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Evaluation of Domiati Cheese Quality During Storage as Affected by Live Selenized Yeast Supplementation to Rations of Lactating Buffaloes

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Abstract: Nine lactating buffaloes were ranked into three groups (three animals each) using 3×3 Latin square design (with 35 days each period). Experimental rations were: control (concentrate feed mixture (CFM): berseem clover (BC), 2:1 DM basis), low selenized yeast [control ration plus10 g/h/d selenized yeast (2.5 mg Se/h/d)] and high selenized yeast [control ration plus10 g/h/d selenized yeast (4.5 mg Se/h/d)]. At the last 3 days of each period, the collected milk from each group was pooled and used for analysis and manufacturing of Domiati cheese. The obtained results indicated that feeding diets supplemented with low or high selenized yeast improved milk yield and its protein content significantly ($p<0.05$). Also, both yield and protein recovery of cheese from group fed diet supplemented with low selenized yeast was improved as compared with high selenized yeast and control diets. Feeding diets supplemented with low or high selenized yeast had no effect on chemical, physical and organoleptic properties of Domiati cheese. The increase in total protein, fat and firmness of cheese during storage was correlated with decrease in pH values and moisture content of cheese. Also, the weight loss of cheese was more correlated with increase in soluble nitrogen and decrease of moisture content of cheese.

Key words: Selenized yeast, buffalo's milk, Domiati cheese properties, cheese weight loss

INTRODUCTION

Milk production and composition in animals are influenced by a number of genetic and non-genetic. The latter include age, stage of lactation, climatic condition and nutritional status and management levels. In order to restore productivity of lactating animals and to optimize milk production, various drugs, hormones and feed additives have been proposed (Lurdi, 1993). The use of live yeasts to supplement diets is one way to achieve this goal (Kholif *et al*., 2000). Selenium is an essential microelement for animal and man. Its deficiency in nutrition may decrease the productivity of domesticated animals (Foster and Sumer, 1997). El-Batal and Fadel (2002) produced an edible food yeast (*S. cerevisiae*) having high levels of organically bound intracellular selenium in an assimilable non-toxic form, which is useful as a dietary supplement. Kholif (2005) and European Food Safety Authority (2006) used selenized yeasts as a nutritional additive in ruminant diets, being a source of the essential trace element selenium in an organic form.

Domiati cheese is a most popular cheese variety made in Egypt. The yield and composition of Domiati cheese vary according to the kind of milk used in cheese making, the recovery of milk constituents in the resulting cheese would also vary accordingly (Ibrahim *et al*., 1974). Therefore, this study was conducted to evaluate the effects of selenized yeast supplemented rations on the milk production and composition and Domiati cheese yield and quality during cold storage period. Also, this study was undertaken to evaluate the relationships among some properties of Domiati cheese as affected by milk composition and storage period.

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MATERIALS AND METHODS

Materials

Selenized yeasts (*Saccharomyces cerevisiae* F-25 with organic selenium) were obtained from Microbial Chemistry Lab. National Research Centre, Dokki, Cairo, Egypt. The cultures were maintained on Malt agar medium.

Calf rennet powder (HALA) and mixed strains of *Lactococcus lactis* sp. *Lactis* and *Lactococcus lactis* sp. cremoris were obtained from Chr. Hansen's Lab Oritorum. A/S Copenhagen, Denmark). Salt was obtained from El-Naser Company of Alexandria.

