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Effect of Somatotropin and Monensin on the Yield and Quality of Milk and Tallaga Cheese from Egyptian Buffaloes

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Abstract: Twenty lactating buffaloes divided in 4 groups (5 animals each) were used to evaluate the effects of somatotropin (bST) and monensin (M) on the yield and quality of buffalo milk and Tallaga cheese made from the obtained milk. The first group was fed the basic ration (C); The 2nd was fed the basic ration and injected with bST; the 3rd was fed the basic ration with 4 g M/day/animal and the 4th group was fed on the 3rd group but was injected two weeks before parturition up to 6 months after parturition with bST every two wks. The milk yield and composition were followed. Pooled milk from each group was used in the manufacture of Tallaga cheese. The obtained cheese was analysed chemically and its organoleptic properties were assessed monthly during cooled storage up to 3 months. The dry matter intake, increased significantly ($p<0.05$) and milk yield was significantly higher ($p<0.01$) in animals treated with bST. The fat, Total Solids (TS) Total Protein (TP), Solids Not Fat (SNF) and lactose contents were significantly higher in milk from 2nd and 4th groups compared to 1st and 3rd groups. The calculated efficiencies of milk yield/DMI, 4% FCM yield/DMI were improved ($p<0.05$) in group II (bST) compared with the other three groups. The yield, fat%, fat/DM%, salt, acidity, TVFA s and SN/TN% of Tallaga cheese made from group 1 milk (control) were better than those of the other three groups, however, organoleptic properties, TP% and TP/DM% of group IV (bST+M) were generally better than those of the other three groups. TS was higher in group 3 (M), tyrosin and tryptophan were higher in group 2 (bST). Storage period significantly affected sensory properties ($p<0.05$) showing the best quality after three months of storage and, also, affected cheese composition (TS, fat, TVFA s, tyrosine, tryptophan, TCC, SN and SN/TN).

Key words: Bovine somatotropin, monensin, tallaga cheese, lactating buffaloes, feed intake, organoleptic properties

Introduction

Buffalo is a major source for milk in Egypt as it contributes more than 50% of the annual milk production in Egypt. Buffalo milk is preferred by the Egyptian consumer for its richness and sensory attributes. Also, soft cheese and yoghurt manufacturers prefer buffalo milk for its characteristic technological properties, high cheese yield and premium quality of the obtained products. Therefore, buffalo milk get 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.

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The advent of commercial recombinant somatotropin provided milk producers with a powerful and economic tool to increase their milk production. Somatotropin (bST) is a homeorhetic agent affecting hepatic and adipose tissues (Etherton and Bauman, 1998). Short and long term treatments of cows with bST proved to increase milk yield (Armstrong, 1988; Radcliff *et al*., 2000) without marked changes in milk composition (Van Den Berg, 1991) 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) in different countries (Armstrong, 1988) and consumer acceptability (Fox *et al*., 1994).

Limited studies (Polidori *et al*., 1997; Ferrara *et al*., 1989; Ludri *et al*., 1989) showed the administration of bST to Italian and Indian buffaloes increased their milk production without marked changes in milk fat content. Apart from the fat content of milk a single study (Polidori *et al*., 1997) recorded a decrease in nitrogen fractions in milk from buffaloes administered bST. No data have been reported on the technological properties of buffalo receiving bST.

Monensin is an ionophore that affect primarily rumen metabolism. Studies showed that it increased the ratio of propionate to acetate produced, during rumen fermentation (Van Nevel and Demeyer, 1977). Also, it decreased rumen methane production (Russell and Strobel, 1989) and decreased protein degradation in the rumen (Bergen and Bates, 1984). The overall result of supplementing animal ration with monensin has been an increase in milk production.

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 (McGuffary and Giner-Chavez, 1998; Vallimont *et al*., 2001) but no data have been reported for the same in buffaloes.

The objectives of the present research were to evaluate the effects of somatotropin and monensin separately or in combination on the yield and quality of milk and cheese made from the obtained milk.

