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EFFECT OF RECOMBINANT BOVINE SOMATOTROPIN ON MILK PRODUCTION AND COMPOSITION OF LACTATING BUFFALOES

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ABSTRACT

Effects of recombinant bovine somatotropin (rbST) treatment on buffalo milk production and composition were studied under the Egyptian dairy farm conditions. Thirty-six buffaloes delivered during the same season were assigned to either control (n=16) or rbST treated groups (n=20). The treated animals were subcutaneously injected biweekly by 500 mg of rbST over a period of five months of lactation, starting at 50 days postpartum. The results showed that rbST treated buffaloes produced significantly (P<0.01) higher average daily milk yield than controls. Average daily milk yield of the experimental period were 8.57±0.39kg and 10.56±0.35 kg for control and treated buffaloes, respectively. Treatment with rbST did not affect buffaloes milk composition (fat, lactose, total solids and solids non fat contents), while it significantly affected(P<0.01) the milk protein %. A slight significant (P<0.05) effect on fat percentage was found during different phases of lactation between treated and control animals (at 5th month of lactation).Percent of milk protein was significantly(P<0.01) affected by the interaction between treatment and month of lactation. Treatment with rbST had a significant (P<0.01) effects on percentage of fatty acids in milk fat which characterized by clearly higher percent of Myristic acid ($C_{14:00}$), Oleic acid ($C_{18:10}$) and Stearic acid ($C_{18:00}$). The percentages of short chain (< $C_{12:00}$) and medium chain acids ($C_{13:00}$-$C_{16.00}$) in milk fat were lower in treated buffaloes compared to controls. It was concluded from this study that treatment of dairy buffaloes with rbST could significantly increase their milk yield without significant changes in milk composition except for higher content of long chain fatty acids

Keywords: Buffalo, bovine somatotropin, milk composition and fatty acids.

INTRODUCTION

Treatment with recombinant bovine somatotropin (rbST) as applied biotechnology has been made commercially available to increase milk production in both dairy cows and buffaloes in many countries. Several authors indicated that the use of rbST in dairy cattle resulted in increases of 10-24% in total milk yield. The percent of increased milk production depends on stage of lactation and various dosages in studied breeds (Bauman *et al.*, 1989; Jordan *et al.*, 1991, Burton *et al.*, 1994; Huber *et al.*, 1997; El-Gandour, 2000). A satisfactory response of rbST may also depend on the level of production, feed intake and provision of adequate management in the herd.

Composition of milk in response to rbST treatment is an important consideration because of its impact on milk nutritive value, flavor and manufacturing of dairy products. Several authors reported no significant changes in fat, protein, lactose and total solids contents in milk cattle due to rbST treatment (Jordan *et al.*, 1991; Burton *et al*, 1994; El-Gandour, 2000).

However, some of authors illustrated that rbST treatment increased milk fat percentage by 6.25% over that of the control (Huber *et al.*, 1997) and protein percentage by 3-5% (Bauman *et al.*, 1989; Jordan *et al.*, 1991).

There are few reports, however, on the use of rbST for milking buffaloes, especially under the prevailing farm conditions in Egypt. Therefore, the objective of this work was to investigate the effect of rbST treatment on buffaloes milk production and composition under the Egyptian dairy farm conditions.

MATERIALS AND METHODS

Experimental animals and management

This trial was conducted on 36 milking buffaloes, at Mehalet Mousa Research Station at Kafer El-Sheikh governorate, Animal Production Research Institute, Agricultural Research Center, Egypt. The experimental animals calved normally and were free of reproductive disorders at the beginning of the trial. Buffaloes were allowed to nurse their offsprings for seven days post-partum then transferred to semi-shed open yards. Buffaloes were hand-milked twice daily at 07:00 h and 14:00 h throughout the experimental period, which lasted for five months. Animals were fed according to their live body weight and milk production level on concentrate feed mixture, corn silage and rice straw. Egyptian clover (*Trifolium alexandrium*) or its hay was offered when available.

Experimental procedure

Thirty six buffaloes were divided into two groups, the first group (control) included 16 buffaloes, while the second group (treated) included 20 buffaloes Differences in initial body weight and daily milk yield between treated group (603.19±31.0 kg) and (12.11± 0.50 kg) and control group (612.00±23.8 kg) and (11.04±0.47 kg), respectively were not significant on day 49 postpartum. The treated group administrated with rbST (Somatech, Elanco Animal Health, Austria) at a dose of 500 mg/head once every 14 days as subcutaneous injection in the tail head depressions (the ischiorectal fossa). Administration of rbST started on day 50 postpartum and continuing for five months of lactation. Administration of rbST was applied at the milking parlor, immediately after the morning milking (08:00 h). The injection site was alternated every time. The rbST used was in the form of vials(10.4 ml.) individual injections each in a ready- to- use containing 500 mg of rbST in controlled release oil formulation. The dosages were kept at 5 °C until usage then, syringes were allowed to warm up to room temperature to facilitate the injection at time of application.

