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Impact of Bovine Somatotropin and Monensin on the Productive Performance of Egyptian Dairy Buffaloes

[1]H.M.M. Khattab, [1]H.M. El-Sayed, [2]S.A.H. Abo El-Nor,
[2]H.A. EL-Alamy and [2]R.M.A. Abd El-Gawad
[1]Department of Animal Production, Faculty of Agriculture,
Ain Shams University, Dokki, Egypt
[2]Department of Dairy Science, National Research Center, Dokki, Egypt

Abstract: Twenty lactating buffaloes divided into 4 groups (five each) were used to evaluate the singular and combined effect of bovine somatotropin and monensin on the productive performance of Egyptian dairy buffaloes. Treatments were (1) control, (2) injection of exogenous bovine somatotropin (bST), (3) concentrate feed mixture top dressed with 400 mg of monensin (M)/d/animal, (4) somatotropin (bST) and monensin in combination, during 14 day before expected calving and the first 120 day of lactation period. Diets and managements were the same for all animals during the experimental period. Dry matter intake was increased for animals which treated with rbST. Digestibility co-efficient of DM, OM, CF, EE and NFE were not affected by treatments, however, digestibility of CP was significantly higher in animals treated with rbST. Milk yield and 4% fat corrected milk yield were significantly ($p<0.01$) higher in animals treated with rbST group than other groups. Milk fat, Total Solids (TS), Total Protein (TP) and ash contents were not significantly ($p>0.05$) changed by treatments, however, milk lactose content was significantly ($p<0.01$) increased by treatments. Plasma total protein and glucose concentrations were significantly ($p<0.01$) increased by rbST treatment, however, plasma albumin, globulin, A/G ratio, urea, GOT, GPT and cholesterol contents were not significantly affected by treatments. The results of the present study suggest that rbST is efficacious in increasing milk yield without effect on milk composition and without any adverse effects on lactating buffaloes.

Key words: Bovine somatotropin, monensin, productive performance, Egyptian buffaloes

INTRODUCTION

Buffalo is a major source for milk in Egypt as it contributes more than 50% of the annual milk production in Egypt (Anonymous, 1997). Buffaloes milk is preferred by the Egyptian consumer for its richness and sensory attributes. Therefore, buffalo's milk gets almost double the price of cow's milk in the local market. Generally, there is an increasing demand for buffalo milk in Egypt. However, buffaloes are low milk producers compared to Western breeds of cows raised in Egypt. Breeding and genetic selection, failed to increase much the amount of milk produced by buffaloes as it did for cows.

The application of new biotechnological treatments (e.g., recombinant somatotropin), supported by appropriate nutrition and herd management can be a feasible alternative for high buffalo milk production.

The advent of commercial recombinant provided milk producers with powerful and economical tools to increase their milk production. Somatotropin (bST) is a homeorhetic agent affecting hepatic and adipose tissues (Etherton and Bauman, 1998). Short and long term treatment of cows with bST proved to increase milk yield (Radcliff *et al*., 2000; Van Baale *et al*., 2005) without marked changes in

Corresponding Author: S.A.H. Abo El-Nor, Department of Dairy Science, National Research Center, Dokki, Egypt

milk composition (Van Baale *et al*., 2005) and technological properties of the obtained milk. The safety of milk and milk products from bST treated cows has been approved by regulatory authorities (Centner and Lathrop, 1997; Anonymous, 1998).

Monensin is an ionophore has been reported to have a variety of beneficial effects in ruminants. Reported benefits in dairy cattle include a lower incidence of ketosis and displayed abomasums, reduced loss of body condition, increased milk production and improved milk production efficiency (McGuffey *et al*., 2001).

As somatotropin and monensin induce different metabolic changes in lactating animals, their combined effects may ameliorate limitation of each other. Limited studies have been cited in respect to the combined effects of monensin and somatotropin in lactating cows (McGuffey and Giner Chavez, 1998; Vallimont *et al*., 2001), but no data have been reported for the same in buffaloes.

The objectives of the present study were to evaluate the effects of somatotropin and monensin separately or in combination on the productive performance of lactating buffaloes.

