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Suggested Plan for Feeding and Weaning of The Egyptian Crossbred Friesian Calves

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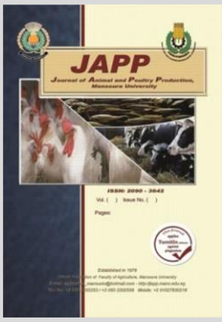

ABSTRACT

Eighteen male and three female of Egyptian crossbred Friesian calves were chosen with average weight of 34.5±0.22 kg. Calves fed colostrum for the first three days, and then it fed whole cow milk (WCM) at 10% of LBW for seven days of age. Calves fed nursery starter (NSD) and grower starter diets (GSD) according to Kearl, (1982) during pre- and post-weaning. Calves subjected to the following treatments: T1, 100% WCM as (control), while, T2 and T3 were fed two milk replacer (MR) programs, and solids rate. The age at weaning was 105, 85 and 105 days, respectively. During pre-weaning, NSD recorded the lowest values in T1 than the other treatments and calves showed an increased in TBW and DG compared with those fed MR (T2 and T3). While the period of 15 days before weaning T2 was high in TBW and DG followed by T3 and the lowest values was in T1. Calves in T1 showed the better feed conversion than those in T2 or T3. From 15 days pre-weaning up to weaning, T2 was better in feed conversion. Early weaning in T2 program (85 d) resulted in higher ($P<0.05$) CF digestibility than those weaning at 105 days in T1 or T3 programs. Calves in T2 recorded the lowest values of LBW, TBWG, and DG than the other treatments. It could be conclude that, animals fed MR reached early weaning age which could help farmers to keep up the suckling calves that alleviate milk and beef shortage problem in Egypt.

Keywords: Whole milk, milk replacer, productive performance, blood biochemicals, body measurements, pre, and post-weaning.

INTRODUCTION

For young calves, the achievement of efficient growth around weaning time is important to the profitability of the animal's production industry. During the pre-weaning phase, milk-feeding levels are generally limited to stimulate early solid feed intake and to allow the development of rumen function and consequently have possibility to applying the early weaning in practicable and economically manner. It is also a stressful period for calves because of physical and chemical components in diets are changed. Although a greater body weight is certainly advantageous for animal growth around weaning time. The intake of nutrients from liquid feed (milk replacer) before weaning is usually limited (because of the aim of so-called early weaning) to accelerate the intake of dry feed ingredients (calf starter and leguminous hay) and to stimulate development of rumen functions in early stages (Bush and Nicholson 1986). On other hand, Soberon and Van Amburgh (2013) showed that pre-weaning nutrient intake, from milk or milk replacer, can have profound effects on the development of the calf that enhance first lactation, subsequent lactations, and lifetime productivity and re-productivity.

However, the advantages of increased milk feeding for calf growth have been shown in recent studies. Khan *et al.* (2007b) showed that increased milk feeding allowed faster body weight gain and rumen development when such increased feeding rate was continued until 25 days of age, then gradually reduced to conventional feeding rate for the remaining pre-weaning period. In addition, Jasper and Weary (2002) reported that calves fed milk ad libitum gained weight much more rapidly before weaning and consumed enough solid feed after weaning, although ad libitum milk feeding suppressed the solid feed intakes before weaning when compared with conventionally reared calves fed a restricted amount of milk. In general, increased intake of nutrients in liquid phase caused less intake of starter and forage (Jasper and Weary 2002), eventually increasing body weight gain (Brown *et al.*, 2005) due to greater deposition of fat and protein (Diaz *et al.*, 2001) and causing diarrhea as well (Quigley *et al.*, 2006) which totally can be expensive and reduce the profit margins. On the other hand, Dennis *et al.*, (2016) fed male Holstein calves on low MR rate as 0.66 kg DM for 39 d followed by 0.33 kg DM for 3 d, and high MR rate as 0.87 kg DM for 5 d, 1.08 kg DM for 37 d, and 0.43 kg DM for 7 d. They found that, calves fed high MR had 9% greater ADG and 4% greater hip-width change than those fed low MR. yet nutrient efficiency was similar despite 80% more MR intake than calves fed low MR. Therefore, the objectives of this study were to evaluate the effect of two feeding levels of milk replacer during the pre-weaning period on solid feeds intake, digestibility, development of rumen, feed cost, body measurements and calves growth performance.

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MATERIALS AND METHODS

Experimental procedures and Management

This experiment was carried out at El-Gemmeza Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center. Twenty-one suckling Egyptian crossbred Friesian calves (eighteen male and three females) were chosen from the herd of station. Newborn calves were separated from their mothers within two hrs. of birth and weighed (average birth weight, 34.5±0.22kg). They were placed in an individual pen (1.0×1.5 m; bedded with rice straw) and fed colostrum at the rate of 10% of their live body weight (LBW) twice daily for the first three days. All claves were fed whole cow milk (WCM) at the rate of 10% of LBW twice daily for seven days of age. Consecutively calves were divided according to LBW into three similar groups with an average body weight of 36±0.30 kg. The WCM directly after milking was stored at 4 to 6°C in milk tank and its temperature degree was increased up to 38±1°C before offered to suckling calves. Also, milk replacer (MR) was prepared at each meal by mixing 0.143 kg of MR powder in 1 L of warm water (60±2°C) in steel buckets, and then reduced to 38°C, at suckling time.

