The effect of live yeast *Saccharomyces cerevisiae* as probiotic supply on growth performance, feed intake, ruminal pH and fermentation in fattening calves

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**Abstract**

**Background:** Live yeast *Saccharomyces cerevisiae* has been used for a long time in ruminant feed as a probiotic supply on the intensifying system to avoid acidosis.

**Objectives:** This study investigated the effects of addition of live yeast *S. cerevisiae* in calf feed on growth, rumen pH and in vitro digestibility.

**Methods:** Sixteen Holstein calves were divided into two homogeneous groups corresponding to body weight. The ration comprises wheat straw 5 kg dry matter (DM)/calf/day and 8 kg DM/calf/day concentrate for the control group C and for the group LY. Each calf of the live yeast group LY gets more than C group, 28 g/calf/day of live yeast *S. cerevisiae* powder on the concentrate.

**Results:** This supplementation improves significantly (*p* < 0.003) the mean daily gain during the trial (ADG) with 400 g/calf. A notable increase (*p* < 0.004) was seen in final body weight gain (FWG) with 39.1 kg/calf. The live yeast supplementation decreases the feed intake and significantly (*p* < 0.05) the feed conversion rate (FCR) average. The live yeast *S. cerevisiae* as probiotic supply in ruminant feed improves the growth performance and feed efficiency in fattening calves.

**Conclusions:** In conclusion, we mentioned that live yeast supply induces a considerable advance in growth performance for calves.

**KEYWORDS**
calves, growth, live yeast *Saccharomyces cerevisiae*, probiotic

**1 | INTRODUCTION**

The cattle breeding is a strategic component of agricultural production in many countries. Because of public growth, the states become ever invested in developing the meat sector to satisfy the current demand for red meat. This production improvement has contributed to the enormous expenditure of concentrate feed and cereals in animal feed, especially in fattening calves. Farming conditions over the decades have continued to evolve to adapt to the expectations and requirements of society and in particular to growing demand for animal products. To improve their profits and increase their revenues, these producers enlarge the shares of concentrate in animal feed without taking into account the compromises of metabolic illnesses such as acidosis led by this harm, contributing to reducing production. To avoid this risk, several studies have shown that these feed additives can resolve the risk of latent acidosis in ruminants. To boost their profits and extend...
their returns, producers grow the percentages of concentrate in animal feed without taking into account the concessions of metabolic disorders (Bramley et al., 2008). This acidosis leads to decreased production. To avert this compromise, several studies have shown that the value of feed additives seems to solve the compromise of latent acidosis in ruminants. They study live yeast *Saccharomyces cerevisiae* (Chaucheyras-Durand & Durand, 2010; Chaucheyras-Durand et al., 2008; Desnoyers et al., 2006). *Saccharomyces cerevisiae* have been used as preventer supplement against diarrhoea and other digestive system problems in livestock (Chaucheyras-Durand et al., 2008). They also give production benefits, reduced digestive problems and better health of animals in cost-effective manners (Huber, 1997). They make it potential to keep animals healthy following digestive comfort and then enhance their production. This research tests the effect of the supplement of *S. cerevisiae* live yeast in the feed of cattle on in vitro digestibility, ruminal fluid pH and production in an intensifying system. Our study can be considered an indirect manipulation of the rumen microbiota with yeast supplementation.

2 | MATERIALS AND METHODS

The experimental procedures were approved by the Committee of Animal Experiments (CEEA).

2.1 | Animals and management

The study was conducted for 147 days on a fattening farm. We divided 16 Holstein Friesian calves into two homogeneous groups of eight calves per group (*n* = 8) corresponding to the body weight. The average body weight at the beginning of the trial was in order of 444 ± 29 kg and 459 ± 17 kg for C and live yeast LY groups, respectively (*p* > 0.7). These calves were given the ration made up of wheat straw and concentrate feed. The ration comprises wheat straw 5 kg dry matter (DM)/calf/day and 8 kg DM/calf/day concentrate feeds for the control group C and for the group LY, respectively. Each calf from LY group receives in addition to the calves from C group, 28 g/calf/day of live yeast *S. cerevisiae* ActisafSc47 in the feed. ActisafSc47 is a concentrate of live yeast *S. cerevisiae* (strain NCYC Sc 47). It is intended exclusively for animal feed. It is sold in the form of spherules characterised by a very low porosity, which preserves it from humidity and also rapid reactivation of cells. This low porosity also confers remarkable resistance to granulation. Therefore, ActisafSc47 can be incorporated into granulated food. It is a zootechnical additive, stabiliser of the intestinal flora and digestibility enhancer in the form of a concentration of live yeast *S. cerevisiae* (strain Sc 47). We measured the weight every 2 weeks with a cattle scale. We also calculated the average daily gain (ADG), the final weight gain (FWG), and feed conversion rate (FCR). The quantity refused of wheat straw is also weighed on each control dates the day after the food distribution using a balance. We should note the full amount of concentrate feed eaten.