Animals and Diets

Nine lactating buffaloes (2-4 lactation season and weighting in average 496±4 kg) in mid-lactation were ranked in three groups (three animals each) according to their milk production and lactation season using 3×3 Latin square design (with 35 days each period). Experimental rations were as follows: control (concentrate feed mixture (CFM): berseem clover (BC), 2:1 DM basis), low selenized yeast [control ration plus10 g/h/d selenized yeast (2.5 mg Se/h/d)] and high selenized yeast (control ration plus 4.5 mg Se/h/d selenized yeast) and high selenized yeast [control ration plus10 g/h/d selenized yeast (4.5 mg Se/h/d)]. Selenized yeasts were top-dressed on the ground CFM. The CFM was consisted of 35% yellow corn, 25% wheat bran, 22% undecorticated cotton seed meal, 15% rice bran, 1.5% ground limestone and 1.5% common salt. The chemical composition of ingredients is show in Table 1. The offered feeds were assessed to cover the requirements for each animal according to NRC (1988) allowances for daily cattle. The CFM for each animal was offered individually once daily at 8.00 am, while berseem clover was offered twice daily at 10.00 am and 4.00 pm Daily milk production was determined.

Methods

Cheese Manufacturing

At the last 3 days of each period, the animals are hand milked (twice/day). The collected milk from each group was pooled and used for analysis and manufacturing of Domiati cheese according to Fahmi and Sharara (1950). All milk batches were heated to 75°C/15 sec. and then cooled to 38°C. The starter culture (1% w/w) and salt (5%w/w) were added to cheese milk and appropriate amount of rennet was added to achieve coagulation in 150 min. The resultant cheeses were separately pickled in their whey and stored at 6±2°C for 3 month. The samples were analyzed fresh and every month of storage.

Analysis of Samples

Samples of ingredients and rations were analyzed for dry matter, ash, crud fiber, organic matter and ether extract according to methods of AOAC (1995). Nitrogen-free extract was calculated.

Moisture and ash contents in milk and cheese samples were determined according to AOAC (2000). Fat content was determined by the Gerber method. Total nitrogen content (TN) of the

Table 1: Chemical composition of concentrate feed mixture (CFM) and berseem clover (BC) (% Dry matter basis)

Items	Concentrate feed mixture (CFM)	Berseem clover (BC)
Dry matter	90.03	16.90
Organic matter	90.00	86.30
Ash	10.00	13.70
Crude protein	14.67	11.10
Ether extract	3.33	2.90
Crude fiber	13.00	31.50
Nitrogen-free-extract	59.00	40.80

samples was determined by Kjeldahl method. The protein content was obtained by multiplying the percentage of total nitrogen content by 6.38. pH value was measured using digital pH meter (HANNA, Instrument, Italy) with glass electrode. Salt contents of Domiati cheeses were estimated using Volhard method according to Richardson (1985). Water soluble nitrogen (WSN) of cheese samples was extracted according to Coskun and Tuncturk (2000) as follow: 20 g cheese was homogenized with distilled water (2:8), hold at 40°C for 1 h and then centrifuged at 3000 x g for 30 min. The extraction was filtered and used for determination of nitrogen content.

Penetration using Koehler K 19500, Penetrometer (Sycamore AVE, USA) as described by Kammerlehner and Kessler (1980) was measured as an indicator for cheese firmness (0.1 mm = penetrometer unit, PE).

Cheese yield was calculated as the weight of finished cheese divided by the weight of milk used. The recovery percentage of fat and protein were calculated according to Mahran *et al*. (1999). The weight loss was calculated relative to fresh cheese weight.

Domiati cheese was judged at fresh and every month of storage for organoleptic properties by 11 staff numbers of dairy department according to Pappas *et al*. (1996).

Statistical Analysis

Data obtained were statistically analyzed according to procedures outlined by Snedecor and Cochran (1982). The Duncan's multiple range tests was used to test the significance between means (Duncan, 1955).

RESULTS AND DISCUSSION

Milk Yield and Composition

Milk yield was significantly ($p<0.05$) higher in selenized yeasts supplemented groups representing an increase of about 15.22 and 18.12% for buffaloes fed low and high selenized yeast diets, respectively than buffaloes received the control diet (Table 2). Also, milk protein was higher ($p<0.05$) in milk from animals fed low selenized yeast diets followed by animals fed high selenized yeast diets and then animals fed control ration. From these data we can conclude that there was a positive effect of selenium and yeast on the digestibility of organic matter and/or metabolic process in the mammary gland, which led to the increase of milk yield and protein synthesis. However, milk fat, total solids and solids-not-fat contents were insignificantly ($p>0.05$) increased with low selenized yeast treated group compared with high selenized or control groups. However, milk pH showed an opposite trend. These results with the animals fed selenized yeasts supplemented diets agreed with those reported by Kholif *et al*. (2000, 2005) with yeast or with selenized yeast (Kholif, 2005).

