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The Productive Perforance of Egyptian Dairy Buffaloes Receiving Biosynthetic Bovine Somatotropin (rbST) with or Without Monensin

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Abstract: Twenty lactating buffaloes divided into 4 groups (five animals 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 (rbST); 3) concentrate feed mixture top dressed with 400 mg of monensin(M)/d/animal; 4) somatotropin(rbST) and monensin in combination, during 14 days before expected calving and the first 120 days of lactation, Dry matter intake was increased for animals which treated with rbST. Milk yield and 4% fat corrected milk yield were significantly ($P<0.01$) higher for 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 (rbST) % Monensin % Productive performance % Dairy buffaloes

INTRODUCTION

Buffalo is the major source for milk in Egypt as it contributes more than 50% of the annual milk production in Egypt [1]. Buffalo's 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 the dairy 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 alternatives for high buffalo milk production.

Somatotropin (rbST) is a homeorhetic agent affecting hepatic and adipose tissues [2]. Short and long term treatment of cows with rbST proved to increase milk yield [3,4] without marked changes on milk composition and technological properties of the obtained milk [4]. The safety of milk and milk products from rbST treated cows has been approved by regulatory authorities [5,6]. Feerara *et al*. [7], Ludri *et al*. [8] and Polidori *et al*. [9] showed that the administration of rbST to Italian and Indian buffaloes increased their milk production without marked changes in milk fat content. Monensin is an ionophore has been reported to have a variety of beneficial effects in ruminants. Reported benefits on dairy cattle included lower incidence of ketosis and displayed abomasum, reduce loss of body condition, increase milk production and improve milk production efficiency [10]. 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 [11,12], 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.

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MATERIALS AND METHODS

Feeding and management: The present study was carried out at the farm station of Animal Production Department, Faculty of Agriculture, Al-Azhr University and laboratories of Animal Production Department, National Research Center, Dokki, Giza, Egypt. 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 four groups (five animals each). The animals were introduced to treatments starting two weeks before the expected calving date and continued till the 16th week of lactation. The 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 fodder (on dry matter basis), 2) control + injection subcutaneously of 500mg rbST/head/14day, 3) control + 400mg monensin /head/day were added on the top of the concentrate feed mixture and 4) somatotropin and monensin in combination during the last 14 days before expected calving up to 120 days after parturition.

Chemical composition of CFM, RS and berseem fodder are shown in Table 1. Daily amounts of diet were formulated to meet the animal's requirements [13]. Animals were fed individually, concentrates were offered twice daily during milking times at 6.0 a.m. and 4.0 p.m. Berseem and rice straw were offered at 9.0 and 11.0 a.m., respectively. Fresh water was available to animals at all time.

Digestibility trial: A grab sample method was applied at which acid insoluble ash (AIA) was used as an internal marker according to Gallup *et al*. [14] and Forbes and Garrigus. [5] for determining nutrients digestibility.

Feed and fecal analysis: The chemical composition of different feed stuffs and feces samples were analyzed according to the A.O.A.C. [16] methods to determine moisture content, DM, OM, Ash. CP, CF, EE and NFE content.

Sampling and analysis of milk: Experimental animals were machine milked (twice daily), milk was recorded individually for each milking. 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 [17] and lactose content according to Barnett and Abd El-Tawab, [18].

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

	Chemical composition (%)		
Item	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

Sampling and analysis of blood plasma: Blood samples were taken from all experimental animals once monthly during the experimental period. Blood samples were taken four hours after the 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 tube contained EDTA. The blood plasma was collected by centrifuging the blood samples soon after collection at 4000 (rpm) (for 15 mins). Blood plasma was transferred into a clean dried glass vials and then stored in deep freezer at -20°C for subsequent specific chemical analysis. Plasma was analyzed for total proteins (TP) by the Biuret method according to Gornal *et al*. [19]. Albumin was determined by calorimetric method based on the principles described by Doumas *et al*. [20]. Plasma globulin was calculated by subtracting the values of albumin from corresponding value of total proteins for each. Plasma urea was determined according to Fawcett and Scott [21], plasma glutamic oxaloacetic transaminase (GOT) and glutamic-pyruvic transaminase (GPT) were determined according to the method of Reitman and Frankel [22], plasma glucose was determined according to Trinder [23] and plasma cholesterol was determined by the method of Richmond [24].

Statistical analysis: The data were analyzed using General linear method of statistical analysis system SAS [25], Duncan multiple range test [26] was carried out for separation among means.