MATERIALS AND METHODS

Feeding and Management

The represent study was carried out in Al-Eman farm station of animal production, Al-Ismalia governorate and lab. of milk production, National Research Center, Dokki, Giza, Egypt. The fieldwork of the experiment started in January 2005 and lasted for 4 months. Twenty lactating buffaloes aged 4-6 years (at the third and fourth season of lactation) were used in the present study. The animals were randomly assigned into 4 groups (5 each) in tow way-classification design. The animals were introduced to treatments starting two weeks before the expected calving and continued till the 16th week of lactation. Average live body weight of animals for the four experimental groups were 644, 710, 677 and 684 kg for T_1 (control), T_2 (rbST), T_3 (M) and T_4 (rbST+M), respectively. Treatments were; (1) control group fed 70% Concentrate Feed Mixture (CFM), 15% rice straw and 15% berseem (on dry matter basis), (2) control + injection subcutaneously of 500 mg rbST/head/14day, (3) control + 400 mg monensin /head/day were added top of concentrate feed mixture and (4) somatotropin and monensin in combination during the last 14 days before expected calving up to 120 days after parturition.

Diet was formulated to meet the animal's requirements (Shehata, 1971). Animals were fed individually, concentrates were offered twice daily during milking time at 6.0 am and 4.0 pm Berseem and rice straw were offered at 9 and 11 am, respectively. Fresh water was available to the animals all time (Table 1).

Digestibility Trail

A grab sample method was applied at which Acid Insoluble Ash (AIA) was used as an internal marker according to Gallup *et al*. (1945) and Forbes *et al*. (1948) for determining the nutrients digestibility.

Table 1: Chemical composition of concentrate feed mixture (CFM), berseem clover and rice straw (RS) (% on dry matter basis)

	Diet ingredients		
Items	CFM*	Berseem	Rice straw
Dry matter	89.00	12.71	92.80
Organic matter	88.50	87.00	84.60
Ash	11.50	13.00	15.40
Crude protein	14.50	17.20	3.50
Ether extract	4.70	2.70	2.10
Crude fiber	14.70	18.60	33.50
Nitrogen free extract	54.60	48.50	45.50

CFM= 24% undecorticated cotton seed meal, 20% wheat bran, 34% yellow corn, 20% gletofeed, 1% limestone and 1% common salt

Feed and Fecal Analysis

The chemical composition of different feed stuffs and fecal samples were analyzed according to the AOAC (2000) methods to determine moisture content, DM, OM, Ash, CP, CF, EE and NFE content.

Sampling and Analysis of Milk

The animals were machine milked (twice daily), milk was recorded for each milking. The milk samples were collected biweekly. Digital pH meter with a glass electrode was used for pH measurement. Representative samples from combined morning and evening milk were analyzed for milk fat, Total Solids (TS), Solids Not Fat (SNF), Total Protein (TP) and ash content according to (Ling, 1963) and lactose content according to (Barnett and Abd El-Tawab, 1957).

Sampling and Analysis of Blood Plasma

Blood samples were taken from all experimental animals monthly during experimental period. Blood samples were taken at four hours after morning concentrate portion feeding. A sample of 10 mL of blood per animal was withdrawn from the jugular vein. The blood was directly collected into a clean dried glass culture tubes after addition of EDTA.

Plasma was analyzed for Total Protein (TP) by the Biuret method according to Gornall *et al*. (1949). Albumin was determined by calorimetric method based on the principles described by Doumas *et al*. (1971). Plasma globulin was calculated by subtracting the values of albumin from corresponding value of total protein for each. Plasma urea was determined according to Fawcett and Scott (1960), plasma Glutamic Oxaloacetic Transaminase (GOT) and Glutamic-Pyruvic Transaminase (GPT) were determined according to the method of Reitman and Frankel (1957), plasma glucose was determined according to Trinder (1969) and plasma cholesterol was determined by the method of Richmond (1973).

Statistical Analysis

The data were analyzed using General linear method of statistical analysis system (SAS, 1998), Duncan multiple range test (Duncan, 1955) was carried out for separation among means.

Data of milk yield, milk composition and blood plasma parameter were analyzed according to repeated measurement where the model as:

$$Y_{ijk} = \mu + T_i + A_K (T_i) + P_j + (T\times P)_{ij} + E_{ijk}$$

Where,

Y = The effect of the observation
μ = The overall mean
T = The effect of the treatment
A (T) = The animal within treatment
P = The effect of the period
T×P = The interaction between treatment and period
E = The experimental error

While nutrient digestibility was analyzed according to one way classification where the model as:

$$Y_i = \mu + T_i + E_i$$

Where,
Y = The effect of the observation.
μ = The overall mean.
T = The effect of the treatment.
E = The experimental error.

