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Growth Performance, Liver and Thyroid Functions in Buffalo Calves Reared on Milk Replacers Supplemented with Hydrogenated Oils

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TWENTY FIVE buffalo calves were fed natural milk for up to one week of age and then were divided into five groups : (A) : controls; fed natural milk, and (B, C, D and E; groups were assigned to a 2 × 2 factorial design, where two brands (Sultan and Momtaz) and two levels (20% and 30% DM) of hydrogenated oils were added to skim milk-based replacers. Calf starter and hay were offered ad libitum with the liquid diets from the fourth week of age. Daily body weight gain and serum levels of : T_3, T_4, cholesterol, total proteins, albumin and the enzyme activities of transaminases (GOT & GPT) and alkaline phosphatase were determined at 3, 6, 9 and 12 weeks of age.

The daily weight gain was significantly ($P < 0.05$) less in the groups receiving hydrogenated oils. Feeding different brands and levels of hydrogenated oils added to skim milk caused significant decreases in the mean values of cholesterol. T_3, T_4 ($P < 0.01$) and T_4/T_3 ratio ($P < 0.05$). Addition of Sultan oil to skim milk resulted in significant increases in serum levels of total proteins and globulins ($P < 0.01$), and significant decreases in A/G ratio ($P < 0.01$) and both of GOT ($P < 0.05$) and alkaline phosphatase ($P < 0.01$) activities. The opposite results were noted in blood constituents and enzymatic activity when Momtaz oil was added. The decrease in thyroid function and body weight gain is clearly shown in this study and needs further investigations.

Key Words : Buffalo calves, milk replacers, hydrogenated oils, thyroid & liver functions, blood parameters.

Nutritional needs of the progressively increasing human population is becoming difficult to satisfy. Consequently, animal products (milk and meat) have to be increased to meet such requirements by increasing livestock population. Water buffaloes have the advantage of producing milk and meat with good quality and can reasonably tolerate the hot climate of subtropic zones. In order to save

the maximum amount of milk for human feeding, milk replacers have been used to feed buffalo calves up to the weaning age instead of slaughtering them. Toullec *et al.* (1980) used milk replacers that were essentially made up of natural milk in which fatty substances were replaced with more economical sources of energy (substitute lipids, powdered milk, whey and starchy products and slightly unsaturated vegetable oils). The effect of source and level of fat in milk replacers on growth and carcass weight of lambs, cows and buffalo calves has been studied (Glimp, 1972; Roy *et al.*, 1973; El-Ashry *et al.*, 1975 and 1978; Jenkins and Emmons, 1979; Soliman *et al.*, 1982 and El-Shinnawy *et al.*, 1984). Data on the effect of source and level of fat in milk replacers on blood constituents, enzymatic activity and thyroid function in buffalo calves are lacking.

The aim of the present study was to examine the effect of replacing milk fat by different brands and levels of hydrogenated oils on daily body weight gain, blood constitutents, enzymatic activity and thyroid function in buffalo calves.

Material and Methods

Twenty five newly-born male and female buffalo calves with average body weight of 42 kg were used in this study. The calves received the colostrum and were then weaned from their dams 48 hr after birth and fed buffalo milk up to 7 days of age at the rate of 6 liters/day in two equal meals at 8:00 a.m. and 3:00 p.m. Later on, the calves were randomly assigned to five groups: Group (A) served as the control; fed natural buffalo's milk. The other four groups (B,C,D and E) were used in 2× 2 Factorial design where two localy produced brands (Sultan and Momtaz) and two levels (20% and 30% on dry weight basis) of hydrogenated oils were added to spray-dried skim milk-based replacers. Table (1) shows the constituents of the natural milk and milk replacers offered to the experimental groups. The liquid diet was prepared by reconstituting 150 gm of the replacer powder in warm water to form a final volume of one liter. The liquid form of the replacers contained 3.8% and 5.2% fat, where the latter was added at 20% and 30% on dry matter basis, respectively. The natural buffalo's milk contained 7.5% fat. The liquid diets were offered

