favorably on improvement of productive performance after weaning along the productive live of dairy and beef animals. These findings are in agreement with the results of Lee *et al.* (2008) and Soberon and Van Amburgh (2012) who reported that the different levels of milk replacer (18- 20% CP and 10- 15% fat on DM basis) reduced the feeding cost of suckling dairy calves during the first three months of age.

Table (10): Economic feed efficiency (%) of buffalo calves in different experimental groups.

Item	G1	G2	G3
Av. daily milk replacer intake (kg)	0.738	0.883	1.013
Cost of milk replacer (L.E./d)	13.28	15.89	18.23
Av. starter intake (kg/d)	0.619	0.503	0.447
Cost of starter (L.E./d)	3.095	2.515	2.235
Av. BH intake (kg/d)	0.425	0.343	0.258
Cost of BH (L.E./d)	0.808	0.652	0.490
Av. RS intake (kg/d)	0.227	0.193	0.141
Cost of RS (L.E./d)	0.125	0.106	0.078
Av. daily feeds cost (L.E.)	17.31	19.17	21.04
daily gain (kg)	0.502	0.570	0.558
Price of daily gain (L.E.)	34.14	38.76	37.94
Economic efficiency (%)*	197.2	202.2	180.3

* *Economic feed efficiency = Price of the weight gain (L.E.)/daily feed cost (L.E.)x100. Price (L.E./ton) of milk replacer powder, starter, berseem hay and rice straw was 18000, 5000, 1900 and 550, while price of each kg gain was 68 L.E. according to marketing price at 2017.*

CONCLUSION

Use milk replacer at a rate of 10% of calves live body weight improved productive performance with normal health and cost effective use for suckling calves, compared with other rates. This may help farmers to keep up and care suckling buffalo calves and not sell them and such regime could help to alleviate the problem of milk and beef shortage in Egypt.

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الأداء الإنتاجي لعجول الجاموس المغذاة على معدلات مختلفة من بديل اللبن

جمال فاروق شاهين ، منى السيد فرج ، E.A. El-Bltage ، وائل محمد وفا ، محمد عبد الحكيم كشك و صلاح ابراهيم عطية

معهد بحوث الإنتاج الحيواني – مركز البحوث الزراعية – وزارة الزراعة – الدقى – الجيزة- مصر.

تهدف هذه الدراسة الى تقييم الأداء الإنتاجي والكفاءة الغذائية والاقتصادية قبل وبعد الفطام لعجول الجاموس المغذاة على بديل اللبن بنسب مختلفة (9 ، 10 ، 11%) من وزن الجسم. تم إختيار 15 عجل جاموس ذكور بمتوسط وزن 38.59±1.55كجم وعزلت عن أمهاتها بعد الولادة بساعتين. غذيت المواليد على لبن السرسوب مرتين يوميا بمعدل 10٪ من وزن الجسم لمدة ثلاثة أيام ثم غذيت على لبن جاموسي كامل لمدة 7 أيام (كان العمر عند بداية التجربة 10 أيام) وبعد ذلك تم تقسيم العجول إلى ثلاثة مجاميع حسب متوسط وزن الجسم (41.89±1.46 كجم) عند بداية فترة المعاملة.

أظهرت النتائج أنه كلما زاد كميه بديل اللبن اليومي المقدم للعجول أنخفض معنويا المأكول من المواد الصلبة المأكولة من (بادئ ، دريس البرسيم وقش الأرز). تم فطام العجول عند عمر 15 أسبوع وكان وزن العجول في كل المجاميع أكبر من 85 كجم وأعلى وزن تحقق بشكل معنوي في المجموعة الثالثة وكانت المجموعة الثانية أثقل وزن معنويا عند عمر18 أسبوع. أظهرت النتائج أنه لا يوجد اختلافات معنوية بين معامل هضم جميع العناصر الغذائية وكذلك القيم الغذائية (TDN و DCP) نتيجة المعاملات الغذائية . ومن ناحية أخرى كانت قيم حجم خلايا الدم المتجمعة وتركيز الهيموجلوبين وعدد كريات الدم الحمراء هي الأعلى (0.05> P) في عجول المجموعة الثانية بينما عدد كريات الدم البيضاء هي الأدنى (P 0.05<) في عجول المجموعة الثانية. كان تركيز الجلوبيولينات المناعية في مصل الدم (A, M, G) الأعلى معنويا في المجموعة الثانية. وبالمثل فإن معظم نواتج الأيض في الدم كانت أعلى بشكل ملحوظ في عجول المجموعة الثانية بالمقارنة بالمجموعتين الأولى والثالثة التي غذيت على مستوى المنخفض أو المرتفع من بديل اللبن على التوالي. كانت قيم إنزيمات الكبد وتركيز هرمونات الغدة الدرقية (T3 و T4) لمجموعة العجول التي غذيت على المستوى المنخفض من بديل اللبن (G1) في الغالب أعلى بشكل ملحوظ عن المجموعة الثانية (G2) وأعلى بشكل طفيف عن المجموعة الثالثة (G3).

يمكن الاستنتاج أن استخدام بديل اللبن بمعدل10% من وزن الجسم يحسن الأداء الإنتاجي لعجول الجاموس فضلا عن أنه يحسن الكفاءة الغذائية والاقتصادية بالمقارنة مع تلك التي غذيت بمستويات 9 أو 11٪. و قد يساعد هذا المزارعين على الحفاظ على عجول الجاموس الرضيعة ورعايتها وعدم بيعها ، ويمكن أن يساعد هذا النظام في التخفيف من مشكلة نقص الحليب واللحوم في مصر.