Milk yield was recorded individually at each milking and milk samples were taken once every month for analysis of milk composition using milko-scan system. Milk samples were taken from six buffaloes for analysis of fatty acids fractions before treatment with rbST on day 50 postpartum and on day 70 postpartum (i.e. one week after the second rbST injection). Individual fatty acids (FA) were measured (Farag *et al.* 1986) after extraction of milk fat using chloroform- methanol (2:1 v/v) and the solvent was evaporated in a rotary evaporator. The methyl esters of the fatty acids were analyzed using

Konik HRGC 3000 (Konik Instruments Inc., Miami-Florida 33015, USA) equipped with a flame ionization detector and fitted with stanless-steel column (1×2m ×1/8 inch diameter) packed with 10% carbowax 20μ and supported on cromosorb WHP 80-100 mesh,. The sample (1.0-1.5μl) was injected into the column using micro syringe. The gas chromatographic conditions used for the analysis included adjustment of temperature range from 130-220°C at the rate of 4°C/min., with a nitrogen flow rate of 30 ml/min., hydrogen 30 ml/min. and air 300 ml/min. Also, the injection and detector temperatures were 220 and 240°C, orderly. The peak areas were measured using an integrator. Identification and percent of the fatty acids fractions were determined by the reference to a standard of known constituent.

Statistical Analysis

Statistical analysis of data was analyzed by the application of the General Linear Models procedure of SAS (2000), according to the following model:

$$Yijk = \mu + Ti + Lj + (T\times L)ij + eijk$$

Where Yijk is the observation on the ijk th litter,
μ = the overall mean,
Ti= fixed effect of i th treatment with rbST, (i=1 and 2),
Lj= fixed effect of j th month of lactation.(j=1,2,...and 5),
(T×L) ij= effect of interaction between treatment and month of lactation,
eijk= random error.

RESULTS AND DISCUSSION

Daily milk yield

Results of the present study indicated that rbST treatment resulted in a significantly ($P<0.01$) higher average daily milk yield of buffaloes than that of the controls throughout the experimental period (Figure1).

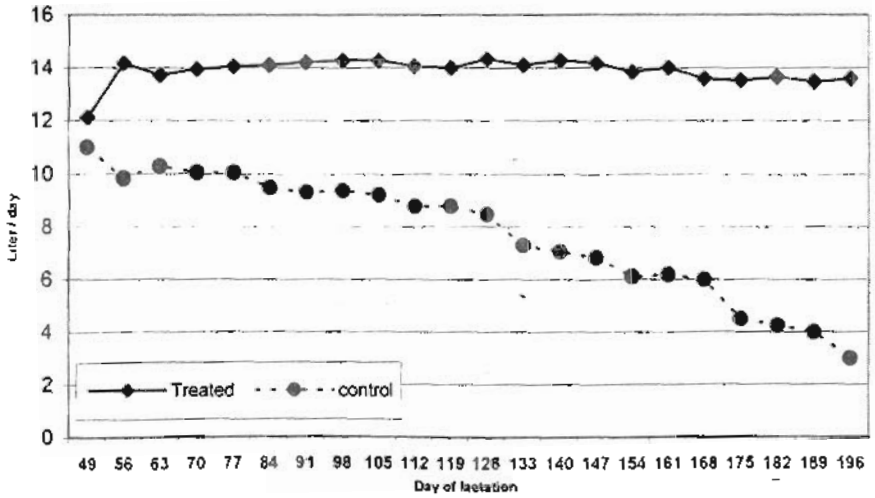

Figure (1): Average daily milk yield at different lactation days.

Daily milk yield over days 50-200 of lactation averaged 8.57 ± 0.39 kg for control animals and 10.56 ± 0.35 kg for treated ones, reporting an increase of 22%. This finding agrees with those obtained by Skarda and Mader (1991), Phipps *et al.* (1997) and El- Gandour (2000).

Milk composition

Treatment with rbST had no significant effect on milk composition except milk protein% which was significant (P<0.01) affected by treatment(Table 1). Several studies on dairy cows and buffaloes showed that treatment with rbST did not cause major changes in milk composition (Ludri *et al.*, 1989; Jenny *et al.*, 1992; Skarda and Mader, 1991; Binelli *et al.*, 1995; Chalupa *et al.*, 1996; Santos et al., 1999; El-Gandour, 2000).

