

Effects of yeast (*Saccharomyces cerevisiae*) feed concentrate supplement on growth performances and microbial activity in the rumen of “Queue Fine de l’Ouest” lambs



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Abstract - The objective of this study was to investigate the effects of yeast *Saccharomyces cerevisiae* feed supplement on lambs growth and their feed intake. For this trial, 14 lambs aged of 148 days were used during 9 weeks and allocated to 2 groups according to body weight and age. Lambs received a basal diet of oat hay ad libitum supplemented with whole grain barley (400g) and concentrate (400g). The control group (C) received oat hay ad libitum, whole grain barley (400g) and concentrate (400g). The second group (Y) received the same feeds as the C group in addition to 1,5g/lamb/day of yeast *Actisaf*® Sc 47. The ration was distributed twice a day at fixed times. Animals had free access to water. Results indicated that the average amount of oat hay voluntarily ingested was 147,1 and 148,7 g DM/lamb/day, for C and Y groups, respectively in the first week of control. Feed intake increased slightly until the 5th week and reached a maximum around the 9th week of trial (374,6 vs. 439,9 g DM/lamb/day for C and Y groups, respectively). Weight of lambs evolved during the trial period, it increased from 22,5 kg to 30,5 kg for C group and 22,3 kg to 34,5 kg for Y group with a notable superiority for Y lambs compared to C animals. For the daily gain, the respective averages are 145 g/day and 223 g/day for lambs of C group and Y one. There significant differences for daily gain (g/day) within 5th, 6th, 8th weeks and throughout the whole growth trial (1th; 8th week). Feed conversion decreased notably for lambs of Y group

For Facies fermentation parameters (digestibility organic matter (OMD), metabolisable energy (ME), volatils fatty acids (VFA) and nitrogen ammonia (NH₃-N)) did not reveal significant differences from yeast addition (P> 0.05).

Keywords: lambs/ concentrate/ *Saccharomyces cerevisiae*/ growth/ rumen/ gas production.

1. Introduction

Sheep farming is traditionally one of the most important activities by Tunisian farmers. It has important social and economic roles, particularly in the context of food security and incomes of small farmers (Brahmi et al. 2010). Indeed, due to population growth, the state is still investing to improve sheep breeding sector to cover the ongoing needs for red meat. This increase in the number of sheep was at the expense of food available. In fact, food intake is limited and do not cover up ruminants needs. Meanwhile, the settlement of nomadic society and the depletion of natural resources and technology have led to a range of driving mode which vary from extensive to intensive, whose degrees of intensification of conduct depends on natural resources and constraints of each herd (Najari 2005). This intensification of livestock has led to the use of excessive use of concentrate and cereals in lambs feed.

Ruminant depend on microbial fermentation within the rumen to acquire energy from plant material. To improve animal productivity, rumen function has been strongly manipulated by supplementing the forage diets with readily fermentable carbohydrates and additives. However, this type of feeding sometimes induces rumen dysfunction because of an imbalance in the microbial populations. To



prevent this risk, several studies have shown that the use of food additives also appears to be an effective solution to reduce latent acidosis in ruminants.

Including yeast *Saccharomyces cerevisiae* have been extensively studied (Chaucheyras-Durand et al. 2008; Desnoyers et al. 2009; Chaucheyras-Durand and Durand 2010). They help maintain a healthy digestive comfort and improve their growth performance. Moreover, the impact of a microbial feed additive (*Saccharomyces cerevisiae*) was also evaluated. Indeed, direct-fed microbial products containing live cells of *Saccharomyces cerevisiae* have been shown to improve rumen colonization by cellulolytic bacteria and fibrolytic activities in young lambs fed with forage-based diets, and also to stimulate the growth of some cellulolytic bacterial species *in vitro*. In addition, they have a beneficial effect on rumen fermentation, in particular, by stabilizing and increasing rumen pH when animals are fed with high-concentrate diets and could, as a result, positively influence cellulolytic bacterial populations and/or activities in such diet conditions.