RESULTS AND DISCUSSION

Dry Matter Intake and Nutrient Digestibility

Dry matter intake was higher by 7.89, 3.68 and 5.26% for T_2 (rbST), T_3 (M) and T_4 (rbST+M), respectively than control group (Table 2). These results in a good agreement with those reported by Hartnell *et al*. (1991) who reported increased DMI when bST was administered to lactating cows because more nutrients were required for the increased synthesis of milk and milk components. Other studies showed no effect of bST treatment on dry matter intake for cows (Eppard *et al*., 1996). Also, Plaizier *et al*. (2000) found that dry matter intake not affected by addition of monensin. The present data (Table 2) showed that digestibility of DM, OM, CF, EE and NFE were not significant difference between treatments. Digestibility of Crude Protein (CP) was significantly higher ($p<0.05$) in T_2 (rbST) than T_3 (M). These results, nearly agreement with Robinson *et al*. (1991) and Lynch *et al*. (1990). They found that total tract apparent digestibility of nutrients was not affected by injection of rbST, although, Osborne *et al*. (2004) concluded that total tract digestion of DM, CP, crude fat, Ash, non fiber carbohydrates and gross energy were unaffected ($p>0.05$) by the dietary addition of monensin. In contrast, Plaizier *et al*. (2000) found that monensin improved apparent DM digestibility numerically both precalving and postcalving, but these improvements were not statistically significant.

Milk Yield and Composition

The productive performance data and milk analysis are shown in Table 3. Administration of rbST increased markedly milk yield in the present study. The average increase in milk yield was 44.15% being much higher than that obtained with Italian buffaloes; namely 17.27% (Polidori *et al*., 1997) and 12.7% (Feerara *et al*., 1989) and for Indian buffaloes; namely 16.8 and 29.5% after 1st and 2nd week of treatment, respectively (Ludri *et al*., 1989). Rose *et al*. (2004) found individual variations in milk yield response to bST in dairy cows which may explain differences in the response of buffaloes to bST treatment in the different studies. The rbST induced enhancement of milk yield can be attributed to mobilization of body energy reserves to meet the elevated energy requirements, which exceed the energy intake. The increase of overall utilization of energy (kg milk/Mega joule of energy intake) with bST treatment can be explained by a reduced proportion of energy required for maintenance relative to the total energy intake and by mobilized body energy (Kirchgessner *et al*., 1991).

Table 2: Live body Weight, dry matter intake and nutrient digestibility as affected by treated lactating buffaloes with somatotropin and monensin

	Treatments				
Items	Control	bST	M	bST+M	SE±
Live body Weight	644.00	710.00	677.00	684.00	7.15
DMI (kg/head/day)	19.00	20.50	19.70	20.00	0.27
DM	67.30	67.20	68.03	68.76	1.01
OM	67.30	67.40	67.36	68.66	0.80
CP	74.16^{ab}	76.15^{a}	73.26^{b}	75.33^{ab}	1.10
EE	80.25	80.12	78.06	79.45	1.08
CF	56.06	56.33	58.43	58.03	1.25
NFE	70.10	72.83	70.27	74.24	0.49

Each value represents an average of three animals each group. a, b in the same row with different superscript are significantly ($p<0.05$) different

Table 3: Overall means of milk yield and its constituents of buffaloes, (for the different treatments) during the first 120 days of lactation period

Items	Control	bST	M	bST+M	±SE
Milk yield (kg day^{-1})	11.12^{D}	16.03^{A}	12.61^{C}	14.40^{B}	0.198
Fat corrected milk (kg day^{-1})	16.37^{D}	23.96^{A}	18.44^{C}	21.29^{B}	0.290
Milk composition (%)					
Fat	7.19	7.32	7.12	7.20	0.030
Protein	4.01	4.07	4.05	4.07	0.010
Lactose	4.71^{B}	5.04^{A}	4.93^{A}	5.00^{A}	0.020
TS	17.13	17.22	17.22	17.17	0.050
SNF	9.97	9.90	10.09	10.00	0.840
ASH	0.92	0.90	0.88	0.89	0.008
pH	6.82	6.86	6.79	6.83	0.009
Efficiency					
Milk yield/DMI	0.58	0.78	0.64	0.72	0.001
FCM yield/DMI	0.86	1.11	0.93	1.06	0.030

Significant differences (p<0.01) a, b, c and d between treatments means are indicated by dissimilar superscript

The effect of monensin treatment on milk yield was less pronounced than the bST treatment (Table 3). An increase of 13.3% in milk yield was observed in buffaloes which received monensin in their diet. The increase in milk yield with monensin treatment had been agreed with those reported by Phipps *et al*. (2000). The increase in milk yield with monensin treatment has been attributed to the increase in ruminal propionate production (Bergen and Bates, 1984), which can be used as a gluconeogenic precoucer.

