Livestock Research for Rural Development 21 (5) 2009 | Guide for preparation of papers | LRRD News | Citation of this paper

Effects of feeding *Saccharomyces cerevisiae* Sc 47 to dairy cows on milk yield and milk components, in Tunisian conditions

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Abstract

The objective of this study was to evaluate yeast effect on dairy cows performances in Mediterranean conditions. 240 Holstein dairy cows, from a dairy commercial herd in Kairouan, Tunisia, were divided in two groups. A control group received ration composed of forages and concentrate (> 50% on dry matter basis). The experimental group received the same diet supplemented with 5 g of yeast (*Saccharomyces Cerevisiae*) per cow per day. Concentrate was distributed in three meals. Every 21 days of lactation, milk yield was measured individually and samples were taken for determining fat, protein and urea content.

Yeast had significant effects on milk yield in early lactation, mid lactation and the whole lactation ($P < 0.001$). Effect was higher in early lactation (22%). Yeast effect was similar for primiparous and multiparous cows. Moreover, Yeast effect on milk yield during early lactation was higher for cows calving in the hot season (July- October) (3546.5 kg vs 2342.6 kg for yeast and control group, respectively). Fat and protein percentages were lower when feeding yeast ($p < 0.001$). However, fat and protein yield were higher with yeast supplementation and during hot season.

In conclusion, yeast seems to have spectacular effect on milk production in cows fed high quantity of concentrate, especially for heat stressed cows.

Key words: Dairy cows, heat stress, milk production, milk components, yeast

Introduction

Dairy cattle farming in Tunisia is characterized by the use of Holstein, as principal breed. Forage availability and nutritive quality are frequently lacking. Breeders are then forced to distribute high quantity of concentrate, especially for milking dairy cows.

Yeast (*Saccharomyces Cerevisiae*) addition in this condition, was reported to increase nutritional value of poor quality forages and high grain diets (Arambel and Kent 1990). Newbold et al (1996) and Beauchemin et al (2003) reported that yeast addition improves the development of rumen lactate-consuming bacteria; prevent accumulation of lactate and rumen pH drop. Yeast is also observed to stimulate cellulolytic bacteria in the rumen, increase fiber digestion and flow of microbial protein from the rumen (Newbold et al 1996; Jouany and Morgavi 2007). Morover, yeast was reported by great number of studies, to improve feed intake and milk yield in dairy cows. In addition, Arambel and Kent (1990); Huber (1998) and Schingoethe et al (2004) suggested that yeast is more effective when animals are under stress, particularly heat stress.

The objective of this study was to evaluate the effects of yeast culture feeding to lactating dairy cows on their performance, at different lactation stages and in condition of important heat stress.

Materials and methods

Animals and diet

The study was conducted in a commercial dairy herd, in the area of El Alem - Kairouan, (central Tunisia). This area is characterized by high heat stress in the period between June and August (temperature-humidity index = 78 ± 3.23, Bouraoui et al 2002). Two hundred forty lactating Holstein dairy cows (132 primiparous and 108 multiparous) were used. They were divided to two equal groups, according to parity and previous milk production. Cows were included in the trial as they calved. The Experiment duration was of 13 month. The control group received a ration composed of forages and commercially available concentrate as is indicated in Figure 1.