2.2 | Chemical analysis

The chemical composition is presented as % of DM. DM was determined after oven drying at 65°C for 24 h and milling through a 1 mm screen that follows method ID 934.01 (AOAC, 2005). Ash content was measured by combustion at 550°C for 16 h according to method ID 942.05 (AOAC, 2005). Organic matter (OM) was calculated by method ID 967.05 (AOAC, 2005). Crude protein (CP) was determined by the Kjeldahl method ID 988.05 (AOAC, 2005). We performed the calculations of energy values using the approach and equations proposed by INRA (INRA, 1978, 1988). We express the nutritional values for nitrogen as digestible protein in the intestine (PDI) (g/kg DM). The PDI values are indicated as follows (INRA, 1978, 1988): PDIE, when energy is the limiting factor for rumen microbial activity; PDIN, when nitrogen is the limiting factor for rumen microbial activity.

2.3 | In vitro fermentation parameters

We performed a determination of the total gas on the contents of the rumen filtered from the calf. In syringes, we set 0.3 g of a substrate (concentrate ground to 1 mm), 10 ml of rumen juice filtered ruminal fluid and 20 ml of artificial saliva. Then, we put the syringes vertically in a water bath at 39°C; we checked reading every 2 h after mixing syringes until a bearing (Orskov & Mc Donald, 1979).

2.4 | Collection and measurements of ruminal fluid pH samples

This action was performed every 2 weeks, the day after the calf weight was measured. Rumen fluid samples were taken from each animal 5–6 h after the distribution of concentrate in the morning using a stomach tube (Sauvant et al., 1999). The pH of ruminal fluid samples was measured immediately using a portable pH meter (PH850 Portable pH Meter Kit; Apera Instruments, China).

2.5 | Statistical analysis

Data of body weight, ADG, feed intake, FCR and ruminal fluid pH twice a month for 147 days were analysed as repeated measures using the mixed procedure of SAS (2000). The statistical model included the experimental diet.

The data recorded during the pre-experimental period were used as covariates and included in the model. Significance was declared at *p* < 0.05 unless otherwise declared.

3 | RESULTS

3.1 | Chemical composition of feeds

The chemical composition of feeds is presented in Table 1. For wheat straw, it allows a low CP content 4% of DM, a high fibre content (CF)
with 29% of DM and metabolised energy (ME) of 3.1 MJ/kg DM. For feed concentrate, the CP content is 16% of DM and the ME 8.2 MJ/kg DM. We could consider the CP content of feed concentrate is not as per the required standard (Norton, 1994).

3.2 Body weight and average daily gain

The results showed that supplementation of 28 g/calf/day of \textit{S. cerevisiae} live yeast in the feed did not result in a significant difference in calf body weight (BW) between the two groups. In fact, body weight begins in the order of 444 ± 29 kg and 459 ± 17 kg for C and live yeast LY groups, respectively. Body weight measured every 2 weeks continued without significant variation between the two groups until reaching a final body weight (FBW) of the order of 603 ± 34 kg and 658 ± 18 kg for C and LY groups, respectively, but without reporting a significant difference. The interaction between the diet effect and the time does not show a significant difference throughout the trial ($p > 0.367$).

In contrast, we declare that the final body weight gain (FBWG) was 159.4 ± 8.6 kg for group C against 198.5 ± 7.5 kg for group LY with a considerable difference ($p < 0.004$). Regarding the ADG, we declare that the ADG of the fourth control increased by +0.6 kg ($p < 0.05$). Furthermore, the mean ADG increased from 1.5 ± 0.08 kg to 1.9 ± 0.08 kg for the groups C and LY, respectively ($p < 0.003$) (Table 2).