twice daily (8:00 a.m. and 3:00 p.m.) to the calves at the rate of 6 liters/calf/day. Starting from the fourth week of age, the amount of replacer was reduced to 4 liters/calf/day and calf starter (consisting of : 18.5% crude protein, 6.7% crude fiber, 4.9% ether extract, 11.3% ash and 58.5% nitrogen-free extract-gross energy 425.9 Kcal/100 gm), clover hay and water were offered *ad. libitum*. Body weight was measured weekly and the average daily gain (kg/day) was calculated. The occurrence of diarrhea was recorded daily. Three blood samples were collected from each calf : I) before suckling (8:00 a.m.), II) two hr after suckling (10 : 00 a.m.) and III) six hr after suckling (2 : 00 p.m.) at the end of 3rd, 6th, 9th and 12th weeks of age. Serum was separated and stored at —20°C till analyzed for total proteins (Armstrong and Carr, 1964), albumin, (Doumas *et al.*, 1971), cholesterol (Watson, 1960), transaminases (GOT & GPT) activity (Reitman and Frankel, 1957), alkaline phosphatase activity (Bessey, 1946), triiodothyronine, T_3 (Larsen, 1972) and total thyrozine, T_4 (Chopra, 1972). Since no apparent differences between the three blood samples collected from each animal were noted, their average was calculated and used as single value. Serum globulin (G), A/G ratio and T_4/T_3 ratio were calculated. The data were statistically examined according to Snedecor and Cochran (1982).

Results and Discussion

Diarrhea occurred more frequently in the two groups given the Momtaz fat (20% and 30% of DM), particularly during the first three weeks of age. The cases were not very severe, therefore, no change in liquid diet intake was recorded.

The calves reared on natural milk gained more weight than those reared on milk-based replacers containing hydrogenated oils, throughout the whole experimental period (Fig. 1). The inclusion of hydrogenated oils at the two levels used from both Sultan and Momtaz brands resulted in almost similar daily body gain throughout the experimental period. These findings are in complete agreement with those reported in buffalo calves (El-Ashry *et al.*, 1978), cattle calves (Roy *et al.*, 1973) and lambs (Soliman *et al.*, 1982). The reduced body weight gain in the calves fed hydrogenated oils may be due to poor digestibility and utilization by the newly-born calves (El-Shinnawy *et al.*, 1984). Furthermore, the lower body

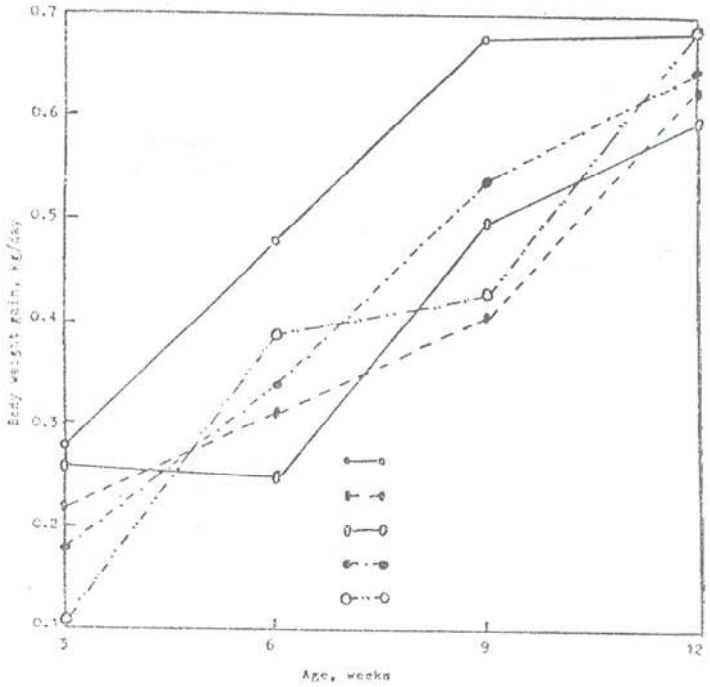

Fig. 1. Effect of replacing milk fat by hydrogenated plant oils on body weight gain (kg/day) in buffalo calves.

weight gains obtained in the skim-milk based replacer groups can be attributed to the fact that these calves were offered diets containing less energy and crude protein than the control group (Table 1). In this respect, Touliec *et al.* (1980) demonstrated that digestion in the pre-ruminant calves and lambs depends much more than in ruminants on the quantitative value of their ration, especially of its protein fraction, and to a lesser extent on the nature of energy.

Replacing milk fat by hydrogenated plant oils had significant ($P < 0.01$) effects on serum total proteins, serum globulins, A/G ratio and cholesterol contents (Table 2). Although the replacement of milk fat by hydrogenated plant oils reduced values of blood

TABLE 1. Composition of natural milk and skim-milk based replacers.