Table 2: Effect of supplementing buffalo's diets with selenized yeast (low or high) on the yield and composition of buffalo's milk

	Treatments		
Items	Control	Low selenized yeast	High selenized yeast
Milk yield (kg day^{-1})	6.90±0.58^{B}	7.95±0.40^{A}	8.15±0.52^{A}
Moisture (%)	84.23±0.52^{A}	82.58±0.68^{A}	84.79±0.42^{A}
Fat (%)	6.77±0.62^{A}	8.17±0.41^{A}	5.97±0.55^{A}
Total solids (%)	15.77±0.52^{A}	17.42±0.68^{A}	15.21±0.42^{A}
SNF (%)	9.00±0.56^{A}	9.25±0.52^{A}	9.24±0.47^{A}
Protein (%)	3.66±0.27^{B}	4.30±0.27^{A}	4.01±0.06^{A}
pH value	6.77±0.07^{A}	6.70±0.03^{A}	6.77±0.09^{A}

Means in the treatments with different superscripts are significant ($p<0.05$), Means each value obtained from 9 animals. Control = Concentrates: berseem clover, 2: 1, SNF = Solid Not Fat

Cheese Yield and Recovery

Supplementing buffalo's diets with low selenized yeast increased cheese yield and protein recovery comparable to control, but the treatments effects were not statistically significant (Table 3). However, milk produced from buffaloes fed diets supplemented with high selenized yeast had lower cheese yield and protein recovery than low level selenized yeast ($p<0.05$) and control ($p>0.05$). The reasons here are not clear. Cheese yield was correlated with milk solids ($r = +0.75^{**}$), especially protein and fat ($r = +0.93^{**}$) contents (Table 7), although, no much differences were observed in fat recovery among all treatments.

Chemical Composition of Domaiti Cheese

Table 4 show that no significant differences were observed in pH values, moisture, total protein, fat, ash and salt contents of fresh Domaiti cheese among all treatments. However, pH values, moisture and ash contents decreased, but total protein and fat contents increased through storage period up to 3 month. The chemical changes during cold storage period were insignificant, except changes in pH values ($p<0.05$). These results could be attributed to the rearrangements, within the network produced by attractive forces between individual casein particles or clusters micelles leading to additional intermolecular bonds and, therefore, to a contraction of the gel and the expulsion of whey, which was favoured by change in pH values (Walstra *et al*., 1985). Statistically, significant correlations were found between milk fat and cheese fat ($r = +0.68^{**}$). Also, cheese moisture was highly correlated with pH values during storage period (Table 7).

Table 3: Effect of supplementing buffalo's diets with selenized yeast (low or high) on cheese yield and protein and fat recovery of Domiati cheese from buffalo's milk

	Treatments		
Items	Control	Low selenized yeast	High selenized yeast
Cheese yield (%)	30.47±1.94^{AB}	33.64±0.27^{A}	27.56±1.30^{B}
Protein recovery (%)	86.77±2.95^{AB}	90.45±1.99^{A}	84.08±3.12^{B}
Fat recovery (%)	91.75±3.31^{A}	91.99±2.35^{A}	90.21±5.31^{B}

Means in the treatments with different superscripts are significant ($p<0.05$), Means each value obtained from 9 animals, Control = concentrates: berseem clover, 2:1

Table 4: Chemical composition of Domiati cheese during cold storage period as affected by selenized yeast supplementation (low or high)