Materials and Methods

Animals and Diets

Twenty lactating buffaloes, aged 4-6 years, 14 days before calving were divided into four groups (5 animals each) in two-way classification design. The average body weight, milk yield and stage of lactation of these groups were almost the same. Treatments were; 1) control (c): was fed 70% concentrate feed mixture, 15% berseem and 15% rice straw (on dry matter basis); 2) injection of exogenous bovine somatotropin (bST) every 14 days during the experimental period. 3) concentrate feed mixture was top dressed with 400 mg menensin/day/animal (M); and monensin and somatotropin in combination (bST+M) during the last 14 days before expected parturition up to 180 days after parturition. The monensin used was a commercial product (Norsin, Quasna Pharmaceutical Industries, Quasna, Egypt) containing 10% monensin. Somatotropin was administered subcutaneously adjacent to the tail head as a 500 mg sustained release formula (posilac, Monsanto, ST. Louis, Mo.USA) every 21 day cycle.

Chemical composition of CFM, berseem clover and rice strew are shown in Table 1. The concentrate feed mixture consisted of 24% undecorticated cotton seed cake, 20% wheat bran, 34% yellow corn, 20% gleto feed, 1% limestone and 1% common salt. Diets were formulated to meet the animals requirements (Shehata, 1971). The CFM for each animal was offered individually twice daily during milking at 6.00 am and 16.00 pm The dry matter intake was recorded once a week to calculate feed efficiency. Water was offered twice a day.

Analysis of Feed Samples

Samples of ingredients and rations were analysed for Dry Matter (DM), ash, Crude Protein (CP), Crude Fiber (CF), Organic Matter (OM), Ether Extract (EE) and Nitrogen Free Extract (NFE) (AOAC, 1995).

Table 1: Chemical composition of dietary ingredients (% DM basis)

Item	CFM*	RS**	Berseem
Dry matter	89.10	91.60	19.32
Ash	9.10	17.00	13.00
Organic matter	90.90	83.00	87.00
Crude protein	14.85	2.90	13.21
Ether extract	3.77	2.23	3.10
Crude fiber	10.26	31.78	27.03
Nitrogen free extract	62.02	46.09	43.66

* CFM = Concentrate Feed Mixture Consisted of 34% yellow, 24% undecorticated cotton seed cake, 20% wheat bran, 20% glutofeed, 1% limestone and 1% common salt. ** RS = Rice Straw

Sampling and Analysis of Milk

The animals were machine milked (twice daily), milk was recorded for each milking. The animals were weighted and milk samples were collected biweekly. Representative samples from combined morning and evening milk were analysed for milk fat, Total Solids (TS), Solids Not Fat (SNF), Total Protein (TP) and ash contents (Ling, 1963) and lactose content (Barnett and Abd El-Tawab, 1957).

Cheese Manufacture and Analysis

Mixed milk from each group was collected separately and stored frozen and was pooled monthly and used in the manufacture of Tallaga cheese (Domiati cheese stored at low temperature) according to Fahmi and Sharara (1950), Thus a total of 3 replicates of cheese were made from each treatment and stored in the refrigerator (7-10°C) for 3 months. Cheeses were analysed monthly for moisture, Total Solids (TS), fat, acidity, Total Protein (TP) according to AOAC (1995), Soluble Nitrogen (SN) and NaCl contents (Ling, 1963) and lactose content (Barnett and Abd El-Tawab, 1957), while pH was measured using a pH meter. Cheese samples were judged by a panel taste of 15 staff members of the dairy department, National Research Centre, Egypt. The cheese was scored for appearance (10 points), body and texture (30) and flavour (60) as suggested by El-Koussy (1966). Also, the cheese was analysed for Total Volatile Fatty Acids (TVFA s) as described by Kosikowski (1986), soluble tyrosine and tryptophan (Vakaleris and Price, 1959). Total carbonyl compounds content as described by Berry and Mckerrigan (1958).

Statistical Analysis

The ANOVA by a two-way classification design using the general linear model procedure

$Y_{ij\kappa} = U + T_i + e_{i\kappa} + A_i + (TA)_{ij} + E_{ij\kappa}$,

where $Y_{ij\kappa}$: is the parameter under analysis of the ijk buffalo,

U: is the overall mean,

T_i: is the effect due to treatment,

e_{ik}: is the effect due to the animals within treatment, (treatment error),

A_j: is the effect due to the stage of lactation,

$(TA)_{ij}$: is the interaction (treatment X stage of lactation),

$E_{ij\kappa}$: is the effect due experimental error associated with the Y_{ijk} observation, according to Snedecor and Cochran (1982).

The DMRT was used to test the significance between means (Duncan, 1955).