Table (1): Least square means ± S.E of milk composition traits for control and rbST treated buffaloes.

Milk composition traits	No. of observations	Control group	No. of observations	Treated group
Fat %	80	07.01 ± 0.14	100	07.04 ± 0.12
Protein %	80	03.70 ± 0.05	100	03.87 ± 0.04**
Lactose %	80	04.86 ± 0.12	100	04.55 ± 0.11
Total Solid %	80	15.29 ± 0.24	100	15.54 ± 0.21
Solid-Non-Fat %	80	09.85 ± 0.24	100	09.25 ± 0.21

** Significant at (P<0.01)

On the other hand, other studies indicated variable responses in milk composition to rbST treatment. In agreement with the present fat percentages were lower and protein yield was higher for cows treated with rbST than for control cows, (Huber *et al.*, 1997). McGuffy *et al.* (1990) and McGuire *et al.* (1992) reported increases in milk fat % and total solids % due to rbST treatment at dose of 25mg/d, in dairy cows. Percentage of milk fat was not affected by rbST at 10.3 mg/d. However, percentage protein was reduced (Austin *et al.*, 1990). Chalupa *et al.* (1996) added that the unaffected milk fat, protein and total solids to rbST reflected the high nutrient densities of the animal diet, because effects of rbST on milk composition seemed to be related to nutritional status. Bauman (1992) noticed that rbST did not affect milk composition when cows were fed diets providing positive balances of energy and protein. The author added that cows in negative energy balance produce milk with higher fat content because of the greater reliance on lipid mobilization from body fat stores. Chalupa *et al.* (1996) suggested that effects of dietary energy and protein on milk fat and protein in rbST treated cows are similar to alterations when high producing cows are fed diets that do not provide adequate energy or protein.

Treatment with rbST maintained slightly level of milk protein over that of the control throughout the 2nd -5th months of lactation period. On the other hand, milk fat % was slightly lower in the treated animals during the 2nd to 4th months ,then increased relatively in comparison with the control until the end of experimental period. Huber et al. (1997) reported that fat percentage of milk was lower for cows treated with rbST than for control cows during the

second, third, and fourth lactations as well as for the combined parities. On the other hand, protein yield was slightly higher for cows treated with rbST than for control cows for the combined four lactations.

The interaction effect between treatment and stage of lactation (lactation month) on milk protein was highly significant ($P<0.01$).

Table (2): Least square means ± S.E of milk fat and protein at successive months of lactation for control and rbST treated buffaloes .

Lactation month	No. of animals	Control		No. of animals	Treated	
		Fat %	Protein %		Fat %	Protein %
2	16	7.65 ± 0.33	3.97 ± 0.11	20	6.93 ± 0.28	3.91 ± 0.09
3	16	7.05 ± 0.31	3.55 ± 0.11	20	6.81 ± 0.28	3.95 ± 0.09
4	16	7.33 ± 0.31	3.52 ± 0.11	20	6.93 ± 0.28	3.85 ± 0.09
5	16	6.54 ± 0.31	3.54 ± 0.11	20	7.42 ± 0.28	3.92 ± 0.09
6	16	6.45 ± 0.31	3.95 ± 0.11	20	7.12 ± 0.28	3.72 ± 0.09

Fatty acids

Distribution of fatty acids percentages of milk fat in samples taken from control and rbST treated animals is shown in table (3). Admininistration of rbST resulted in higher propotion of Myristic acid ($C_{14:00}$), Oleic acid ($C_{18:10}$) and Stearic acid ($C_{18:00}$). On the other hand, the proportion of short chain ($< C_{12:00}$) and medium chain fatty acids ($C_{13:00}$-$C_{16:00}$) in milk fat were lower in treated buffaloes compared to the controls. The most abundant class of lipids in milk fat is tri-glycerides representing almost 98% of total milk lipids, which contain a great diversity of fatty acids concentrations. The basic mechanism of fat synthesis is established; briefly about one-half of milk fatty acids are synthesized in the mammary gland from acetate and β-hydroxy butyrate 40-45% are from the diet (Larson, 1985).

Table (3): Fatty acid percentage of milk fat in control and rbST treated buffaloes.