Method, quantities, and experimental periods for three different feeding programs are detailed in Table (1).

Also, ingredients of MR and either nursery or grower starter for pre or post weaning calves are given in Table (2). Chemical compositions of all experimental feedstuffs are presented in Table (3). All experimental newborn calves were fed during the suckling period a fully mixed diet of 75% nursery starter as solid suckling diet (NSD), and 25% of third cut shopped berseem hay (BH). While, all weaned calves of the three groups were fed a growing diets (GSD) that consisted of 65% grower starter, 20% BH and 15% rice straw (RS), according to the standard levels of Kearl, (1982) and offered twice daily at 7.0 a.m and 4.0 p.m. Calves were suckled three times daily (at 8 am, 12 pm, and 6 pm), in order to milk was gradually reduced whenever they towered to the closure of suckling period. At the beginning of the last two weeks of suckling period, the frequency of daily meals was stepwise reduced to twice daily for 10 days and lastly once before 5- d of weaning periods. Minerals blocks and freshwater were available freely through the experimental periods.

Table 1. Program of feeding calves on whole milk (WCM) or milk replacer (MR) during pre-weaning period (estimated as kg DM/head/day).

Item	Treatments					
	T1(WCM)		T2 (MR)		T3 (MR)	
	days	Intake	days	intake	days	intake
Program duration (d) and intake (kg DM/d)	40	0.64	10	0.70	10	0.60
	40	0.74	20	0.85	20	0.70
	10	0.64	20	0.90	30	0.90
	10	0.48	20	0.75	20	0.70
	5	0.25	10	0.55	10	0.60
	-	-	5	0.35	10	0.50
	-	-	-	-	5	0.25
Total program period	105	0.65	85	0.76	105	0.70
TDMI / calve	68.25		64.60		73.5	

Table 2. Ingredients of milk replacer powder and starter based on DM (%).

Milk replacer composition	%	Ingredients starter	Nursery starter %	Growth starter %
Skimmed Milk powder	35.00	Corn	48	44
Fat filed milk powder	20.00	Soybean meal (44%)	23	12
Sweet whey powder	15.00	Wheat bran	15	19
Corn gluten meals (60%)	5.00	Sunflower meal	10	15
Soybean meal powder (48%)	10.00	Extracted rice bran	-	6
Animal fat	5.00	Limestone	2	2
Feed additives	3.48	Salt	1	1
Creole ground	2.00	Premix[1,2]	1	1
Corn flour	2.00			
Corn starch	2.00			
Premix[1,2]	0.50			
Butyl hydroxyl toluene	0.02			

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

[2]Provided per kilogram of MR (on DM basis), 55000 IU vitamin A, 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, 5600 IU vitamin D, 75 mg/kg of pantothenate.

Table 3. Chemical analysis (on DM basis) of milk replacer, starters, berseem hay and rice straw fed to calves during pre and post-weaning phase.

Item	WCM	Milk replacer	Nursery starter	Grower starter	Berseem hay (BH)	Rice straw (RS)	NSD*	GSD**
DM	14.21	97.35	89.13	87.62	88.42	87.84	88.96	87.81
Chemical composition (%):								
OM	95.46	94.12	92.41	92.38	86.58	82.06	90.95	89.68
CP	24.21	23.98	19.89	17	12.29	2.42	18.02	13.87
CF	-	0.7	6.06	8.62	28.02	37.01	11.56	16.75
EE	28.53	23.9	2.95	2.98	0.82	1.35	2.41	2.30
NFE	42.72	45.54	63.51	63.78	45.45	41.28	58.96	56.76
Ash	4.54	5.88	7.59	7.62	13.42	17.94	9.05	10.32

WCM: whole cow milk NSD*: 75% nursery starter + 25% BH
GSD: 65% grower starter + 20% BH + 15% rice straw.**

Growth performance parameters:

Daily feed intake was individually recorded, while the live body weight of each calf was biweekly recorded before feeding and drinking and then total and average daily gain (ADG) was calculated. Feed allowance was adjusted biweekly according to the change in body weight. Feed consumption, growth, and health condition of calves were recorded over pre and post-weaning period.

Body measurements:

Calves body measurements were estimated every month including body length (distance between shoulder and pin bone), heart girth (circumference of the chest measured directly behind the front leg), withers height (distance from base of front feet to the withers), hip height (distance from base of rear feet to hook bones) and hip widths. The BCS was recorded monthly (1 being thin and 5 being obese; modified from Wildman *et al*., 1982).

Digestibility trails:

Two digestibility trials were conducted at the 45-d before and after the weaning time of the experimental period 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 digestibility using silica as an internal marker according to McDonald *et al*. (2010).

Analytical procedures:

Chemical analyses of feedstuffs and feces:

Representative samples of used feedstuffs, milk replacers 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 biweekly from each calve from the jugular vein after three hours of morning feeding. Sample portion was allowed to clot and centrifuged at 3000 rpm for 20 min. then serum samples were separated and stored at -20°C till later analysis. Blood serum samples were analyzed for determination of total protein, urea N, glucose, triglycerides, creatinine and transaminase activity of AST and ALT using readymade kits as described by the manufacturer.