3.3 Total dry matter feed intake, feed conversion rate and ruminal fluid pH

The quantity of total DM feed intake (TDMI) remains proportionate to the two groups during the trial with the modest inferiority in the LY group but without significant variation. This parameter remains around

### TABLE 1

| Items                | Concentrate | Wheat straw |
|----------------------|-------------|-------------|
| DM (%)               | 89.6        | 89.5        |
| Crude protein (%)    | 16          | 4           |
| Crude fibre (%)      | 6.3         | 29          |
| Ash (%)              | 9           | 7           |
| Organic matter (%)   | 91          | 93          |
| Fat (%)              | 4.3         | nd          |
| PDIE (g/kg DM)       | 96          | 48          |
| PDIN (g/kg DM)       | 80          | 22          |
| ME (MJ/kg DM)        | 8.2         | 3.1         |

**Note**: The nutritional values for nitrogen are expressed as digestible protein in the intestine or PDI (g/kg DM).

**Abbreviations**: DM, dry matter; ME, metabolised energy (MJ/kg DM); nd, not determinated; PDIE, when energy is the limiting factor for rumen microbial activity; PDIN, when nitrogen is the limiting factor for rumen microbial activity.

### FIGURE 1

Evolution of the corresponding curves of body weight for each group as a function of diet, of time, and their interaction; ns, not significant at ($p > 0.05$); diet*week: interaction effect between diet and time; C: control group; LY: group with live yeast supply

### TABLE 2

| k   | Control week | Group | SEM  | p-Value |
|-----|--------------|-------|------|---------|
|     |              | C     | LY   |         |
| BW (kg) |          |       |      |         |
| 2nd  | 444 ± 29     | 459 ± 17 | 68.47 | 0.7     |
| 4th  | 470.5 ± 32   | 492 ± 17 | 73.4  | 0.56    |
| 6th  | 486.5 ± 31   | 519 ± 20.9 | 77.4  | 0.41    |
| 8th  | 498 ± 31.5   | 535 ± 23 | 77.99 | 0.36    |
| 10th | 513 ± 32.9   | 558 ± 22.7 | 79.98 | 0.27    |
| 12th | 536 ± 35     | 595 ± 20 | 81.11 | 0.17    |
| 14th | 557 ± 36     | 615 ± 21 | 83.91 | 0.18    |
| 16th | 578 ± 36     | 634 ± 20 | 82.19 | 0.19    |
| 18th | 603 ± 34     | 658 ± 18 | 78.96 | 0.19    |
| ADG (kg/c/d) |          |       |      |         |
| 2nd  | 1.98 ± 0.301 | 2.5 ± 0.32 | 0.98  | 0.27    |
| 4th  | 1.25 ± 0.270 | 2 ± 0.39  | 0.95  | 0.1     |
| 6th  | 0.930 ± 0.19 | 1.25 ± 0.30 | 0.71  | 0.39    |
| 8th  | 1.11 ± 0.160 | 1.7 ± 0.33 | 0.75  | 0.05    |
| 10th | 1.8 ± 0.410  | 2.8 ± 0.41 | 1.16  | 0.1     |
| 12th | 1.6 ± 0.210  | 1.6 ± 0.26 | 0.68  | 0.85    |
| 14th | 1.5 ± 0.200  | 1.4 ± 0.14 | 0.49  | 0.58    |
| 16th | 1.9 ± 0.290  | 1.8 ± 0.25 | 0.77  | 0.65    |
| Mean ADG (kg/calf/d) | 1.50 ± 0.08 | 1.90 ± 0.08 | 0.21  | 0.003   |
| Final weight body gain (kg) | 159.4 ± 8.6 | 198.5 ± 7.5 | 22.9  | 0.004   |