Components	Natural milk (liquid)	Skim milk + Sultan fat		Skim milk + Momtaz fat	
		20%	30%	20%	30%
	(A)	(B)	(C)	(D)	(E)
Dry matter (DM), %	17.67	94.45	95.40	94.45	95.40
Organic matter, % DM	95.72	92.27	92.49	92.27	92.27
Crude protein, % DM	26.58	22.93	21.81	22.93	21.81
Ether extract, % DM	42.29	24.93	34.75	24.99	34.75
Crude fiber, % DM	—	2.78	2.51	2.78	2.51
Nitrogen-free extract, % DM	26.86	41.57	33.43	41.57	33.43
Ash, % DM	4.28	7.73	7.51	7.73	7.51
Gross energy (K cal/100 gm DM)	661.85	551.89	601.92	551.89	601.92
Mineral mixture(1), DM	—	0.5	0.5	0.5	0.5
Vitamin mixture(2), % DM	—	1.0	1.0	1.0	1.0

(1) Mineral mixture was composed of the following ingredients : dicalcium phosphate 89%, sodium chloride 6%, magnesium oxide 2% and trace elements (Zn : Mn : Fe : Cu mixed as 2.5 : 1 : 1 : 0.5) 2%

(2) Vitamin mixture was composed of the following vitamins (mg/kg) : vitamin A 400, Vitamin E 22, vitamin B-12 200, vitamin D-3 12.5 ascorbic acid 150, chloride, coline (50%) 40, riboflavin 8, folic acid 0.2, micotinic acid 30 and Ca-pantothenate (80%) 20.

TABLE 2. Effect of replacing milk fat by hydrogenated plant oils on blood constituents buffalo calves (mean ± S.E.).

Items	Age (weeks)	Natural milk (A)	Skim milk with hydrogenated plant oils			
			Sultan fat		Momtaz fat	
			(B) 20%	(C) 30%	(D) 20%	(E) 30%
Serum total proteins, gm/dl**	3	6.2 ± 0.29	6.2 ± 0.10	6.2 ± 0.23	6.1 ± 0.59	6.0 ± 0.09
	6	5.7 ± 0.27AC	6.3 ± 0.13A	6.2 ± 0.16B	5.5 ± 0.16ABE	5.6 ± 0.07ABD
	9	6.2 ± 0.15B	6.0 ± 0.17C	6.4 ± 0.21A	5.7 ± 0.21ABD	5.7 ± 0.16ABE
	12	6.4 ± 0.23A	6.1 ± 0.25C	6.4 ± 0.18B	5.8 ± 0.07ABE	5.9 ± 0.09ABD
Serum albumin, gm/dl	3	2.9 ± 0.05	2.9 ± 0.04	2.8 ± 0.02	3.3 ± 0.28	2.7 ± 0.05
	6	2.9 ± 0.02	2.8 ± 0.17	2.9 ± 0.05	2.9 ± 0.12	2.8 ± 0.07
	9	3.0 ± 0.04	2.9 ± 0.04	3.0 ± 0.05	3.0 ± 0.02	2.9 ± 0.05
	12	3.0 ± 0.16	3.0 ± 0.04	2.9 ± 0.06	2.8 ± 0.08	3.0 ± 0.10
Serum globulins, gm/dl**	3	3.3 ± 0.33B	3.3 ± 0.10C	3.4 ± 0.24A	2.8 ± 0.25AE	3.3 ± 0.08D
	6	2.9 ± 0.31ABC	3.4 ± 0.09ACE	3.4 ± 0.15B	2.6 ± 0.28ABE	2.8 ± 0.06ABD
	9	3.2 ± 0.11B	3.3 ± 0.10C	3.4 ± 0.18A	2.7 ± 0.26ABE	2.9 ± 0.15AD
	12	3.4 ± 0.39B	3.4 ± 0.09A	3.5 ± 0.16A	3.0 ± 0.14AD	2.9 ± 0.04ABE
A/G ratio**	3	0.89± 0.10AB	3.2 ± 0.27C	0.83± 0.07ABCe	1.18± 0.01A	0.85± 0.03DA
	6	1.04± 0.11B	1.82± 0.06ABC	1.85± 0.04BCD	1.12± 0.16A	0.98± 0.04AC
	9	0.98± 0.05AC	0.94± 0.07AD	0.88± 0.04ABE	1.13± 0.11A	1.02± 0.07B
	12	0.90± 0.04ABD	0.99± 0.10B	0.86± 0.05ABE	0.95± 0.074C	1.06± 0.03A
Cholesterol, gm/dl**	3	78.2 ± 4.74A	54.3 ± 3.08ABE	55.8 ± 2.77ABD	61.7 ± 5.02AC	68.1 ± 3.53B
	6	77.7 ± 3.62A	54.6 ± 1.83AD	58.2 ± 3.50ABC	52.1 ± 0.74AE	61.6 ± 2.52AB
	9	72.0 ± 4.94A	53.7 ± 1.13AD	54.1 ± 2.06AC	53.6 ± 1.79AE	62.2 ± 4.08B
	12	75.3 ± 7.13A	53.8 ± 1.00ABD	56.5 ± 4.02ABC	51.6 ± 1.38ABE	74.2 ± 0.56B