The present study reports the effects of yeast (*Saccharomyces cerevisiae*) feed supplement on growth performances in lambs and its microbial rumen activity.

2. Materials and Methods

2.1. Experimental design

The experiment was carried out at the Regional Center of Agricultural Research Sidi Bouzid (CRRRA), Tunisia. The experiment started in April with a total of 14 “Queue Fine de l’Ouest” male lambs. They were 148 days old and had an average body weight (BW) of $22,5 \pm 3,9$ kg and $22,3 \pm 2,6$ kg for C and Y groups, respectively. They were divided into two equal groups according to live weight and age. Animals were subjected to the same conditions of temperature and density (lamb/2 m²). Lambs received a basal diet of oat hay ad libitum supplemented with whole grain barley (400g) and concentrate (400g). The control group C received oat hay ad libitum, whole grain barley (400g) and concentrate (400g). The second group Y received the same feeds as the C group in addition to 1,5g/lamb/day of yeast *Actisaf*® Sc 47. The ration was distributed twice a day at fixed times. Animals of the two groups had free access to water. Concentrate was based on barley (30%), maize (24%), wheat bran (25%), soya bean (17%) and mineral-vitamin supplement (4%). Lambs were weighed weekly just prior to feed distribution. Quantities of feeds offered and refused were recorded daily.

2.2. Laboratory analysis

The chemical composition of oat hay, concentrate and whole grain barley was determined. Samples of these components were dried in a forced-air oven at 105 °C for 24 h to determine DM. Dried samples were then ground through a 1-mm screen. Ground samples were used to determine ash content (450 °C for 8 h), crude fiber by the method of Weende (AOAC, 1984). Crude protein was determined by Kjeldahl method (AOAC, 1984).

Determination of the total gas was performed on the contents of the rumen filtered, collected before the distribution of the morning meal. In syringes, were put 0.3 g of substrate (concentrate ground to 1 mm), 10 ml of rumen juice and 20 ml of artificial saliva.

The syringes are then placed vertically in a water bath at 39 °C; the reading is done each 2 hours after mixing syringes until a bearing (Orskov and Mc. Donald., 1979).

2.3. Statistical analysis

Data of feed intake, initial body weight, final body weight, daily gain and feed conversion were analyzed using the General Linear Model of SAS (2000) using a one way anova. Means of dietary treatments were compared by a t-test p-diff procedure of SAS.

The model equation was: $Y_{ij} = \mu + R_i + ij$

Where Y_{ij} : is the measured paramete.

μ : is an overall average.

R : is the effect of the i^{th} diet (1, 2).

E_{ij} : is a residual error with a mean 0 and a constant variance.

The kinetics of gas production was analyzed using a non-linear regression model by Orskov and MacDonald (1979): $\text{Gas} = a + b(1 - e^{-ct})$.

3. Results and discussion

3.1. Feed composition

The ration was rich in starch and carbohydrate; it has about 40% of concentrate and 40% of whole grain barley. According to table 1, the proportions of CP were respectively 19,7% for concentrate, 9,2% for barley grain and 4,2% for oat hay. This ration can probably induce a ruminal acidosis for lambs used for fattening and receive large amounts of concentrate and barley grains in order to have a weight for finishing. According to Sauvants and Peyraud (2010), a ration which it has a concentrate more than 40% induce acidogenic potential risk. Desnoyers (2008) indicated that feeding a high concentrate diet led to acidosis which could influence performances for ruminants.

Table 1. Chemical composition of concentrate, barley grain and oat hay

	Concentrate	Barley grain	Oat hay
Dry matter (DM) (%)	95.6	92.08	89.68
Crude protein (% DM)	19.7	9.2	4.2
Crude fiber (% DM)	2.4	4.0	34.5
Ash (% DM)	6.0	2.4	8.9
Organic matter (% DM)	94.0	97.6	91.1
Fat matter (%DM)	3.0	2.6	2.4
dDM (%)	90.2	77.5	50.3
UF / Kg DM	1.12	1.09	0.59

DM : dry matter ; OM : organic matter ; CP : crude protein ; FM : fat matter ; CF : crude fiber ; dMD : dry matter digestibility ; UF: fodder unit.