Statistical analysis:

Data were analyzed as a randomized complete block design with repeated measures when applicable by PROC MIXED in SAS (version 9.2; 2009). Treatment means were separated using Tukey's honestly significant difference comparisons (Tukey, 1977) if the overall F test for the measurement was significant (P<0.05). Nutrient digestibility (at 45-d before and after weaning time of the experimental period) and other data were analyzed by individual collection periods independently and combined within trial with repeated measurements. The detected significant differences were performed at (P<0.05) by Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Feed intake:

The intervals from the initial of the experimental up to 45 days before weaning was 60, 40 and 60 days for groups T1, T2 and T3, respectively. Data of DMI during initial up to weaning period are presented in Table (4). Data of (0 - 45 days) pre-weaning periods clearly indicated that the solid feeds (NSD) recorded the highest values in T3, followed by T1 and the lowest values being associated with T2. Concerning data of periods (45 up to 15 days pre-weaning), 15 days before weaning, it could be noticed that the solid feeds (NSD) recorded the highest values in T3, followed by T2 and the lowest values being associated with T1.

Table 4. Daily dry matter intake from different feedstuffs for calves pre and post-weaning intervals.

Item	**Treatments**		
	T1	**T2**	**T3**
0 - 45 d. pre-weaning:	(60 days)	(40 days)	(60 days)
WCM (L/h/d)	0.673	-	-
MR (L/h/d)	-	0.825	0.783
NSD (kg/h/d)	0.323	0.293	0.453
AV. TDMI (kg/h/d)	0.996	1.118	1.236
45 to 15 d. pre-weaning:			
WCM (L/h/d)	0.707	-	-
MR (L/h/d)	-	0.800	0.667
NSD (kg/h/d)	0.493	0.603	0.770
TDMI (kg/h/d)	1.200	1.403	1.437
Last 15 d. pre-weaning:			
WCM (L/h/d)	0.410	-	-
MR (L/h/d)	-	0.483	0.417
NSD (kg/h/d)	0.883	0.903	1.043
TDMI (kg/h/d)	1.293	1.386	1.460
Whole suckling periods:			
WCM (L/h/d)	0.644	-	-
MR (L/h/d)	-	0.756	0.698
NSD (kg/h/d)	0.452	0.510	0.628
TDMI (kg/h/d)	1.096	1.266	1.326
15 d. post-weaning:			
GSD (kg/h/d)	1.75	1.70	1.93
15-45 d. post-weaning:			
GSD (kg/h/d)	2.40	2.25	2.35
Whole growing periods:			
Total DMI/ calves	98.25	93.00	99.45
AV. feed intake /h/d	2.183	2.067	2.21

The clear reduce in pre-weaning starter intake as affected by increased MR feeding was a similar with previous research (Hill *et al*., 2016 a, b). Generally, the feeding of the MR over the experimental groups during the first three stages of growth corresponded by an increase in feeding levels of the solid feed in the daily meal of suckling calves compared with the calves fed WCM (T1) during weaning periods. Additionally, calves received milk replacer contain concentrated feed from plant sources enhanced progressively its acceptability to consume the solid feeds offered during the whole suckling periods. Also, Church *et al*. (1980) indicated that calves fed restricted amounts of WCM were able to increase the forage consumed to compensate the decreased in nutrient supply from milk. Similarly, Abdelsamei *et al*. (2005) noted that, the Holstein's calves increased hay intake as affected by the decrease in MR consumption. These and other searches (Jensen, 2004; Khan *et al*., 2007a) found a negative relationship between the consumption of liquid and solid feed in calves during the pre-weaning period. While the post-weaning period, it could be noticed that animals fed MR (T3 or T2) slightly consumed more solid feeds compared with animals fed WCM (T1), however, the difference was not significant. This is due to the occurrence of rumen development in all calves of the three treatments. However, the rate of rumen development in T2 or T3 was faster than that in T1, which was the main reason for the convergence of feeding rates during this period. Generally, solids feed intake is a limiting factor affecting on weaning period. Previous studies reported significant differences in the consumption of solid feed when calves were offered restricted or ad-libitum amounts of liquid feed using nipples (Khan *et al*., 2007a, b) or by buckets (Hammell *et al*., 1988). In the current study, the liquid feed consumption from a nipple by calves fed either WCM or MR resulted in similar solid feed consumption during the pre-weaning period. The rapid surge in starter consumption in all groups during weaning and within a few days of post-weaning may be attributed to a hyperphagic response caused by the reduced supply of nutrients from WCM or MR, similar trend was described by Jasper and Weary (2002) and Khan *et al.* (2007a,b). On the other hand, Bach *et al.* (2007) stated that 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.

Growth performance:

Body weight (BW), total body weight gain (TBW), daily gain (DG) and feed conversion (from solid and liquid feeds) of calves fed whole cow milk (WCM) or two milk replacers (MR) programs at pre-weaning are given in Table (5). Calves fed WCM had a heavier LBW during the pre-weaning period compared with those fed MR (T2 and T3), the differences were significant (P<0.05) at 15 days pre-weaning and at weaning. The lowest values of LBW were associated with T2 which reached the weaning stage faster (85 d.) than the other treatments (105 d). Concerning the TBW, DG and feed conversion, calves fed WCM achieved more TBW and DG during pre-weaning compared with those fed MR (T2 and T3), it was significantly (P<0.05) at days 45 to 15 pre-weaning and initial up to weaning. While the period of 15 days before weaning the second group (T2) was gained more BW, followed by T3 and the lowest values being in T1 that attributed with rumen development occurrence.