	Chemical composition					
	pH	Moisture	Total protein	Fat	Ash	Salt
Treatments	(%)					
Control						
Fresh	6.36±0.12^{A}	61.17±0.96^{A}	10.49±0.73^{B}	20.33±1.20^{AB}	4.74±0.16^{AB}	3.98±0.12^{A}
1 month	5.07±0.10^{C}	59.13±0.91^{A}	12.20±0.39^{AB}	21.67±0.73^{AB}	4.63±0.15^{AB}	4.00±0.08^{A}
2 month	4.35±0.05^{D}	57.31±0.02^{A}	12.30±0.69^{AB}	22.50±1.25^{AB}	4.54±0.25^{AB}	4.11±0.05^{A}
3 month	4.29±0.12^{D}	56.98±1.11^{A}	12.27±0.64^{AB}	23.33±0.83^{AB}	4.44±0.18^{B}	4.07±0.03^{A}
Low selenized yeast						
Fresh	6.30±0.07^{A}	59.78±3.63^{A}	11.56±0.12^{AB}	22.33±1.20^{AB}	4.91±0.07^{AB}	4.03±0.07^{A}
1 month	5.20±0.18^{BC}	59.51±1.26^{A}	11.83±0.33^{AB}	22.50±1.75^{AB}	4.83±0.18^{AB}	4.02±0.08^{A}
2 month	4.50±0.27^{D}	57.53±0.82^{A}	11.76±0.12^{AB}	25.00±1.25^{A}	4.67±0.08^{AB}	4.10±0.15^{A}
3 month	4.36±0.04^{D}	57.14±1.35^{A}	11.83±0.27^{AB}	25.00±1.52^{A}	4.46±0.13^{B}	3.97±0.06^{A}
High selenized yeast						
Fresh	6.43±0.08^{A}	59.80±0.74^{A}	12.32±0.97^{AB}	19.50±1.80^{B}	5.08±0.25^{A}	3.96±0.09^{A}
1 month	5.49±0.02^{B}	59.64±0.71^{A}	12.61±1.93^{AB}	21.83±1.36^{AB}	5.02±0.30^{AB}	4.20±0.11^{A}
2 month	4.57±0.13^{D}	57.83±1.10^{A}	13.30±1.27^{A}	22.67±1.76^{AB}	4.87±0.10^{AB}	3.96±0.08^{A}
3 month	4.30±0.08^{D}	56.42±2.12^{A}	12.48±0.76^{AB}	22.83±2.20^{AB}	4.65±0.27^{AB}	3.94±0.11^{A}

Means in the treatments with different superscripts are significant ($p<0.05$)

Water Soluble Nitrogen: Total Nitrogen Ratio (WSN/TN)

WSN/TN ratio was studied as indicator for protein proteolysis of cheese during cold storage period. According to the results in Table 7, WSN/TN ratio of fresh Domiati cheese was lower with feeding by low or high selenized yeast than control treatment ($p>0.05$). However, during storage period, gradual and the same rate nearly increases in WSN/TN ratios were observed in all cheese treatments ($p<0.05$). Significant correlation was found between WSN/TN ratios and pH vales ($r = -0.78^{**}$) and moisture content ($r = -0.64^{**}$) (Table 7).

Cheese Weight Loss

After 1 month pickling, the weight loss was lower in cheese made with feeding by low selenized yeast than other treatments (Table 5), but the differences were insignificant ($p>0.05$). Also the results show that a marked and progressively increase ($p<0.05$) in cheese weight loss during cold storage period. The weight losses of Domiati cheese are usually attributed to biochemical changes that result in curd condition and exclusion of moisture and soluble constituents in pickling Brine. Statistically, correlations show negative correlation between weight loss and moisture content ($r = -0.5^{*}$), but positive correlation between weight loss and WSN/TN ratio ($r = +0.78^{**}$) (Table 7).