** $P < 0.01$.

Within rows means with the same superscripts are significantly different.

TABLE 3. Effect of replacing milk fat by hydrogenated plant oils on enzymatic constituents activity in buffalo calves (mean ± S.E.).

Items	Age (weeks)	Natural milk (A)	Skim milk with hydrogenated plant oils			
			Sultan fat		Momtaz fat	
			(B)20%	(C)30%	(D)20%	(E)30%
GOT_1 U/dl*	3	72.0±5.79b	62.0±2.96ae	70.7±4.17c	82.8±28.84a	67.2± 3.89ad
	6	76.8±5.36a	62.8±3.40ad	64.7±4.36ac	70.2±14.50b	61.5± 5.77ae
	9	71.0±1.00b	61.2±6.09ae	63.0±4.15ad	72.8± 2.30a	68.1± 4.72c
	12	72.5±1.00b	62.2±6.99ae	65.8±4.85d	70.8± 0.30c	74.3± 1.50a
GPT, U/dl	3	20.9±1.45	21.9±1.96	23.1±1.94	22.2±3.17	22.0± 0.95
	6	22.9±1.13	21.2±2.36	23.5±1.72	21.5±5.50	20.4± 2.27
	9	21.1±0.94	22.8±2.31	23.4±1.89	22.7±1.68	25.3± 2.83
	12	24.0±0.33	24.8±3.82	24.7±1.01	23.7±2.00	25.5± 3.39
Alkaline phosphatase, U/dl**	3	47.8±5.25ABC	36.2±3.60ABE	39.8± 6.08ABD	78.7± 0.01B	74.5±10.83A
	6	66.2±16.26AC	41.2±6.37ABCE	53.9±11.42ABD	76.0± 6.00B	88.4±12.18A
	9	72.6±16.65ABC	49.7±9.67ABCE	69.2±13.09ABD	75.3±12.83B	89.1± 7.33A
	12	94.7±14.67A	65.9±5.20ABE	74.8±16.68ABC	73.3± 4.67ABD	94.4±10.05B

* $P < 0.05$

** $P < 0.01$

Within rows, means with the same superscripts are significantly different.

TABLE 4. Effect of replacing milk fat by hydrogenated oils on thyroid hormones in buffalo calves (mean ± S.E.).

Items	Age (weeks)	Skim milk with hydrogenated plant oils				
			Sultan fat		Momtaz fat	
		(A)	(B)20%	(C)30%	(D)20%	(E)30%
Triiodothyronine (T_3)** ng/dl	3	94.1±24.03A	77.3±13.23C	49.3±14.01ABCE	81.1± 1.17B	61.5± 5.28D
	6	112.2± 9.26A	72.0± 7.46D	51.6± 6.55ABCE	106.8±27.25B	85.3±10.12C
	9	102.0±17.03B	69.3± 5.75ABCD	69.3±15.67ABCD	114.7±28.06A	101.9±12.59C
	12	103.7± 7.00B	83.5± 3.16D	73.7± 8.30ABE	86.8± 0.17C	116.9± 8.14A
Thyroxine (T_4), ug/dl**	3	5.2±0.97A	3.3±0.41AG	2.4±0.73ABD	3.4± 0.13B	2.8± 0.35AE
	6	5.6±0.44A	2.7±0.29ABE	2.8±0.31ABC	4.1± 1.01B	2.8± 0.37ABC
	9	5.8±0.55A	2.9±0.24ABE	3.2±0.32ABD	4.4± 0.36B	3.7± 0.40C
	12	5.8±0.55A	2.9±0.24ABE	3.2±0.32AD	4.4± 0.36B	3.7± 0.40C
T_4/T_3 ratio*	3	57.6± 3.78a	44.4± 4.53ad	48.8±12.06b	42.3± 1.04ae	46.0± 4.61c
	6	50.3± 3.04b	38.9± 3.47ac	56.4± 4.95a	38.1± 0.28ad	34.0± 5.47abe
	9	58.6± 5.27a	42.6± 2.14ad	53.0± 8.58b	42.2± 8.93ac	37.2± 3.10abe
	12	48.3± 2.23ad	44.5± 4.38b	48.5± 3.94ac	56.2± 1.45a	37.2± 4.42ae