Table 5. Performance of calves fed whole cow milk (WCM) or two milk replacer (MR) programs at pre-weaning.

Item	Treatments		
	T1	T2	T3
Change of LBW (kg)			
Initial BW	36.4±1.86	36.0±1.53	36.10±1.21
45-d pre-weaning	70.50±4.22[a]	53.50±2.35[b]	69.80±3.48[a]
15-d pre-weaning	91.40±6.46[a]	72.50±5.81[c]	85.75±7.26[b]
At weaning	97.30 ±6.96[a]	81.41±3.19[b]	94.0±6.39[ab]
Total weight gain (kg)			
Initial up to 45-d pre-weaning	34.10±2.55[a]	17.50±1.12[b]	33.70±4.63[a]
Days of 45-15 pre-weaning	20.90±1.87[a]	19.00±1.56[b]	15.95±4.41[c]
Last 15-d pre-weaning	5.90±0.59[c]	8.91±0.68[a]	8.25±1.27[b]
Whole suckling periods	60.90±6.50[a]	45.41±3.89[c]	57.90±5.75[b]
Daily gain (kg)			
Initial up 45-d pre-weaning	0.568±0.02[a]	0.438±0.03[b]	0.562±0.06[a]
Days of 45-15 pre-weaning	0.697±0.05[a]	0.633±0.04[b]	0.532±0.04[c]
Last 15-d pre-weaning	0.393±0.02[c]	0.594±0.05[a]	0.550±0.04[b]
Whole suckling periods	0.580±0.04[a]	0.534±0.04[b]	0.551±0.05[b]
Feed conversion (kg feed/kg gain)			
Initial up 45-d pre-weaning	1.754[a]	2.553[c]	2.200[b]
Days of 45-15 pre-weaning	1.722[a]	2.216[b]	2.701[c]
Last 15-d pre-weaning	3.290[c]	2.333[a]	2.655[b]
Whole suckling periods	1.89[a]	2.371[b]	2.405[b]

a, b and c: Values with different superscripts within the same raw are significantly different at P< 0.05.

These results are agreement with those reported by Lynch *et al.* (1978) who showed a poor growth rate in MR-fed calves that attributed to the heat-damaged protein sources usage, lack of available amino acids (Kanjanapruthipong, 1998), and inability of MR to form a firm clot in calve abomasum (Lammers *et al.*, 1998). The greater BW gain in WCM-fed calves probably attributed with the availability of casein as ideal protein and both fat and lactose as energy-yielding constituents along with other known (vitamins, minerals, hormones, and enzymes) and the other unknown growth factors compared with those calves fed MR. Montagne *et al.* (2001) reported that, the decreased in plant protein sources apparent digestibility resulted more from an enhanced loss of host and bacterial endogenous enzymatic digestion or protein than from decreased hydrolysis of dietary protein and absorption of their AA. Moreover, plant storage proteins, as well as other components including ant-nutritional factors (e.g., proteinase inhibitors, antigenic proteins) may interact with the gut and modify the absorptive capacity of the mucosa in neonatal calves (Montagne *et al.*, 1999). Concerning feed conversion during the pre-weaning period, the calved fed WCM (T1) was better than those calved fed MR (T2 or T3), that reflected better assimilation of milk constituents. While the animals fed T2 was better in feed conversion followed by T3 and the lowest values being in T1 during the 15 days pre-weaning, this is due to increased growth rates and a lower rate of solid feed consumption in calves fed WCM during the pre-weaning period. These results are in good agreement with those obtained by Lee *et al.* (2008) who concluded that body weight gain was more efficiency during pre-weaning and overall during the studied period in calves fed WCM than those fed MR. On the other hand, BW, TBW, DG and feed conversion of calves fed different treatments at post-weaning are given in Table (6). Data of the change of LBW at different periods of post-weaning clearly indicated that calves fed WCM (T1) recorded the highest significantly (P<0.05) values, followed by T3 and the lowest (P<0.05) values was in T2.

Table 6. Performance of calves fed whole cow milk (WCM) or two milk replacer (MR) programs at post-weaning.