3.2. Feed Intake

Oat hay intake was 147,1 and 148,7 g DM/lamb/day, for C and Y groups, one respectively, in the first week of trial. Feed intake increase progressively until the 5th week and reached a maximum around the 9th week of trial (374,6 vs. 439,9 g DM/lamb/day for C group and Y respectively). The respective intake values remained within the standards of the intake capacity which closely depends upon the weight of the animal (2 to 2,5 kg DM/100kg BW) (Jarrige et al. 1995). Statistical analysis revealed that there is no significant difference between groups. Indeed, total dry matter intake in the whole period was 56,1 against 58,9 kg DM/lamb for the C and Y groups, respectively (Table 2). The amount of total dry matter intake per day was 1,02 against 1,07 kg DM/lamb/day for C group and Y one respectively as shown in table 2. Our results are consistent with those of Desnoyers et al. (2006), who found that feed intake didn't differ with yeast supply. A work on beef cattle, led by Moncoulon and Auclair (2001) found a significant decrease in the amount of 2,6% of dry matter intake. By cons, Mutsvangwa et al. (1992) reported that the addition of yeast to a diet acidogenic nature contributes to increasing amounts of dry matter intake in beef cattle. This trend can be explained by the fact that the effect of yeast on intake is negligible with a diet rich in concentrate (high energy intake) due to metabolic satiety already established following the major VFA production from carbohydrates quickly fermentable. Thus, feed intake may likely to increase in the case of a diet rich in fiber due to the direct action of yeast on communities that degrade fiber in the rumen through its action at the level of oxygen consumption (Marden et al., 2008) and promote the fibrolytic activity accelerated intestinal transit and subsequently increase the amount of dry matter intake (Chaucheyras-Durand and Durand, 2010).

Table 2. Effect of yeast supply on total and daily dry matter intake (DMI)

Group	Control (C)	Yeast (Y)	m.s.e	Pr < F
Total DMI (kg)	56.1 ± 8.4	58.9 ± 5.1	4.8	0.4
DMI/day (kg)	1.02 ± 0.15	1.07 ± 0.09	0.16	0.4

^{a, b} Mean values with different letters in the same row are significantly different.
 m.s.e: mean standard error.
 (±): standard error.

3.3. Lamb Growth and Ratio of feed to live weight gain

Body weight of lambs increased from 22,5 to 30,5 kg for the C group and from 22,3 kg to 34,5 kg for Y group with notable superiority for the lambs that received yeast supply. From table 3, it appears that lambs receiving *Saccharomyces cerevisiae* yeast feed supplement had greater cumulate body weight gain than those of C group ($12,3 \pm 2,6$ kg vs. $8 \pm 2,4$ kg for Y group and C one respectively). Statistical analysis revealed that cumulative weight gain was significantly higher ($P < 0,01$) with 34,9% for the (Y) group in comparison with C group.

For the daily weight gain (g/day), the respective averages were $145 \pm 44,5$ g/day and $223 \pm 47,1$ g/day for lambs of C group and Y one (Table 3). A significant difference ($P < 0,01$) of daily gain throughout growth trial (1th, 8th week) was found (table 3). Feed conversion decreased notably ($P < 0,05$) for lambs of Y in comparison with those of the C group. Results are entirely consistent with those of El Hassan et al. (1993) and Hancock et al. (1994) who mentioned a significant increase in body daily gain when animals are fed a acidogenic diet and received yeast supply. This could be caused by of yeast effect that probably limits the disruption fermentation in the rumen generally caused by diets rich in concentrate (Desnoyers, 2008). Indeed, Beauchemin et al. (2003) denoted that the addition of the yeast *Saccharomyces cerevisiae* allows the user flora lactate to be effective and thus prevent the accumulation of lactic acid in nutritional situations leading to the onset of acidosis. Fermentation of starch (carbohydrate of concentrate and barley grain) is much faster and gives rise to a greater amount of VFA and the intermediate production of lactic acid is less rapidly metabolized. Therefore, supplementation with yeast can stimulate lactic acid bacteria in rumen digestion and improving the flow of microbial protein in the rumen, resulting in increased weight gain.