* $P < 0.05$

** $P < 0.01$

Within rows, means with the same superscripts are significantly different.

constituents studied, the measured values for these parameters were within the range of the normal mean values for healthy buffalo and cattle calves (Foad *et al.*, 1975 and O'Kelly, 1973).

Table (3) shows that replacing milk fat by hydrogenated plant oils, especially the Sultan, decreased the activity of serum GOT ($P < 0.05$) and alkaline phosphatase ($P < 0.01$). Boots *et al.* (1969) found a linear relationship between body weight and GPT in Holstein cattle, and suggested that any factor affecting metabolism will affect transaminase activity. In the current study, the decrease in body weight gain noted in the hydrogented oils-fed groups can be attributed at least in part, to the depressing effect of hydrogenated oils on serum enzymes responsible for various processes related indirectly to growth and development.

Measurement of thyroid function revealed that the natural milk-fed calves had, in general, significantly higher serum T_3 ($P < 0.01$), T_4 ($P < 0.01$) and T_4/T_3 ratio ($P < 0.05$) than those fed skim-milk containing hydrogenated oils (Table 4). It is well known that thyroid hormones significantly influence growth and development of animals as well as protein, carbohydrate, fat, minerals and energy metabolism (Mixner *et al.*, 1966). The relationship between thyroid hormones and growth has been investigated (Post, 1965 and Kahll *et al.*, 1977), and such relationship is highly dependent on the nutritional status of the animal (Post, 1965). Therefore, the decreased body weight gain noted in hydrogenated oils-fed calves may be attributed, at least in part, to the decreased level of thyroid hormones.

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النمو ونشاط كل من الكبد والغدة الدرقية للعجول الجاموسى المنشأة على بدائل البان تحتوى على زيوت مهدرجة

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استخدم فى هذه الدراسة خمسة وعشرين عجل جاموسى ابتـداء مـن الاسبوع الاول من العمر قسمت الى خمس مجموعات . مجموعة مقارنة غذيت على لبن كامل (أ) مجموعات ب ، ج ، د ، هـ استخدمت لدراسة تأثير نوعين من الزيوت المهدرجة (السلطان والممتاز) عند استخدامهـا بمستويين (٢٠ و ٣٠ ٪ من المادة الجافة) كأضافة الى مكونات بديـل اللبن المستخدم فى تنشئة هذه العجول . قدم للعجول البادىء والدريس للتغذية حتى الشبع أبتداء من الاسبوع الرابع من العمر وقد درس أثر هذه المعاملات الغذائية على معدلات الزيادة اليومية فى وزن الجسـم ومستوى هرمونى T_4, T_3 فى مصل الدم بالاضافة الى مستوى كل من الكولسترول والبروتين الكلى والالبيومين ونشاط أنزيمات التـرانس أمينيز GPT & GOT وأيضا نشاط أنزيم الفوسفاتيز القاعدى فى مصل دم الحيوانات فى أعمار ٣ ، ٦ ، ٩ ، ١٢ أسبوع .

وقد لوحظ انخفاض معنوى فى معدلات الزيادة فى الوزن للمجاميع التى حصلت على زيوت مهدرجه فى بديل اللبن وقد نتج عن اضافة الزيوت المهدرجة بالمستويات التجريبية المختلفـة أنخفاض معنـوى فى تركيز الكولسترول وهرمونى T_4, T_3 والنسبه بينهما فى مصل الـدم . فى حين أن أستخدام الزيوت المهدرجة نوع سلطان فى بديل اللبن صـحبه أرتفاع معنوى فى البروتينات الكلية ونسبة الجلوبيولين وأنخفضـت نسبة الالبيومين والجلوبيولين وأيضا نشاط أنزيمات الترانس أمينيـز GPT & GOT والفوسفاتيز القاعدى . وقد أمكن التوصل الى نتائج عكسية عند أستخدام زيوت مهدرجة من نوع الممتاز .