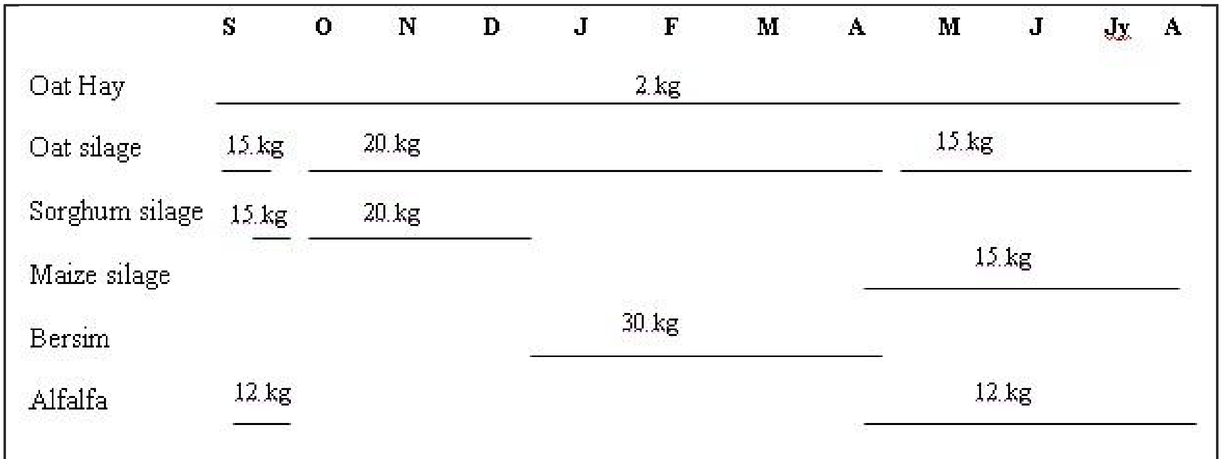

Figure 1. Planning of forage distribution

Concentrate was composed of maize, soya bean meal, ban and mineral-vitamin supplement. Proportion of concentrate in the ration (on dry matter basis) was higher than 50%. Forages were distributed ad libitum and the concentrate quantity varied according to the milk yield (between 8 and 11 kg per day). Concentrate was distributed in three meals The experimental group received the same ration composed of forages and concentrate. Five grammes of yeast (Biosaf, Lesaffre S.A, France) were added per cow in one kg of concentrate in order to control the quantity of yeast consumed by each cow and was distributed to the experimental group in the morning. Cows were housed in free stalls and had free access to water. They were milked daily at 5h 00 and 17 h 00.

Milk production and composition

Milk production was recorded and sampled individually, each twenty one days. Milk samples for early lactation were preserved with potassium dichromate, stored at 4°C and sent to the laboratory of the Office d'elevage et de pâturage for milk fat, crude protein and urea contents analyses with an infrared analyzer (Milk-O- Scan).

Calculations and statistical analysis

Individual milk production for the 100 first days of lactation, 200 days and 305 days of lactation were calculated according to Fleishmann equation. Milk composition and quantity of milk components secreted per day were calculated for the 100 first days of lactation. For early lactation, cows in the two groups were compared according to their calving date. Cows calving in a 15 day interval were compared.

Data were analyzed using STATISTICA 2000. Two models were used. In the first one, the effects of treatment, calving date and the interaction between the two factors were included. In the second model, the effects of treatment, parity and the interaction between the two factors were studied. Model effects were considered significant at $P < 0.05$.

Results

Not all cows completed the trial. Some cows were removed for lower yielding cows based on normal management procedures at the dairy farm or for pathological problem. The experiment was realized in a commercial herd and there is systematically a program for removing some cows for low milk production, low fertility and age. Some cows were also removed for accident and pathological problem. These cows did not complete the experiment. They were removed during the experiment and we don't have results for them. There are only five cows removed for the control group and 8 cows removed for the yeast group.

Milk yield for 100 days, 200 days and 305 days of lactation was significantly affected by yeast treatment (P < 0.03). Milk Yield during the whole lactation (305 days) averaged 5161.1 ± 160.6 kg in control group. It was higher by 15% (P < 0.03) in yeast group (Table 1).

Table 1. Yeast effects on milk yield (kg/ cow) during different period of lactation

	Control		Yeast	
	N	**μ ± se**	**N**	**μ ± se**
For 100 days	115	$2253.2^a \pm 48.6$	112	$2760.4^b \pm 65.9$
For 200 days	80	$4136.4^a \pm 107.4$	81	$4679.9^b \pm 97.8$
For 305 days	48	$5161.1^a \pm 160.6$	48	$5927.6^b \pm 162.1$

^{ab} means with different letters are significantly different (P < 0.05)
N : number of cows

The improvement of milk yield was the best in early lactation (22%, P < 0.001). Milk fat and protein contents in early lactation were respectively of 3.73 ± 0.05 % and 3.40 ± 0.02% for control group. They were smaller by 8% and 4% in yeast group (P <0.005). However, fat and protein secreted per day and per cow during early lactation were higher in yeast group (P < 0.001) (Table 2).