For efficiency of feed in a production by weight (Jarrige et al., 1995). It is of the order of $7,6 \pm 2,5$ and $4,9 \pm 0,9$ kg DMI/kg weight gain, respectively, for C group and Y one respectively.

Although feed intake did not significantly differ between the two groups of lambs throughout the trial, statistical analysis showed a significant difference ($P < 0,05$) of food conversion rate between the two groups. Indeed, the food conversion factor for (Y) group was significantly lower than that of the control group. This result confirms that of Bocard (1963) who showed that a low growth rates lead to a high ratio of feed to live weight gain. Similarly, for cattle, these results are entirely consistent with those of Moncoulon and Auclair (2001) who suggested a significant decrease in food conversion factor of veal calf received yeast and fed with rations rich in rapidly fermentable carbohydrates.

Table 3. Effect of yeast supply on cumulative (kg), daily weight gain (g/day) and on food conversion factor

Group	Control (C)	Yeast (Y)	m.s.e	Pr < F
Weight gain (kg)	$8^b \pm 2.4$	$12.3^a \pm 2.6$	6.35	0.007
Daily weight gain (1w-8w)	$145^b \pm 44.5$	$223^a \pm 47.1$	21	0.008
FCF	$7.6^a \pm 2.5$	$4.9^b \pm 0.9$	3.3	0.02

^{a, b} Mean values with different letters in the same row are significantly different.

m.s.e: mean standard error.

(\pm): standard error.

3.4. Rumen microbial activity

The parameters studied were facies fermentation digestibility of the organic matter (OMD), metabolizable energy (ME), volatils fatty acids (VFA) and ammonia nitrogen (NH₃-N). These were determined after the prediction method of *in vitro* gas production (Menke and Steingass, 1988).

From Figure 1, it was found that the production of gas evolving in syringes fast after incubation without latency since micro-organisms are already suitable substrates. The total volume of gas after 48 hours of incubation was not statistically different ($P > 0.05$) between the two tested diets. The predicted values of respective parameters are shown in Table 4.

For digestibility of organic matter, the addition of yeast to the concentrate Y had no significant effect on this parameter. Indeed, the digestibility of organic matter of concentrate C was only 73.6 % and for concentrate with yeast supply Y was 76%. The same applies to metabolisable energy where the addition of yeast to the food concentrate Y did not affect this parameter. The metabolisable energy was

11 against 11.4 MJ / kg DM for the substrate concentrate feed C against substrate concentrate + yeast food Y.

As for total VFA, values were 1.27 (mmol / syringe) for concentrate feed C and 1.33 (mmol / syringe) to concentrated+ yeast food Y, respectively without having a significant difference.

For concentrations of ammonia nitrogen (NH₃ - N), the addition of yeast to the food concentrate Y also had no significant effect. The levels were 0.16 (mg / ml) for the concentrate C and 0.2 (mg / ml) to the food concentrate + yeast Y.

Our results are in agreement with those of Rey- mickael (2012) who found that parameters already described were not affected by supplementation of ration rich in rapidly fermentable carbohydrates with yeast. In the same context, Desnoyers (2008) did not find any influence of yeast supplementation on the digestibility of organic matter. Similarly, several other studies showed that there was no effect of yeast on these parameters in ruminants fed with higher levels of concentrates 50% (Edwards et al, 1990; Beauchemin et al, 2003). Indeed, the differences in the effects of yeast are probably due to differences in power between the studies with more or less fiber and / or concentrates but also the dose and the type of yeast used. The effect observed in the incorporation of the yeast could variability ration be explained by the physiological state of animals (Williams and Newbold, 1990) and the nature of the ration (Dawson, 1989).