Item	Treatments		
	T1	T2	T3
Change of LBW (kg):			
At weaning	97.30±6.96[a]	81.41±3.19[b]	94.0±6.39[a]
15-d post-weaning	106.90±7.53[a]	89.85±5.81[b]	103.85±3.27[a]
45-d post-weaning	129.32±6.69[a]	109.10±6.39[b]	124.75±7.32[a]
Total weight gain (kg):			
Weaning - 15d post-weaning	9.60±0.26[a]	8.44±1.12[b]	9.85±4.63[a]
Last 30d post-weaning	22.42±4.37[a]	19.25±1.56[c]	20.9±4.41[b]
Whole growing periods	32.02±3.81[a]	27.69±.68[b]	30.75±1.27[ab]
Throughout the experiment	92.92±6.67[a]	73.10±5.39[b]	88.65±6.72[ab]
Daily gain (kg):			
Weaning - 15d post-weaning	0.640±0.02[a]	0.563±0.08[b]	0.657±0.03[a]
Last 30d post-weaning	0.747±0.08[a]	0.642±0.07[b]	0.697±0.14[a]
Whole growing periods	0.712±0.06[a]	0.615±0.13[b]	0.683±0.08[a]
Throughout the experiment	0.619±0.11[a]	0.562±0.08[b]	0.591±0.06[a]
Feed conversion (Kg feed/kg gain):			
Weaning - 15d post-weaning	2.734[a]	3.020[b]	2.938[b]
Last 30d post-weaning	3.213[a]	3.505[b]	3.371[b]
Whole growing periods	3.066[a]	3.361[b]	3.236[b]
Throughout the experiment	2.297[a]	2.746[b]	2.692[b]

a, b and c: Values with different superscripts within the same column are significantly different at P< 0.05.

Concerning the TBWG and DG at different periods of post-weaning stage, data in Table (6) showed that animals fed T2 were significantly (P<0.05) had the lower values than those in other treatments. The reason for the low LBW, BW change and DG rate in the second group (T2) may be due to its reaching weaning age faster than those other treatments. While the feed conversion at different periods of post-weaning noticed that, animals fed T1 recorded significantly (P<0.05) the better values compared with other treatments (T2 or T3). This result may be explained by increase the average DG values for T1 group, which may be attributed to the better bioavailability of nutrients (protein and energy) from WCM than MR. These results are in agreement with those reported by Lynch *et al*. (1978) who showed a poor growth performance in calves fed MR. Increased growth rates of calves fed different level of MR or WCM was expected and consistent with previous studies demonstrating greater rates for calves fed larger amounts of WCM (Jasper and Weary, 2002) or milk replacer based on skim milk (Gerrits *et al*., 1996) or whey protein (Brown *et al*., 2005). On the other hand, increases in ratio of gain : feed have been clearly demonstrated in response to increased rates of WCM or MR feeding that allow greater ADG (Diaz *et al*., 2001). The higher values obtained in our study also are comparable to gain : feed ratios reported for the young of other species that consume milk ad libitum, including lambs (Greenwood *et al*., 1998) and pigs (Kim *et al*., 2001). Also, Blome *et al*. (2003) reported that improvement of gain : feed in animals fed ad libitum intakes relative to animals fed at restricted intakes is attributed to the dilution of maintenance expenditures.

Digestibility and feeding values:

Data of Table (7) showed the nutrients digestibility of calves fed different experimental programs at 45 days up to weaning (pre-weaning) and 45 days post weaning. Results in Table (7) indicated that from 45 days pre-weaning up to weaning, animals fed T1 were recorded the highest (P<0.05) digestibility values of DM and EE and higher value in CP and NFE with no significant differences compared with other treatments (T2 or T3).

Table 7. Nutrients digestibility of calves fed different experimental programs at 45 days up to weaning (pre-weaning) and 45 days from weaning (post-weaning).

Item	45 days up to weaning			45 days post-weaning		
	T1	T2	T3	T1	T2	T3
Nutrient digestibility (%)						
DM	86.80±6.23[a]	80.14±4.83[b]	80.92±5.39[b]	76.81±7.82	79.10±5.74	78.25±6.20
CP	80.24±4.66	78.06±5.29	78.85±5.17	73.27±2.44	75.35±3.40	76.07±5.60
CF	13.40±1.21[c]	24.25±2.17[a]	22.49±2.56[b]	42.56±3.26[b]	51.28±3.17[a]	49.61±2.70[ab]
EE	92.40±3.81[a]	83.45±4.29[b]	85.81±6.21[b]	80.85±6.27[a]	75.48±4.73[b]	76.60±3.75[b]
NFE	87.95±4.87	82.77±3.59	84.36±8.79	75.89±4.69	78.53±7.21	77.11±5.73
Feeding values (%)						
TDN	69.83[b]	70.14[b]	73.38[a]	64.55	67.52	66.59
DCP	17.80	17.50	17.20	10.16	10.45	10.55

a, b and c: Values with different superscripts within the same column are significantly different at P< 0.05.

In general, early weaning ages in T2 program (85 d.) resulted in higher (P<0.05) digestibility value of CF, while, most nutrients digestibility compared with those weaning at 105 days in T1 or T3 groups. Hill *et al*. (2016a) found that fiber digestibility at d 35 was low in all groups then increased on d 49 and 60. On the other hand, Bhatti *et al*. (2012) reported that animals fed high level of milk or milk replacer were not affected by all nutrients digestibilities. Concerning, the nutrients digestibility of calves fed different experimental programs during 45 days post-weaning, data in Table (7) showed that the differences respecting DM, CP and NFE digestibilities and feeding values (%) as TDN and DCP among the experimental groups were not significant. The digestibility values of most nutrients for animals fed MR (T2 or T3) were slightly higher than those animals fed WCM (T1) and the animals in T1 had significantly (P<0.05) higher in EE digestibility than those other treatments (T2 or T3), while the slightly lower values were recorded in T2 group. Whoever, CF digestibilities were recorded the highest significantly (P<0.05) values in T2, followed by T3 and the lowest values being associated with T1. In general, the group fed on MR (T2 or T3) had a significant rumen development and therefore digestion coefficients were better than the first group (WCM). The low solids feed intake of calves fed program T1 (at pre-weaning) is consistent with previously cited research (Hill *et al*., 2007) as is the low dietary digestibility that may result in reduced rumen development and microbial function (Terre *et al*., 2007).