Fatty acid	Control	Treated
≤ $C_{08:00}$ Caprylic acid	05.84	05.71
$C_{10:00}$ Capric acid	------	00.61
$C_{12:00}$ Lauric acid	02.37	00.43
$C_{14:00}$ Myristic acid	03.76	04.69
$C_{15:00}$ Pentadecamoic	00.05	00.34
$C_{16:00}$ Palmitic acid	39.80	31.63
$C_{16:10}$ Palmitoleic acid	00.20	00.23
$C_{18:10}$ Oleic acid	40.14	46.50
$C_{18:00}$ Stearic acid	07.83	10.54
Short $< C_{12:00}$	08.21	06.75
Medium $C_{13:00}$ - $C_{16:00}$	43.81	36.89
Long $> C_{16:00}$	47.97	57.04

However, other studies demonstrated that fatty acid composition and cholesterol content of cattle milk were not altered by rbST treatment (Barban and Lynch, 1989). Bauman (1992) stated that even when cows are in negative energy balance, the typical shifts in milk fat composition toward higher proportion of long chain unsaturated fatty acids was observed among rbST injected cows. The author observed a substantial change in fatty acids composition due to stage of lactation as well as in rbST-supplemented cows.

It is well-established that the effect of rbST on increasing milk yield is associated with its effect on increased the mobilization of body fat reserves to meet the increased energy demands required for higher milk production (Bauman *et al.*, 1989). When animals are in negative energy balance, there is a tendency for milk composition to shift towards a higher proportion of long chain saturated fatty acids (Bauman, 1992). Based on these findings, it is postulated that rbST treatment of buffaloes in the present study which resulted in significant increases in milk yield, may enhanced body fat mobilization to meet the increasing demand of energy, required to produce buffalo milk with its higher fat content. Consequently, this may be the reason for the significant increase in the proportion of long chain fatty acids ($>C_{16:00}$) in milk of the rbST treated buffaloes. More studies are needed, however, to verify this hypothesis, with detailed measurements of the composition of lipid fractions in blood and milk. Furthermore, monitoring of feed intake and body weight changes throughout the lactation in buffaloes treated with rbST would be helpful to verify its impacts.

CONCLUSION

It was concluded from this study that treatment of dairy buffaloes with rbST could significantly increase their milk yield without significant changes in milk composition except for higher content of long chain fatty acids.

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تاثير استخدام السوماتوتروبين المخلق صناعيا على انتاج اللبن ومكوناته في الجاموس المصرى

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تاثير استخدام السوماتوتروبين المخلق صناعيا على انتاج اللبن ومكوناته قد درس في محطة لانتاج اللبن تحت الظروف المصرية . ستة وثلاثون جاموسة ولدت خلال موسم واحد سواء الكنترول (ن=١٦) أو المعاملة بالسوماتوتروبين (ن=٢٠) حقنت الحيوانات المعاملة كل اسبوعين ب ٥٠٠ ملليجرام سوماتوتروبين لمدة خمسة شهور متتالية من الحليب بدءاً من ٥٠ يوم بعد الولادة . ودلت النتائج على ان الجاموس المعامل بالسوماتوتروبين اعطى انتاج لبن اعلى (معنوية ٠,٠١) عن الكنترول . متوسط انتاج اللبن اليومى خلال فترة التجربة كان ٨,٥٧ ± ٠,٣٩ كجم و ١٠,٥٦ ± ٠,٣٥ كجم للكنترول والمعاملة على الترتيب . المعاملة بالسوماتوتروبين لم تؤثر على مكونات اللبن (دهن ، لكتوز ، الجوامد الكلية ، الجوامد اللادهنية) ، بينما كان التأثير معنوى (٠,٠١) على نسبة البروتين ، كان هناك تأثير معنوى خفيف (معنوية ٠,٠٥) على نسبة الدهن خلال المراحل المختلفة للحليب بين الكنترول والمعاملة (عند الشهر الخامس من الحليب) . نسبة البروتين تأثرت (معنوية ٠,٠١) بالتداخل بين المعاملة وشهر الحليب . المعاملة بالسوماتوتروبين كان لها تأثير معنوى (٠,٠١) علي الاحماض الدهنية فى دهن اللبن حيث كانت الاحماض تتسم بارتفاع نسبة حمض الميرستيك (ك١٤) وحمض الاوليك (ك١٨:١) وحمض الاستيارك (ك١٨) . وكانت نسبة الاحماض قصيرة السلسلة (ك١٢) ومتوسطة السلسلة (ك١٣ - ك١٦) فى دهن اللبن فى الجاموس المعامل مقارنة بالكنترول . وتلخيصا لهذه الدراسة بأن الجاموس المعامل بالسوماتوتروبين ممكن أن يزيد انتاجه من اللبن بدون تغير معنوى في مكونات اللبن فيما عدا ارتفاع المحتوى من الاحماض الدهنية طويلة السلسلة .