Table 2. Yeast effects on milk components in early lactation (100 days)

	Control		Yeast	
	N	**μ ± se**	**N**	**μ ± se**
Fat content, %	104	$3.73^a \pm 0.05$	104	$3.42^b \pm 0.05$
Protein content, %	104	$3.40^a \pm 0.02$	104	$3.26^b \pm 0.03$
Urea content, mg/dl	102	$32.20^a \pm 0.66$	103	$40.10^b \pm 1.13$
Fat quantity, g/d	104	$866.5^a \pm 24.4$	104	$969.7^b \pm 32.3$
Protein quantity, g/d	104	$776.1^a \pm 19.6$	104	$918.8^b \pm 25.3$

^{ab} means with different letters are significantly different (P < 0.05)
N : number of cows (why were more cows included for milk analysis than those for milk production? If cows are removed from trial is it correct to use their data for selected analysis? No, 104 vs 115 (early lactation)

Urea content in control group was of 32.2 mg/dl and was affected by treatment. Cows receiving yeast in their diet had higher milk urea (P < 0,001).

Milk yield during early lactation was higher for multiparous cows (P < 0.02). Nevertheless, Yeast effects on milk yield and composition were the same for primiparous and multiparous cows (Tables 3, 4). No interaction existed between treatment and parity

Table 3. Yeast and parity effects on milk yield (kg/ cow) during different period of lactation

	Control		Yeast	
	primiparous	**multiparous**	**primiparous**	**multiparous**
For 100 days	$2177.6^a \pm 60.0$	$2375.28^b \pm 79.2$	$2604.2^c \pm 90.4$	$2916.6^d \pm 92.1$

For 200 days	$4107.9^{a} \pm 130.3$	$4184.9^{a} \pm 189.1$	$4473.9^{b} \pm 126.4$	$4913.1^{b} \pm 144.2$
For 305 days	$5173.1^{a} \pm 183.3$	$5240.3^{a} \pm 262.5$	$5475.9^{b} \pm 228.8$	$6098.5^{b} \pm 206.4$

^{ab} means with different letters are significantly different ($P < 0.05$)

Table 4. Yeast and parity effects on milk composition in early lactation (100 days)

	Control		Yeast	
	primiparous	**multiparous**	**primiparous**	**multiparous**
Fat content, %	$3.84^{a} \pm 0.07$	$3.60^{a} \pm 0.07$	$3.40^{b} \pm 0.09$	$3.41^{b} \pm 0.06$
Protein content, %	$3.39^{a} \pm 0.03$	$3.40^{a} \pm 0.03$	$3.26^{b} \pm 0.04$	$3.22^{b} \pm 0.03$
Urea content, mg/dl	$31.73^{a} \pm 0.91$	$32.87^{a} \pm 0.94$	$39.37^{b} \pm 1.56$	$40.83^{b} \pm 1.64$
Fat quantity, g/d	$858.7^{a} \pm 26.4$	$840.8^{a} \pm 38.5$	$961.3^{b} \pm 47.4$	$970.3^{b} \pm 44.8$
Protein quantity, g/d	$775.3^{a} \pm 26.2$	$770.6^{a} \pm 34.4$	$915.6^{b} \pm 36.4$	$910.9^{b} \pm 35.3$

^{ab} means with different letters are significantly different ($P < 0.05$)

During early lactation, a significant interaction existed between yeast and calving period effects (Table 5).