Some body measurements:

Results obtained in Table (8) and Fig (1) cleared those stature measurements of calves fed different experimental programs at birth, pre, and post-weaning, the differences respecting all different body measurements among the experimental groups were not significant. The animal's group fed WCM (T1) was recorded the slightly higher values of body length, wither height, hip height and hip width, followed by T3 and the lowest values being associated with T2.

Table 8. Stature measurements of calves fed either WCM or two MR programs at post-weaning.

Item	Treatments		
	T1	T2	T3
Body length (cm)			
At initial	68.41±4.71	67.67±4.58	67.89±3.46
At weaning	88.71±6.18	85.89±5.89	86.83±4.77
45-d post-weaning	102.16±5.84	98.29±5.49	99.63±6.17
Heart girth (cm)			
At initial	70.61±3.22	71.45±3.73	71.34±4.12
At weaning	82.81±4.36	85.05±5.37	84.09±6.49
45-d post-weaning	91.21±5.74	92.30±6.80	90.89±7.83
Wither height (cm)			
At initial	73.29±3.46	73.50±3.96	73.76±4.25
At weaning	85.99±4.82	84.25±5.26	84.83±4.75
45-d post-weaning	90.89±5.32	86.42±4.78	87.43±5.71
Hip height (cm)			
At initial	77.49±2.85	77.75±2.95	77.97±3.73
At weaning	89.28±3.44	86.75±4.70	87.22±4.53
45-d post-weaning	93.84±3.56	90.96±4.33	92.89±3.87
Hip width (cm)			
At initial	15.49±1.12	15.65±1.34	15.27±1.16
At weaning	19.39±1.34	18.05±1.25	18.54±1.29
45-d post-weaning	22.42±1.73	19.68±1.43	21.29±1.26

The differences among the experimental groups might be due to greater BW in calves fed WCM compared with those fed MR at pre- and post-weaning periods. Increases in stature measurements demonstrate that increases in BW and ADG as dietary feed intake increased were increases in frame size.

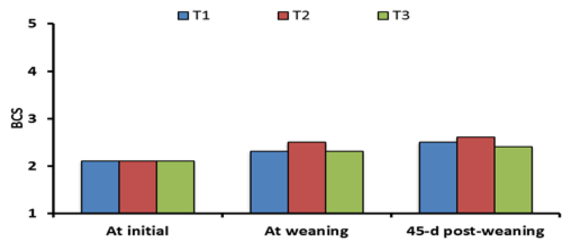

Fig (1): Effect of WCM or two MR programs on body condition score of calves at post-weaning

These results are in good agreement with those obtained by Lee, *et al.* (2009) who reported that, when calves fed WCM or MR with equal amounts of feed the body measurements were greater for WCM calves than those fed MR. It is clear to note that, the heart girth was higher in T2 and T3 calves than those in T1, this is due to the occurred of rumen development at pre-weaning with faster rate than that in T1, which was the main reason for the convergence of feeding rates during this period. This affects the rates of rumen development and size of heart girth in the post-weaning phase. Also, Bartlett *et al.* (2006) showed that body length of calves and heart girth increased and wither height also, tended to increase as dietary at 1.75% than those 1.25% of LBW. Increased some body measurements of calves fed different level of MR or WCM was expected and consistent with previous studies demonstrating greater for calves fed larger amounts of WCM (Jasper and Weary, 2002) or milk replacer based on skim milk (Gerrits *et al.*, 1996) or whey protein (Brown *et al.*, 2005). However, body condition score (BCS) is presented in Fig (1) cleared that animals fed T2 had insignificant higher BCS compared with other treatments (T1 or T3) at weaning and post-weaning. These results are an agreement with those obtained by Dennis *et al.* (2018) who reported that the greater BCS found in calves fed higher MR rates.

Blood parameters:

Blood serum metabolites concentrations in calves fed either WCM (T1) or MR (T2 or T3) at different ages are given in (Table 9). Serum concentrations of total protein, urea N, creatinine, AST and ALT were almost similar among treatments throughout the experiment in calves fed WCM or MR. Differences were not significant. The total protein concentration was increased with increasing calve age and decreased at weaning, then gradually increased after weaning. Concentrations of urea N, AST and ALT were increased with increasing age of calves. While, creatinine concentrations decreased with increasing age of calves. On the other hand, concentration of glucose increased as dietary WCM (T1) content compared with dietary MR (T2 or T3) with no significant differences during pre-weaning that attributed to better bioavailability of nutrients from WCM than from MR. While, at 15 days post-weaning, there linearly increased with significant ($P<0.05$) differences. This trend is due to it could be a rapid surge in starter consumption in both groups (T2 or T3) than those (T1) during post weaning and may be attributed to a hyperphagic response caused by the reduced nutrients supply from WCM or MR, and different speed of develop rumen. Also, increased glucose concentration that observed by advanced age of the calves followed by gradually decreasing after weaning, this change may been attributed to the physiological shift in the primary energy source from glucose to volatile fatty acids (VFA) when the rumen in young calves becomes functional (Hammon *et al.*, 2002).