The combined effect of bST+M on milk yield was higher than the effect of monensin only, but less than that observed with the use of bST separately (Table 3). It may be attributed to that more production of propionate in the rumen by monensin treatment, after absorption increased the production of insulin by the pancreas, the increase in insulin had a decreasing effect on the production of somatotropin and diverted nutrients to body tissues rather than to milk production (Bines and Hart, 1982). Vallimont *et al*. (2001) mentioned that the combination of somatotropin and monensin did not reflect results for either treatment when evaluated separately, which agree with the present results.

The milk pH, total solid, solid not fat, total protein and ash content were not significantly (p>0.05) affected by the treatments, however, lactose content was significantly (p<0.01) higher in bST, bST + M and M group than control group, respectively. Milk fat content for monensin treatment was lower than other groups but the differences were not significant. It may be attributed to the decrease of acetate production on the rumen which it is the precursor of fat synthesis. Polidori *et al*. (1997) reported an increase in milk fat but the total protein content was almost unchanged in buffaloes treated with bST. Tarazon *et al*. (2000) reported that the composition of milk (SNF, fat, protein and lactose) were not significantly altered by rbST treatment. Osborne *et al*. (2004) found no change on milk fat and protein content and milk fat and protein yield when dairy cows were treated with monensin.

The efficiencies in milk production calculated as milk yield/DMI and 4% fat corrected milk /DMI were improved in 2nd and 4th groups as compared with 1st and 3rd groups.

Blood Parameters

The results in (Table 4) showed that plasma total protein and glucose concentration were significantly (p<0.01) increased by bST treatment. While, plasma albumin concentration was lower in monensin group than the other groups, but not significant. However, plasma globulin, urea, Glutamic-Oxaloacetic Transaminase (GOT), Glutamic-Pyruvic Transaminase (GPT) and cholesterol contents were not significantly affected by treatments (Table 4). Gulay *et al*. (2004) confirmed that treatment of cows with rbST during the postpartum period stimulates glucose metabolism in cows. Typical responses include decreased whole body oxidation of glucose (Cohick *et al*., 1989), increased hepatic rates of gluconeogensis (Bauman *et al*., 1988) and decreased glucose response to insulin

Table 4: Overall means of some blood parameters of buffaloes, (for the different treatments) during the first 90 days of lactation period

Items	Control	bST	M	bST+M	±SE
Total protein (g/100 mL)	7.70[b]	8.22[a]	7.71[b]	8.17[a]	0.48
Albumin (g/100 mL)	4.10	4.37	3.96	4.22	0.07
Globulin (g/100 mL)	3.54	3.84	3.74	3.96	0.09
Albumin: Globulin ratio	1.17	1.19	1.10	1.07	0.07
Urea (g/100 mL)	25.62	26.36	24.62	24.80	0.48
GOT (μ/100 mL)	40.77	38.00	39.77	40.11	0.50
GPT (U/100 mL)	34.93	32.88	33.44	34.55	0.44
Glucose (g/100 mL)	58.03[c]	75.45[a]	64.94[b]	73.05[a]	1.73
Cholesterol (g/100 mL)	137.00	146.85	138.90	144.60	3.57

Significant differences ($p<0.01$) a and b between treatments means are indicated by dissimilar superscript

(Bauman and Vernon, 1993). Hayes *et al.* (1996) found that monensin treated cows had significantly higher levels of serum urea. Also, he found no significant effects of monensin on plasma glucose level. Bauman and McCutcheon (1985) reported that milk yield responses to STH are perfectly coordinated with the alteration in the metabolism of body tissues as evidenced by the fact that steady state concentrations of blood metabolites are maintained, which consistent with the present study (Table 4).

It is of interest to notice that blood plasma glucose of the different experimental treatments followed the same trend of their milk yield (Table 3) and may confirm the results of Clarc *et al.* (1977) that positive relationship was found between blood glucose and milk yield.

CONCLUSIONS

The present study come to the conclusion that treatment of buffaloes with rbST, M and rbST+M increased their milk yield without affecting on milk composition except that of milk lactose content which increased by rbST treatment. However, treatment with rbST gave the highest increase in milk yield of lactating buffaloes. Dry matter intake was increased by rbST and monensin treatments, however, digestibility of DM, OM, CF, EE and NFE were not affected by treatments, but digestibility of CP was decreased by monensin treatment. Plasma total protein and glucose were enhanced by the treatments. However, plasma globulin, urea, GOT, GBT and plasma cholesterol concentrations were not affected by the treatments. Finally, American Food and Drug Administration (FDA) has determined that milk from rbST cows is safe for human consumption and has not found to be different from milk non-treated cows (Anonymous, 1994). It is apparent that using bST or/and bST+M improved the productive and economic performance of lactating buffaloes without adverse effects on animal health and productivity during this study.

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