Results and Discussion

Dry Matter Intake and Milk Yield and Composition

The production performance data and analysis of milk are shown in Table 2. The dry matter intake (DMI) was significantly (p>0.05) increased in 2nd group (bST) as compared with the other three groups (Table 2). Hartnell *et al.* (1991) found that the DMI was significantly higher with bST

Table 2: Effect of treatments on milk performance (days 7 to 180)

Item	Treatments				±SE
	C	bST	M	bST+M	
No. of animals	5	5	5	5	
Live body weight	650.00	695.00	677.00	684.00	12.30
Dry matter intake (kg/h/day)	16.75	17.72^{a}	16.31^{b}	16.10^{b}	1.30
Yield (kg/day)					
Milk	10.28^{D}	16.72^{A}	12.85^{C}	14.31^{B}	3.20**
4% FCM	14.14^{D}	24.24^{A}	17.67^{C}	20.75^{B}	2.7**
Fat	0.67^{D}	1.20^{A}	0.84^{C}	1.02^{B}	0.03*
SNF	1.28^{D}	1.82^{A}	1.22^{C}	1.56^{B}	0.003*
Protein	0.43^{D}	0.74^{A}	0.49^{C}	0.63^{B}	0.007*
Efficiency					
DMI/Milk	1.63^{a}	1.06^{d}	1.27^{b}	1.13^{c}	0.005*
Milk/DMI	0.61^{d}	0.94^{a}	0.79^{c}	0.89^{a}	0.001*
FCM/DMI	0.84^{d}	1.38^{a}	1.08^{ca}	1.29^{a}	0.03*
Milk composition					
Fat	6.50^{b}	7.20^{a}	6.50^{b}	7.10^{a}	0.87*
TS	17.00^{b}	18.10^{a}	16.00^{b}	18.00^{a}	0.21*
SNF	10.00^{b}	10.90^{a}	9.50^{b}	10.90^{a}	0.49
TP	4.20^{a}	4.40^{a}	3.80^{b}	4.40^{a}	0.31
Lactose	4.70^{B}	5.80^{A}	4.60^{B}	5.50^{A}	0.30
Ash	0.90	0.80	0.80	1.00	0.02

*Significant ($p<0.05$) small letter, ($p<0.01$) captial letter between means at the same row within treatment or storage period, are indicated by dissimilar superscripts

treatment compared with control. Increases in DMI resulting from treatment of cows with 250, 500 and 750 mg bST were 1.6 kg day^{-1} (8.0%), 1.9 kg day^{-1} (9.5%) and 3.3 kg day^{-1} (16.5%), respectively. Other studies showed no effect of bST treatment on DMI for cows (Eppard *et al*., 1996) or heifers (Stelwagen *et al*., 1992).

The milk yield in the present study was much higher in all group of buffaloes compared to that reported for Indian buffaloes (Ludri *et al*., 1989) and Italian buffaloes (Ferrara *et al*., 1989; Polidori *et al*., 1997). This can be attributed mainly to differences in buffalo breeds involved in these studies. Administration of bST increased markedly milk yield in the present study. The average increase in milk yield was 62.6% being much higher than that obtained with Italian buffaloes; namely 17.27% (Polidori *et al*., 1997) and 12.7% (Ferrara *et al*., 1989) and for Indian buffaloes; namely 16.8 and 29.5% after 1st and 2nd week of treatment, respectively. Different doses of bST had been used in the different studies. In the present study, a dose of sustained release bST of 500 mg was used compared to 320 and 670 mg used in other studies (Polidori *et al*., 1997; Ferrara *et al*., 1989). It is apparent that differences in the bST dose can not explain the recorded response of buffaloes to the bST treatment in different studies. 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 bST-induced enhancement of milk yield can be attributed to mobilization of body energy reserves to meet the elevated energy requirements, which exceeded the energy intake. The increase of overall utilization of energy (kg milk/Megajoule 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).

The effect of monensin treatment on milk yield was less pronounced than the bST treatment (Table 2). An increase of 25% in milk yield was observed in buffaloes which received monensin in their diet. The increase in milk yield with monensin treatment was higher than that reported for cows' (Phipps *et al*., 2000) The increase in milk yield with monensin treatment has been attributed to the increase in ruminal propionate production (Bergen an Bates, 1984; Callaway *et al*., 1997), which can be used as a gluconeogenic precursor.

The combined effect of bST+M on milk yield was higher than the effect of M only, but less than that observed with the use of bST separately (Table 2). 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.