Table 9. Some blood serum concentrations of mentalities calves fed WCM or two MR programs at post-weaning.

Item	Sampling time						SE
	10 d of age	45 d pre weaning	15 d pre weaning	weaning	15 d post-weaning	45 d post weaning	
Total protein (g/dl)							
T1	5.21	5.35	5.52	5.36	5.48	5.54	
T2	5.13	5.24	5.46	5.27	5.44	5.63	0.51
T3	5.03	5.19	5.38	5.24	5.40	5.64	
Urea N (mg/dl)							
T1	6.78	7.88	9.74	10.89	12.65	13.10	
T2	7.04	7.63	9.45	11.15	12.85	13.25	0.76
T3	6.88	7.58	9.39	10.73	12.86	13.28	
Glucose (mg/dl)							
T1	78.84	76.13	72.60	70.93	69.88[a]	61.38	
T2	78.25	76.86	72.89	71.24	64.45[b]	62.73	4.20
T3	78.06	76.69	72.76	71.36	64.58[b]	62.78	
Triglycerides (mg/dl)							
T1	26.65	34.25[a]	26.85	24.41	22.58[b]	20.81	
T2	26.32	33.86[b]	27.24	25.56	24.34[a]	20.74	1.52
T3	26.45	32.61[b]	27.20	25.62	24.41[a]	20.93	
Creatinine (mg/dl)							
T1	2.36	2.10	1.90	1.82	1.71	1.65	
T2	2.34	2.11	1.93	1.81	1.72	1.66	0.20
T3	2.35	2.13	1.92	1.78	1.72	1.67	
AST (U/l)							
T1	37.89	50.90	55.88	57.34	60.81	62.30	
T2	38.42	51.21	56.49	57.94	61.55	63.12	3.41
T3	38.45	51.23	56.35	57.96	61.43	63.08	
ALT (U/l)							
T1	13.01	18.35	19.01	19.36	20.10	23.10	
T2	13.09	18.41	18.71	18.94	19.95	23.21	2.56
T3	13.11	18.48	18.75	18.98	19.55	23.24	

a, b and c: Values with different superscripts within the same raw are significantly different at $P< 0.05$.

Khan *et al*. (2007b) pointed out that the glucose is the primary source of the energetic substrate derived from intestinal absorption. With the initiation of solid feed consumption, ruminal fermentation proceeds and VFA starts replacing glucose as an energy source (Baldwin *et al*., 2004). Concentration of triglycerides was ($P<0.05$) greater at 45 d pre-weaning, while, at 15 d pre-weaning the differences were not significant among all calves. The animals fed MR recorded higher values of at weaning and d 45 from pre-weaning than those WCM (T1), but difference was higher ($P<0.05$) at 15 d post-weaning. This may be ascribed to the greater content of milk fat and increased fat absorption in the former. Reduction in serum glucose concentration and increased concentration of blood urea N with advancing age in calves fed WCM or MR indicated a normal physiological fuel shift with the initiation of rumen fermentation and functions (Khan *et al*., 2007c). On the other hand, Urea-N was greater in calves fed program T1 during 45 to 15 d pre-weaning up to weaning, when Urea-N was greater in calved fed program T2 at weaning, thereafter, gradually increased with their advancing age and increased CP intake. This result may be ascribed to higher CP consumption from solid feed and its subsequent degradation in the rumen. These results are an agreement with those reported by Khan *et al.* (2007 a,b). The increase in creatinine concentration is a marked sign of renal dysfunction however, its concentration in the calves fed WCM or MR in the present study was within the normal concentration range (Hammon *et al*., 2002) and declined, as calves grew older. Serum concentrations of total protein, ALT and AST, were within normal and safe ranges (Khan *et al*., 2007 a,c).

Economic feed efficiency:

Data presented in table (10) cleared that the expensive daily feeding cost (LE/ head) was recorded for group T1 with reduction in TDM intakes, compared with other treatments, while the lowest (cheapest) daily feeding cost was recorded for group T2 and T3.

Table 10. Economic feed efficiency (%) of calves as influenced by either WCM or two MR programs during pre and post-weaning intervals.

Item	Treatments		
	T1	T2	T3
Av. intake (DM; kg/d)			
WCM	0.645	-	-
MR	-	0.756	0.698
FS1	0.452	0.51	0.628
FS2	2.183	2.067	2.210
AV. DMI	1.423	1.543	1.591
Cost of total intake (DM; L.E./d)			
WCM	22.70	-	-
MR	-	22.68	20.94
NSD	2.32	2.614	3.219
GSD	9.87	9.35	10.0
Total cost of TDMI (LE/d)	34.89	34.65	34.15
AV. daily gain (kg)	0.619	0.562	0.591
Cost of daily gain (L.E.)	37.14	33.72	35.46
Economic efficiency (%)*	106.45	97.34	103.84

The price of feedstuffs as dray matter (LE/ton): Nursery starter, grower starter, BH, RS, WCM, MR, FS1, and FS2 were 6000, 5200, 2500, 820, 35187, 30000, 5125 and 4523. While the price of each kg of daily gain (LE/kg) was 60 LE according to marketing price in 2019.