Table 5. Probabilities of yeast, calving period and their interaction effects in dairy cows during early lactation

Factors	**Milk Yield, kg**	**Fat, %**	**Protein, %**	**Urea, mg/dl**
Yeast	0.0001	0.0002	0.03	<0.0001
Calving period	0.0001	0.09	0.87	0.24
yeast x Calving period	0.003	0.56	0.74	0.2

The milk yield improvement due to yeast feeding was higher for cows calving between July and October (3546.5 kg vs 2342.6 kg for control and yeast group, respectively). Between November and January, calving period effect was not significant, but yeast effect persisted (2533.1 vs 2202.2 kg, Figure 2a).

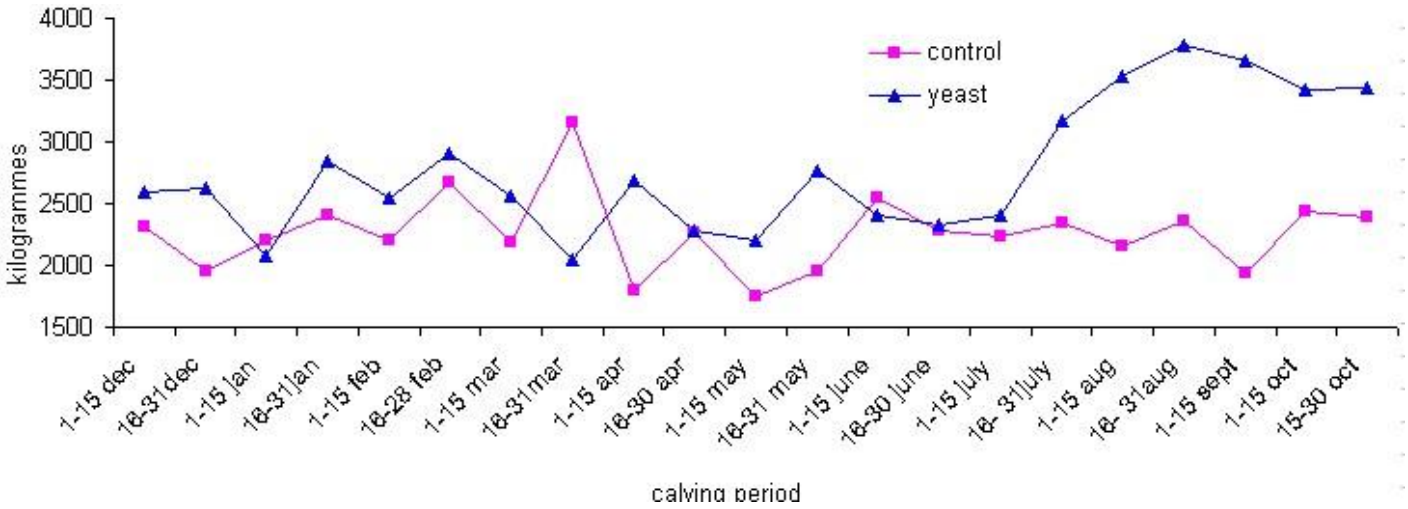