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

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

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 = is the effect of the observation
μ = is the overall mean
T = is the effect of the treatment
E = the experimental error

RESULTS AND DISCUSSION

Dry matter intake and nutrient digestibility: Dry matter intake and nutrient digestibility are shown in Table 2. 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. These results are in a good agreement with those reported by Hartnell *et al*. [27] who reported increased DMI when rbST was administered to lactating cows because more nutrients were required for the increase synthesis of milk and milk components. Other studies Eppard *et al*. [28] showed no effect of rbST treatment on dry matter intake for cows. Also, Plaizier *et al*. [29] found that dry matter intake not affected by the addition of monensin. Data presented in Table 2 showed that digestibility of DM, OM, CF, EE and NFE were not significantly different among 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 those reported by Robinson *et al*. [30] and Lynch *et al*. [31], they found that total digestive tract apparent digestibility of nutrients was not affected by injection of rbST. Moreover, Osborne *et al*. [32] 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, Piaizier *et al.* [29] found that monensin improved apparent DM digestibility numerically both precalving and postcalving, but these improvements were not statistically significant.

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

Item	Treatment				
	Control	rbST	M	rbST+M	SE±
Live body weight	644	710	677	684	7.15
DMI (kg/head/day)	19.00	20.50	19.70	20.00	0.27
	Digestibility coefficient (%)				
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

Item	Control	rbST	M	rbST+M	SE±
Milk yield (kg/day)	11.12^{D}	16.03^{A}	12.61^{C}	14.40^{B}	0.198
4% fat corrected milk	16.37^{D}	23.96^{A}	18.44^{C}	21.29^{B}	0.29
	Milk composition %				
Fat	7.19	7.32	7.12	7.20	0.03
Protein	4.01	4.07	4.05	4.07	0.01
Lactose	4.71^{B}	5.04^{A}	4.93^{A}	5.00^{A}	0.02
TS*	17.13	17.22	17.22	17.17	0.05
SNF**	9.97	9.90	10.09	10.00	0.84
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	0.03

Significant differences (P<0.01) A, B, C, D between treatments means are indicated by dissimilar superscripts
* TS = Total Solids.
** SNF= Solid not fat.

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% [9] and 12.7% [7] and for Indian buffaloes; namely 16.8% and 29.5% after 1st and 2nd weeks of treatment; respectively [8]. Rose *et al*. [33] found individual variations in milk yield response to rbST in dairy cows which may explain differences in the response of buffalos to rbST 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 rbST treatment can be explained by a reduced proportion of energy required for maintenance relative to the total energy intake and by mobilized body energy [34].

The effect of monensin treatment on milk yield was less pronounced than the rbST 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*., [35]. The increase in milk yield with monensin treatment has been attributed to the increase in ruminal propionate production which can be used as a gluconeogenic precursor. The combined effect of rbST+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 [36]. Vallimont *et al*. [12] 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 rbST, rbST+M and M group than control groups, 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*. [9] reported an increase in milk fat but the total protein content was almost unchanged in buffaloes treated with rbST. Tarazon-Herrera *et al*. [37] reported that the composition of milk (SNF, fat, protein and lactose) were not significantly altered by rbST treatment. Osborne *et al*. [32] found no change on milk fat and protein content 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 group's as compared with 1st and 3rd groups.

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

Item	Control	rbST	M	rbST+M	SE±
Total proteins (gm/100ml)	7.70^{B}	8.22^{A}	7.71^{B}	8.17^{A}	0.48
Albumin (gm/100ml)	4.10	4.37	3.96	4.22	0.07
Globulin (gm/100ml)	3.54	3.84	3.74	3.96	0.09
Albumin: Globulin ratio	1.17	1.19	1.10	1.07	0.07
Urea (mg/100ml)	25.62	26.36	24.62	24.80	0.48
GOT (U/100ml)	40.77	38.00	39.77	40.11	0.50
CPT (U/100ml)	34.93	32.88	33.44	34.55	0.44
Glucose (gm/100ml)	58.03^{C}	75.45^{A}	64.94^{B}	73.05^{A}	1.73
Cholesterol (gm/100ml)	137	146.85	138.90	144.60	3.57

Significant differences (P<0.01) A, B, C, D between treatments means are indicated by dissimilar superscripts

Blood parameters: The results in Table 4 showed that plasma total proteins and glucose concentrations were significantly (P<0.01) increased by rbST treatment. While, plasma albumin concentration tended to be lower in monensin group than the other groups, but not significant. Moreover, plasma globulin, urea, glutamic-oxaloacetic transaminase (GOT), glutamic-pyruvic transaminase (GPT) and cholesterol contents were not significantly affected by treatments. Gulay *et al*. [38] 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 [39], increased hepatic rates of gluconeogensis [40] and decreased glucose response to insulin [41]. Hayes *et al*. [42] 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 [43] 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 arc maintained, which consistent with the present study. 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 Clark *et al*. [44] that positive relationship was found between blood glucose and milk yield.

CONCLUSION

The present study come to the conclusion that treatment of buffaloes with rbST, M and rbST+M increased their milk yield without affecting 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, except digestibility of CP which was decreased by monensin treatment. Plasma total proteins and glucose were enhanced by the treatments. However, plasma globulin, urea, GOT, GPT 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 (FDA. 1994). It appears that using rbST or/and rbST+M improved the productive and economic performance of lactating buffaloes without adverse effects on either animal health or productivity during this study.

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