Administration of bST to buffaloes increased significantly ($p<0.05$) the fat, total solids, solids not fat, total protein and lactose contents (Table 2). Polidori *et al.* (1997) reported an increase in milk fat, but the total protein content was almost unchanged in buffaloes treated with bST. van den Berg (1991) found that fat, protein and lactose contents of the milk were affected negligibly by bST when the cow was in positive energy balance. With the use of sustained-release bST system, some cyclic effects on fat and protein contents were found (van den Berg, 1991). However, McGuffey *et al.* (1987) concluded that the average fat and protein contents was not affected significantly when bST was applied every 2 or 4 week. A comparative study of a daily and a biweekly injection system gave somewhat higher average protein content for the sustained release system at a low dose and a similar protein content at a normal dose (De Boer and Kennelly, 1989).

Buffaloes supplemented with monensin produced milk of the same fat, but less protein content than the control (Table 2). However, the yield of these constituents was higher in group receiving monensin that the control. Phipps *et al.* (2000) reported a decline in milk fat and protein content of milk from cows' receiving monensin, while the yield of these constituents was not affected.

The effect of bST+M on milk composition was comparable to the effect of bST only. This suggest that bST overcame the limited effect of M on milk composition.

The efficiencies in milk production calculated as DMI/kg milk yield, milk yield /DMI, 4% fat corrected milk/DMI were improved ($p>0.05$) in 2nd and 4th groups as compared with 1st and 3rd groups.

It is apparent that using bST or/and bST+M improved the performance of lactating buffaloes without adverse effects on animal health and productivity during this study.

Cheese Yield

The use of buffalo milk from animals treated separately with bST and M gave cheese yield comparable to the control, while that from animals treated with bST+M gave significantly higher cheese yield (Table 3). This may be attributed to high recovery of milk constituent in cheese from bST+M treated milk. Generally, the cheese yield found in the present study was less than that reported for Tallaga cheese from buffalo milk (Badawi and Kebary, 1998). This can be attributed to the lower moisture content of cheese in the present study. Calculating corrected cheese yield to 60% moisture content revealed cheese yield comparable to that reported in the other study (Badawi and Kebary, 1998).

Cheese Composition

Table 4 shows that Tallaga cheese from different treatments had almost the same acidity, fat and salt contents. The cheese from bST+M milk contained significantly higher protein content than other treatments, while cheese from bST and M treatments had comparable total protein being higher than the control. The high protein content of cheese from bST+M treatment may explain the high cheese yield of this treatment.

Cheese acidity developed rapidly during storage. However, changes in fat, protein and salt were slight but significant (Table 4). The protein content tended to decrease with advanced storage. This can be attributed to protein degradation and subsequent losses of the formed soluble degradation products in brine (Awad *et al.*, 2002).

The effect of treatments on the ripening indexes is recorded in Table 5. The control showed the highest and cheese from bST+M the lowest TVFA. The soluble tyrosine and tryptophan were slightly but significantly affected by treatments. The cheese from bST+M treatment showed the highest, while the control showed the lowest average soluble tyrosine content. On the other hand, the control showed the highest and those from bST+M treatment the lowest soluble N and SN/TN ratio.

Table 3: Yield and organoleptic properties of Tallaga cheese as affected by bST and monensin

	Treatments					Storage period (month)				
Item	C	bST	M	bST+M	±SE	Fresh	1	2	3	±SE
Cheese yield%	25.6^{b}	25.8^{b}	25.5^{b}	27.0^{a}	2.8^{ns}	-	-	-	-	-
Organoleptic properties										
Flavour (60)	47.3^{c}	53.1^{b}	52.1^{b}	56.4^{a}	0.08*	50.3^{d}	51.3^{c}	53.0^{b}	54.4^{a}	0.13*
Body and texture (30)	25.8^{a}	24.2^{b}	21.4^{c}	25.8^{a}	0.05*	23.3^{c}	24.5^{b}	24.7^{b}	25.1^{a}	0.07*
Appearance (10)	8.5^{a}	7.3^{b}	7.6^{b}	8.3^{a}	0.06*	8.5^{a}	8.1^{a}	7.7^{b}	7.4^{b}	0.05*
Total scoring (100)	81.5^{C}	84.6^{B}	81.1^{C}	90.4^{A}	0.68**	82.0^{B}	83.3^{B}	85.3^{A}	86.9^{A}	0.62**

Significant ($p<0.05$) small letter, ($p<0.01$) capital letter between means at the same row within treatment or storage period, are indicated by dissimilar superscripts. SE = Standard Error

Table 4: Effect of bST, M and bST + M and storage period on the composition of Tallaga cheese*