Figure 2a

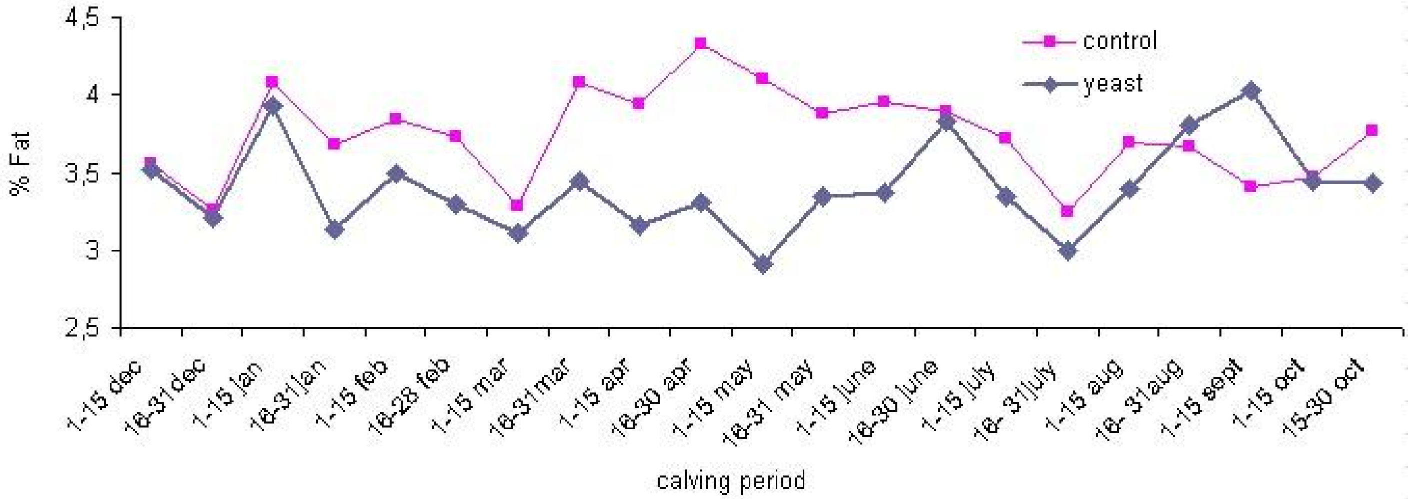

Figure 2b

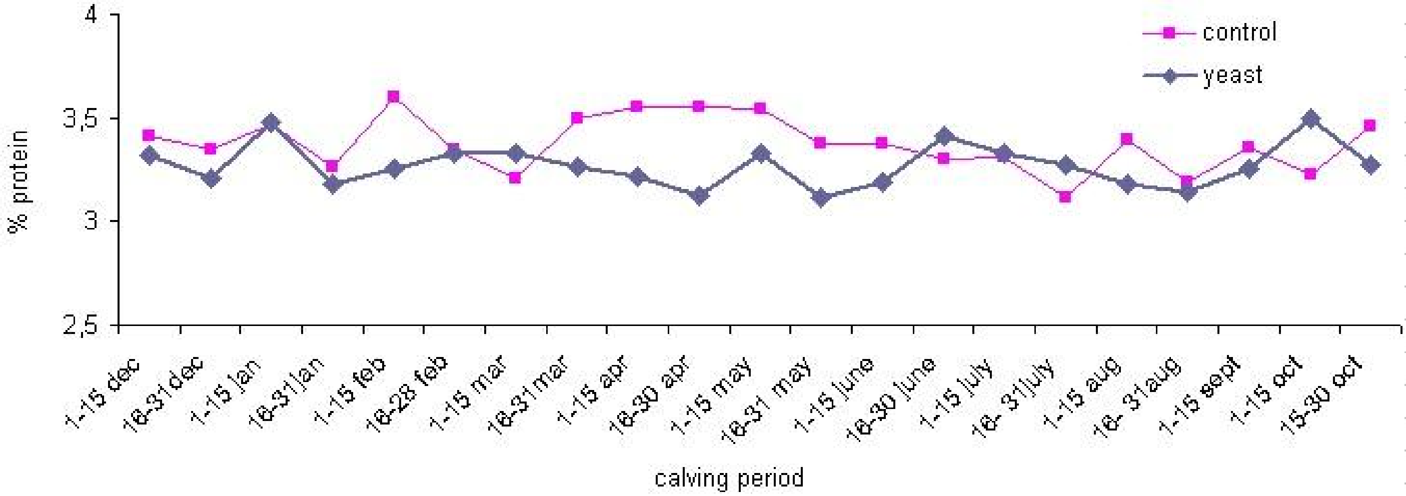

Figure 2c

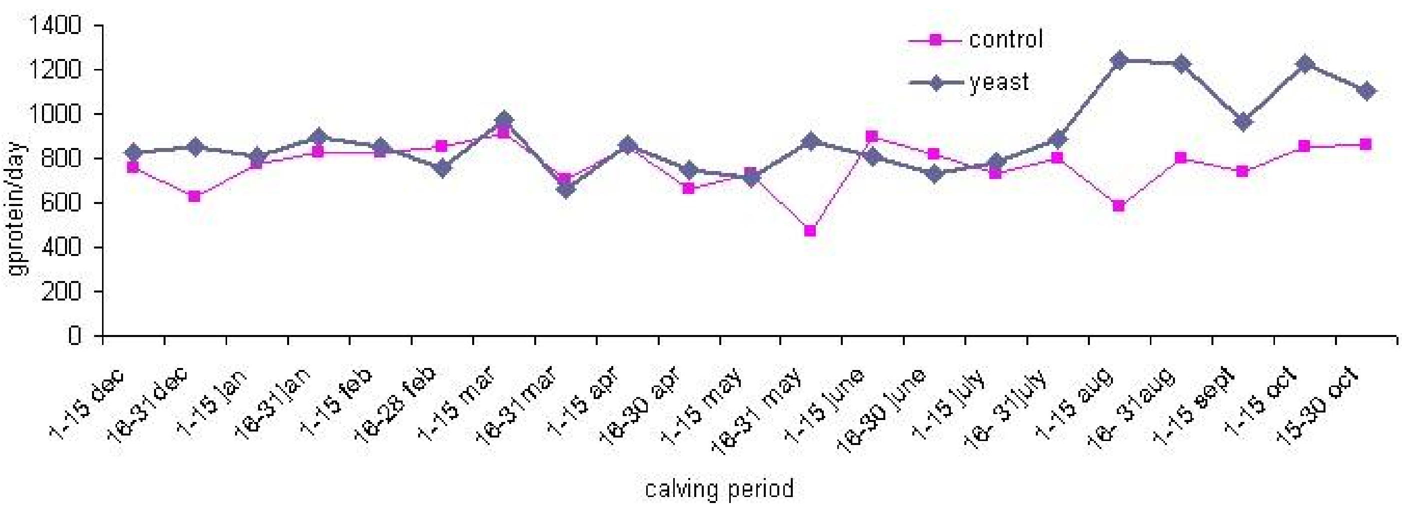

Figure 2d

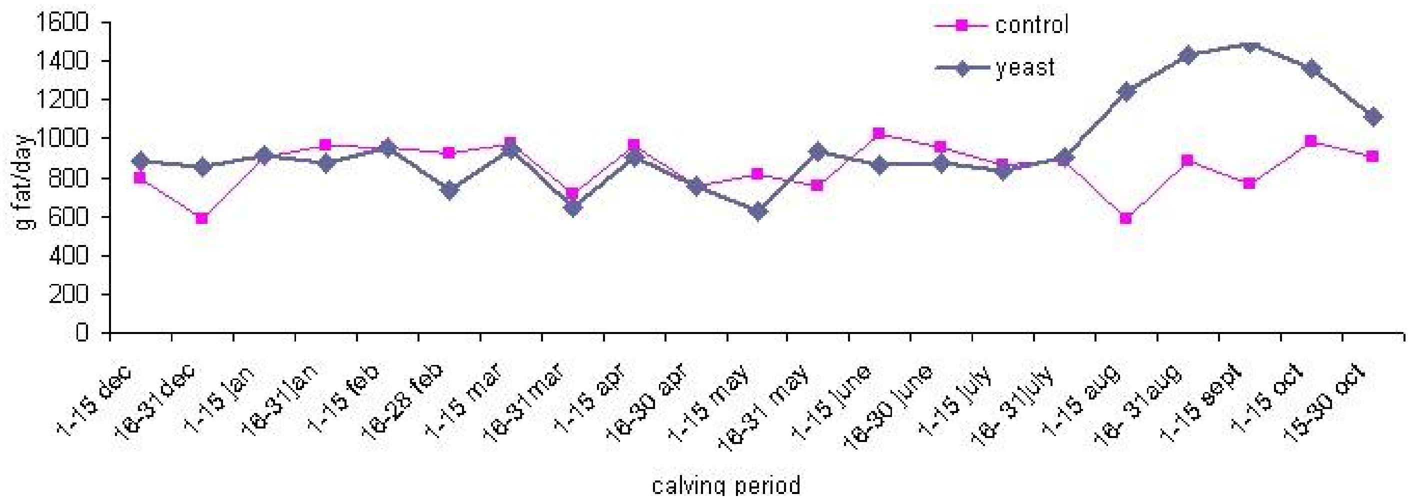

Figure 2e

Figure 2. Effect of calving period on milk yield and composition during early lactation