Cheese Firmness

Firmness is not closely related to an elastic modulus but rather to a yield stress. Its value depends on the method of measurement, especially the time scale and on several product and process variables.The results in Table 5 showed slight differences were record among all treatments in fresh cheese firmness ($p>0.05$). During cold storage, cheese firmness gradually increased with the time, but this increasing was more pronounced after 2 month in all treatments ($p<0.05$). This may be due to rearrangement within the network produced by attractive forces between individual casein particles leading to contraction of the milk gel (Walstra *et al*., 1985). There were significant correlations between cheese firmness and either pH values or cheese moisture (Table 7).

Organoleptic Properties

It seems from the data given in Table 6 that the all fresh Domiati cheese had nearly the same scoring point for flavour, body and texture and the general appearance. The resultant cheese had a good body and texture (soft, smooth and lubricity texture) and pleasant creamy flavour. However, a little change was observed in cheese quality during storage period (2 month), except the body was firm

Table 5: Effect of supplementing diets with selenized yeast (low or high) on soluble nitrogen, weight loss and firmness of Domiati cheese produced from buffalo's milk during cold storage period

Treatments	SN/TN (%)	Weight loss (%)	Cheese firmness (PE. Unit)
Control			
Fresh	11.10 ± 1.06^{DEF}	0.00 ± 0.00^{D}	185.53 ± 10.51^{A}
1 month	11.92 ± 1.23^{CDE}	9.14 ± 2.97^{C}	153.13 ± 4.05^{AB}
2 month	$15.23\pm2.11^{A\text{-}D}$	17.75 ± 1.61^{B}	112.40 ± 6.11^{C}
3 month	17.90 ± 1.84^{AB}	26.93 ± 1.94^{A}	109.60 ± 7.25^{C}
Low selenized yeast			
Fresh	9.25 ± 1.06^{EF}	0.00 ± 0.00^{D}	184.83 ± 20.39^{A}
1 month	12.68 ± 1.54^{CDE}	4.14 ± 5.30^{CD}	153.73 ± 4.55^{AB}
2 month	15.51 ± 0.33^{ABC}	17.65 ± 0.92^{B}	128.77 ± 13.07^{BC}
3 month	18.82 ± 0.16^{A}	25.41 ± 3.45^{A}	115.03 ± 10.51^{C}
High selenized yeast			
Fresh	7.62 ± 1.46^{F}	0.00 ± 0.00^{D}	170.53 ± 3.94^{A}
1 month	13.39 ± 1.82^{CDE}	9.16 ± 2.38^{C}	166.13 ± 1.12^{A}
2 month	14.38 ± 0.45^{BCD}	17.92 ± 4.31^{B}	115.43 ± 1.09^{C}
3 month	16.17 ± 1.23^{ABC}	29.59 ± 3.59^{A}	100.77 ± 13.99^{C}

Means in the treatments with different superscripts are significant ($p<0.05$), Means each value obtained from 9 animals, SN: Soluble Nitrogen, TN: Total Nitrogen, PE: Penetrometer (the higher PE unit means less firmness)

Table 6: Effect of supplementing diets with selenized yeast (low or high) on sensory properties of Domiati cheese produced from buffalo's milk during cold storage period