	Treatments					Storage period (month)				
Item	C	bST	M	bST+M	±SE	Fresh	1	2	3	±SE
Acidity%	1.27	1.25	1.24	1.24	0.02	0.3^{b}	1.10^{c}	1.37^{b}	2.02^{a}	0.007*
TS%	47.48^{b}	47.48^{b}	47.70^{b}	49.65^{a}	0.12*	45.60^{c}	47.43^{b}	49.08^{a}	50.20^{a}	0.05*
Fat%	26.33	25.7	25.25	26.83	0.11	24.25^{c}	25.78^{b}	26.88^{a}	27.20^{a}	0.09*
Fat/DM%	55.45	54.13	52.14	53.03	0.21	53.18	54.35	54.77	54.18	0.04
TP%	12.08^{c}	13.27^{b}	13.08^{b}	14.29^{a}	0.12*	12.90	13.35	13.28	13.20	0.004
TP/DM%	25.44^{c}	27.95^{b}	27.42^{b}	28.78^{a}	0.11*	28.29^{a}	28.15^{a}	27.06^{b}	26.29^{b}	0.006*
Salt%	4.74	4.64	4.59	4.65	0.0005	5.08^{a}	4.65^{b}	4.35^{b}	4.53^{b}	0.005*
Salt/DM%	9.98	9.77	9.64	9.37	0.002	11.14^{a}	9.80^{b}	8.86^{b}	9.02^{b}	0.006*

SE = Standard Error. Significant difference ($p<0.05$), small letter between means, at the same row within treatment or storage period are indicated by dissimilar superscripts. *Each value represents the average of 12 samples for treatments and 9 samples for storage period. SE = Standard Error

Table 5: Change in the ripening parameters of Tallaga cheese manufactured during storage as affected by bST and monensin*

	Treatments					Storage period (month)				
Item	C	bST	M	bST+M	±SE	Fresh	1	2	3	±SE
TVFA's	31.27^{A}	18.85^{C}	21.91^{B}	15.27^{D}	0.02	9.18^{D}	20.14^{C}	25.13^{B}	32.85^{A}	0.007
Tyrosin	35.19^{c}	38.68^{a}	38.23^{a}	37.12^{b}	0.12	16.26^{D}	31.97^{C}	40.92^{B}	60.07^{A}	0.05
Tyrptophane	48.25^{b}	51.61^{a}	49.75^{b}	51.41^{a}	0.11	29.62^{D}	43.75^{C}	51.41^{B}	71.00^{A}	0.09*
TCC	14.83	14.74	13.73	14.15	0.21	6.80^{B}	16.49^{A}	17.00^{A}	17.14^{A}	0.004
SN%	0.43^{a}	0.38^{b}	0.40^{a}	0.35^{b}	0.12	0.25^{c}	0.32^{b}	0.47^{a}	0.54^{a}	0.004
SN/TN%	22.52^{a}	18.26^{b}	17.60^{c}	17.06^{c}	0.11	12.45^{D}	15.49^{C}	21.23^{B}	26.27^{A}	0.006*

SE = Standard Error. Significant difference ($p<0.05$), small letter between means, at the same row within treatment or storage period are indicated by dissimilar superscripts. *Each value represents the average of 12 samples for treatments and 9 samples for storage period. TVFA's (mL 0.1 N NaOH/100 g cheese), Tyrosin (mg/100 g cheese), Tyrptophane (mg/100 g cheese), TCC (μmol/100 kg cheese)

The storage period had a marked effect on the ripening indexes. All determined indexes increased significantly with storage (Table 5). The present results are in accordance with that reported by Awad *et al*. (2002) and Badawi and Kebary (1998). The increased proteolysis in cheese during storage had been attributed mainly to residual rennet retained in cheese curd.

Sensory Properties of Cheese

The cheese from milk obtained from animals treated with bST+M and bST only were ranked higher scores for flavour and total scores than the control (Table 3). The scores for different attributes increased with storage except for appearance decreased with advanced storage. Similar trend was reported by Awad *et al*. (2002)

Conclusions

Treatment of buffaloes with bST, M and bST+M increased their milk yield and milk fat, protein and lactose contents. However, treatment with bST gave the highest increase in milk yield of lactating buffaloes. The use of milk from animals treated with bST, bST+M and M in the manufacture of Tallaga cheese had no adverse effect on the yield, quality and ripening changes in cheese during storage. Treatment of lactating buffaloes with bST is recommended to increase buffalo milk production.

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