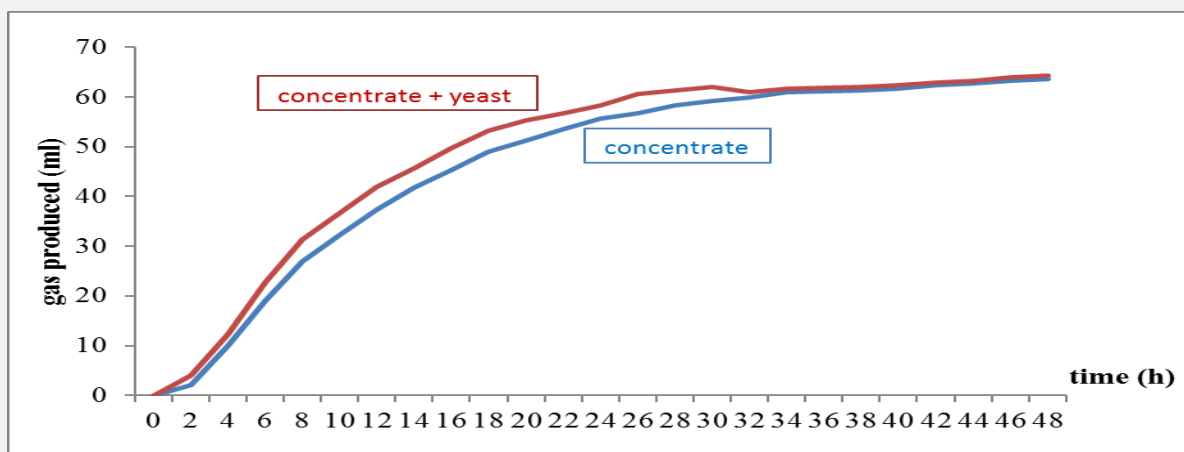


Figure 1: Gas production kinetics of concentrate (C) and concentrate +yeast (Y)

Table 4. The a, b, c and a + b parameters of non-linear model of gas production and the parameters estimated from the gas produced in 24 hours: comparison of the two diets.

Group	Control (C)	Yeast (Y)	m.s.e	Pr < F
a (ml)	-4.7 ^b (0.002)	-4.6 ^a (0.001)	0.4.10 ⁻⁴	<0.0001
b (ml)	71.91 ^a (0.001)	71.52 ^b (0.0001)	0.36.10 ⁻⁵	<0.0001
c (h ⁻¹)	0.07 ^b (0)	0.09 ^a (0)	0	<0.0001
a + b (ml)	67.2 ^a (0.003)	66.9 ^b (0.001)	0.4.10 ⁻⁴	<0.0001
Prod gas 24 h (ml)	55.7 (3.2)	58.3 (1.5)	6.3	0.26
Total gas (ml)	63.7 (2.5)	64.3 (0.6)	2.9	0.5
OM digestibility (%)	73.6 (2.8)	76 (1.4)	4.9	0.26
ME (MJ/kg DM)	11 (0.5)	11.4 (0.2)	0.15	0.27
VFA (mmol/syringue)	1.27 (0.07)	1.33 (0.04)	0.004	0.26
N-NH ₃ (mg/ml)	0.16 (0.04)	0.20 (0.02)	0.0009	0.15

^{a, b} Mean values with different letters in the same row are significantly different.

m.s.e: mean standard error. (): standard error.

With G24: Gas 24 hours of incubation.

a: amount of produced gas (ml) from the immediately soluble substrate.

b: potential production of gas.

c: gas production rate.

Control (C): concentrated feed without yeast; Yeast (Y): yeast concentrate feed with a dose of the order of 0.006 g.

4. Conclusion

This trial allowed us to clarify the interest of yeast as food additive to modulate microbial fermentations rumen and improve performance production. The results show that supplementation of rations with yeasts, can improve moderately animal performances.

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