	Sensory properties			
Treatments	Appearance (10)	Body and texture (40)	Flavour (50)	Total scores (100)
Control				
Fresh	9.18 ± 0.23^{A}	35.82 ± 0.84^{A}	45.82 ± 0.57^{ABC}	90.82 ± 0.57^{ABC}
1 month	8.73 ± 0.24^{A}	35.36 ± 0.49^{A}	45.45 ± 0.47^{ABC}	89.54 ± 0.47^{ABC}
2 month	8.91 ± 0.15^{A}	35.82 ± 0.87^{A}	44.00 ± 0.95^{BCD}	88.73 ± 0.95^{C}
3 month	8.68 ± 0.17^{A}	37.00 ± 0.42^{A}	45.64 ± 0.83^{ABC}	91.32 ± 0.83^{ABC}
Low selenized yeast				
Fresh	8.64 ± 0.20^{A}	36.18 ± 0.020^{A}	44.18 ± 0.81^{BC}	89.00 ± 0.81^{BC}
1 month	8.91 ± 0.20^{A}	36.45 ± 0.93^{A}	43.91 ± 1.06^{BC}	89.27 ± 1.06^{BC}
2 month	8.72 ± 0.14^{A}	36.27 ± 0.33^{A}	44.27 ± 0.76^{ABC}	89.26 ± 0.75^{BC}
3 month	9.18 ± 0.23^{A}	37.18 ± 0.52^{A}	46.00 ± 0.78^{AB}	92.36 ± 0.78^{AB}
High selenized yeast				
Fresh	8.73 ± 0.14^{A}	35.82 ± 0.48^{A}	43.45 ± 0.58^{C}	88.20 ± 0.58^{C}
1 month	8.64 ± 0.24^{A}	35.64 ± 0.87^{A}	43.91 ± 0.72^{BC}	88.19 ± 0.72^{C}
2 month	8.82 ± 0.12^{A}	36.00 ± 0.66^{A}	43.55 ± 0.68^{C}	88.37 ± 0.68^{C}
3 month	9.23 ± 0.18^{A}	37.18 ± 0.52^{A}	46.45 ± 0.58^{A}	92.86 ± 0.58^{A}

Means in the treatments with different superscripts are significant ($p<0.05$)

Table 7: Correlation coefficient between milk composition and/or Domiati cheese characteristics during storage period

Items	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
16	-0.14ns	-0.06ns	-0.14ns	-0.16ns	-0.01ns	-0.11ns	0.08ns	0.01ns	0.16ns	-0.88**	-0.50*	0.28ns	0.37*	0.78**	-0.88**	-
15	0.22ns	0.03ns	0.19ns	0.15ns	0.05ns	0.08ns	-0.24ns	0.09ns	-0.08ns	0.85**	0.40*	-0.30ns	-0.26ns	-0.61**	-	
14	0.15ns	0.06ns	0.20ns	0.15ns	0.01ns	0.03ns	0.20ns	0.02ns	0.13ns	-0.78**	-0.46*	-0.09ns	0.60**	-		
13	0.98ns	0.08ns	-0.09ns	-0.06ns	0.08ns	0.07ns	-0.02ns	-0.09ns	-0.05ns	-0.52**	-0.65**	-0.40*				
12	0.53**	-0.04ns	0.68**	0.55**	0.021ns	0.38*	0.06ns	-0.17ns	-0.10ns	-0.21ns	0.15ns	-				
11	-0.34*	0.10ns	-0.58**	-0.59**	0.04ns	-0.18ns	0.07ns	0.20ns	0.14ns	0.53**	-					
10	0.09ns	0.19ns	-0.26ns	-0.08ns	-0.06ns	-0.18ns	-0.12ns	0.18ns	0.04ns	-						
9	0.13ns	0.01ns	0.11ns	0.01ns	0.03ns	-0.18ns	0.80**	0.89**	-							
8	0.13ns	0.14ns	0.08ns	-0.03ns	-0.19ns	-0.23ns	0.45*	-								
7	0.06ns	-0.14ns	0.07ns	0.03ns	0.32ns	-0.11ns	-									
6	0.32ns	0.06ns	0.40*	0.47**	0.12ns	-										
5	0.41*	0.10ns	0.51**	0.50**	-											
4	0.75**	0.19ns	0.93**	-												
3	0.87**	0.15ns	-													
2	0.34*	-														

1: Milk solids, 2: Milk protein, 3: Milk fat, 4: Cheese yield, 5: Protein recovery, 6: Fat recovery, 7: Body and texture, 8: Flavour, 9: Total score, 10: pH, 11: Cheese moisture, 12: Cheese protein, 13: Cheese fat, 14: SN/TN ratios, 15: Cheese firmness, 16: Weight loss

comparable with fresh cheese. As ripening advanced (3 month), the flavour, body and texture and appearance of cheese were improved. This may be contributed to the high content of soluble nitrogen serve as a precursor of certain flavour compounds.

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