*** Economic feed efficiency = Price of the weight gain (L.E.) / daily feed cost (L.E.) x 100.**

On the other hand, increasing daily gain of calves in T1, followed by T3 and the lowest values being associated with T2, resulted in increasing the economic efficiency of T1 (106.45%) and T3 (103.84%) compared with T2 (97.34%), (Table, 10). This leads to the farmer refrain from feeding and fattening calves and not selling them at the age of one month to two months. As mentioned before, T2 showed the shortest period at weaning ages 85 days, followed by T1 and T3 (105 days, Table 3). As well as providing the quantities of milk necessary for feeding calves (T2 or T3), this is the most important characteristic in terms of the speed of capital turnover, reduce risk, save labor costs and provide natural milk as it can be used in the process of manufacturing various dairy products. These findings are in agreement with the results of Lee *et al.* (2009), who reported that commercially available MR inclusion of plant protein (soy and wheat protein concentrate) in MR depressed the growth of MR calves probably by limiting the supply of some indispensable AA, Which may decrease somewhat the economic feed efficiency.

CONCLUSION

Our research showed that although it is preferable to use whole milk in feeding the newborn calves, where we found that BW and body measurements tended to increase in calves fed WCM than in those fed MR. Also, calves fed WCM consumed less DM for a unit BW gain, except for 15 days after weaning. While, the animals fed the milk replacer, it's the improved of rumen performance and the calves reach age of weaning at younger ages and does not occur health relapses during weaning period, in addition to rapidly of capital turnover, reduce risk, save labor costs and provide whole milk as it can be used in the process of manufacturing various dairy products, this may encourage farmers to keep up and care of suckling calves and not sell them. Such regime could help to alleviate the problem of milk and beef shortage in Egypt.

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الخطة المقترحة لتغذية وفطام عجول الفريزيان الهجين المصرية

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تهدف هذه الدراسة إلى مقارنة عدد من برامج تغذية وفطام عجول الأبقار خليط الفريزيان بإستخدام اللبن البقرى الكامل وبديل الألبان وتأثيرها على الأداء الإنتاجي والكفاءة الاقتصادية في مرحلة قبل وبعد الفطام للعجول تحت الظروف المصرية. تم إستخدام ثمانية عشر ذكر وثلاثة إناث من عجول الأبقار خليط الفريزيان بمتوسط وزن 34.5 ± 0.22 كجم وغذيت على لبن السرسوب بمعدل 10٪ من وزن الجسم مرتين يوميًا خلال الأيام الثلاثة الأولى من عمرها. ثم غذيت يوميا بمعدل 10٪ من وزن الجسم لبن بقرى كامل (WCM) لمدة سبعة أيام من العمر. تم تقسيم العجول حسب وزن الجسم والجنس إلى ثلاث مجاميع بمتوسط وزن 36.0 ± 0.30 كجم. تم تسكين العجول بحيث تتمكن من تناول عليقة البادئ قبل الفطام وعليقة النامي بعد الفطام حسب مقررات Kearl, 1982. إمتدت الفترة التجريبية حتى 45 يوم بعد الفطام وتم تقسيم العجول للمجاميع كالتالي:- المجموعة الأولى تم تغذيتها على 100٪ من إحتياجاتها من اللبن البقري الكامل (كنترول). المجموعة الثانية والثالثة غذيت على برنامجي بديل ألبان بمستويين وأعلاف مركزة بمستويين وكان العمر عند الفطام 105 , 85 و105 يوم للمجاميع الثلاثة على التوالي. سجلت مجموعة الكنترول أقل معدل مأكول من الأعلاف المركزة مقارنة بباقي المجاميع مع زيادة في وزن الجسم ومعدل النمو , وخلال فترة 15 يوم قبل الفطام زاد معدل النمو في المجموعة الثانية يليها المجموعة الثالثة وكان أقل معدل نمو في مجموعة الكنترول. كان معدل التحويل الغذائي أفضل في المجموعة الأولى مقارنة بالمجاميع الثانية والثالثة في حين قبل 15 يوم من الفطام وحتى الفطام كانت نتائج المجموعة الثانية هي الأفضل. أدى الفطام المبكر في المجموعة الثانية عند عمر 85 يوم لزيادة معدل هضم الألياف الخام معنويا (P<0.05) في حين إنخفض معدل هضم معظم المركبات الغذائية مقارنة بالمجاميع الأولى والثالثة. إنخفض معنويا (P<0.05) كل من وزن الجسم ومعدل النمو الكلي واليومي في مختلف الفترات في المجموعة الثانية مقارنة بباقي المجاميع. ويمكن استخلاص أن تغذية العجول على اللبن البقري الكامل أدى لأفضل معدلات نمو وكفاءة الاقتصادية , كما أن التغذية على بدائل الألبان يؤدي لتحسين أداء الكرش (سرعة تطور الكرش) وأدى للوصول للفطام في عمر مبكر (85 يوم) بدون حدوث أي مشاكل أثناء فترة الفطام مما يساعد المربين في الحفاظ على العجول الرضيعة ورعايتها وعدم بيعها مما يساهم في حل مشكلة نقص المنتج من اللبن واللحم في مصر.