Fat and protein and urea contents were not significantly affected by calving period (Table 5, Figure 2b, 2c). Whereas, yeast effects on quantity of fat and protein exported daily was affected by calving period ($P < 0.002$, Table 5). It was higher between July and October (Figure 2d, 2e).

Discussion

Yeast addition in the diet of dairy cows increased milk yield by 5.1 kg/day for early lactation and by 2.5 kg/day for standard lactation. This increase was important compared to previous studies which showed an improvement between 1.4 to 3 kg/d for postpartum dairy cows fed with direct-fed microbes (Williams et al 1991; Erasmus et al 1992; Piva et al 1993; Adams et al 1995; Wohlt et al 1998; Nocek and Kautz 2006). Data collected from 122 in vivo experiments showed that yeast improved milk yield by 1.3 kg/day, when all stages of lactation were considered (Sauvant 2005). In other studies, no significant effect was reported (Arambel and Kent 1990, Higginbotham et al 1994; Dann et al 2000; Raeth-Knight et al 2007). In these previous studies, diets were distributed as a total mixed ration and cows had higher performance (more than 30 kg/d). The rumen conditions were probably satisfied and the DFM supplementation could not improve the milk yield enormously. In our study conditions, cow performances were lower (16.9 kg/d for control treatment) and the quantity of concentrate distributed per meal was high. The risk for rumen malfunction and subclinical acidosis were more probable, especially for postpartum cows. Yeast addition had been reported to stimulate development of cellulotic and lactate-utilizing bacteria in the rumen (Newbold et al 1996; Jouany and Morgavi 2007), which can improve rumen pH, fiber digestibility (Sauvant 2005; Jouany and Morgavi 2007) and voluntary forage intake (Wohlt et al 1998). Effects on by-products of ruminal fermentations were not significant (Sauvant 2005). In our study, it was difficult to control the voluntary intake with a large number of cows, in a commercial farm. However, in an essay, realized on bulls with the same additive, we observed an increase in the dry matter intake and in the feed efficiency (not published).

Improvement in milk yield was associated with an increase in fat and protein production, despite the decrease in milk fat and protein contents. Results were coherent and dilution can explain the lower milk contents of fat and protein (Adams et al 1995; Mc Gilliard and Stallings 1998; Nocek and Kautz 2006). Increase in fat and protein production had also been reported by Williams et al (1991) and Piva et al (1993).

In addition, yeast effects on milk yield and composition were higher in the hot season (July-October). The

environmental conditions were characterized by an average daily THI of 68 in spring and 78 in summer (Bouraoui et al 2002). Huber (1998) and Schingoethe et al (2004) suggested an increase in milk yield for dairy cows fed yeast during summer. Schingoethe et al (2004) reported an improve in feed efficiency when adding yeast, and which can be explained by an improvement in the appetite of heat stressed cows or in the diet digestibility (Huber 1998; Gomez-Alarcon et al 1990).

- In conclusion, in a commercial dairy farm, yeast has been shown to improve milk yield and composition, especially for cows in early lactation and during hot season. These effects were spectacular and confirmed the fact that additives are more effective when animals are stressed. These effects must be explained in an experimental essay, realized with a lower number of cows, in which it is possible to evaluate feed intake, body weight and temperature.

Acknowledgments

The authors thank Lesaffre Society in France, the Office des Terres Domaniales and the Office d'Elevage et de Pâturage in Tunisia for Financial and technical support.

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Received 8 October 2008; Accepted 4 February 2009; Published 1 May 2009

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