**Note**: Mean values with different letters in the same row are significantly different at $p < 0.05$.

**Abbreviations**: ADG, average daily gain; BW, body weight; c, calf; d, day; SEM, standard error mean.
TABLE 3  Effect of *Saccharomyces cerevisiae* on feed intake, feed conversion rate (FCR) and ruminal pH

| Items                        | Group   | SEM | p-Value |
|------------------------------|---------|-----|---------|
| Average intake (kg/c)        | C 9.6±0.1 | 0.27 | 0.3     |
| Total intake (kg/c)          | LY 9.4±0.06 | 0.27 | 0.3     |
| Average FCR                  | C 9.9±0.8  | 2.5  | 0.3     |
| Average ruminal pH           | LY 7.4±0.4  | 1.8  | 0.05    |

Note: Mean values with different letters in the same row are significantly different at *p* < 0.05. Abbreviations: c, calf; d, day; SEM, standard error mean.

The respective ruminal fluid pH values for the two groups are around an average value of 5.94. The respective pH values are 5.93±0.01 and 5.97±0.007 for the C and LY groups, respectively (*p* > 0.4) (Table 3). However, as shown in Figure 2, we can note a minor step up in ruminal fluid pH for the group LY compared to the group C due to live yeast.

3.4 Limits and rumen fermentation facies

The supplementation with live yeast *S. cerevisiae* did not alter the facies’ limit fermentation as organic matter digestibility (OMD), volatile fatty acid concentration (VFA), and ME, as well as the ammonia nitrogen (*p* > 0.1).

After incubation, the gas produced in the 100 ml glass syringe developed rapidly. After 24 h of incubation, the C diet recorded the maximum amount of gas 62.5 ml/0.3 g DM. The diet containing live yeast *S. cerevisiae* is <55.5 ml/0.3 g DM. After incubation of experimental diets in the 100 ml glass syringe, the diet supplemented with live yeast registered the largest volume of gas 56±10.8 ml/0.3 g DM for cons, the control diet, which gave a small volume, produced 42.7±8.8 ml/0.3 g DM. We show the kinetic limits of in vitro fermentation of the different substrates deduced from the exponential model of Orskov and McDonald (1979) in Table 4. They showed that they recorded the highest value of the volume of gas; the LY group diet 64.3±0.3 g DM against the C group diet displays a lower value of 63.7±0.3 g DM. The mixture (concentrate feed + live yeast) is the most fermented by the ruminal microbiota 0.03/h followed by the concentrate feed with 0.02/h. In vitro fermentation of two substrates depends on a lag phase, shown by the negative value of the soluble fraction (α) −3.1 ml/0.3 g DM and −2.7 ml/0.3 g DM for C and LY feed. This explains its low degradation. This lag phase looks because of the time required for microorganisms to accede to and colonise dietary fibre. As for the other limits, the predicted value points out that the OMD of the concentrate feed alone is 73.6% and 76% of the mixture, which explains why the supplement of live yeast shows no significant effect on this parameter (*p* > 0.26). It is common to ME issued by the various substrates (*p* > 0.4). Furthermore, although the total volatile fatty acids recorded; various values were 1.27 mmol/syringe in the concentrate feed only and 1.33 mmol/syringe for the concentrate feed + live yeast. The statistical analysis shows no significant variation (*p* > 0.26). The addition of live yeast produced more ammonia nitrogen N-NH3. We register for the LY diet 0.20±0.02 mg/ml compared with C diet 0.16±0.04 mg/ml but without reporting a considerable difference (Table 4).

4 DISCUSSION

Throughout the experimental period, the assigned ration is energetic, so it can fill the corresponding requirements. It has a significant percentage of acidogenic feed (61.5% of concentrate). Contents in CP were 16% in the concentrate feed and 4% for straw. This ration can lead to a state of ruminal acidosis (affirming to the feeder, it marks’ instances of acidosis marked by diarrhoea and lameness). According to Sauvant and Giger-Reverdin (2015), we establish this pathology in intensive rearing when animals at a high production level receive rations richest concentrate feeds. Moreover, with proven results, Desnoyers (2008)
demonstrated that the major sources of acidosis being insufficient adaptation of the rumen to the diet and with rapid or high digestion and fermentable carbohydrates. This ration can produce a state of rumen acidosis.

According to a study by Sauvant and Peyraud (2010), the diets with more than 40% of concentrate have a potential risk of acidosis. Desnoyers (2008) also showed that the main cause of acidosis is the normal adaptation of the rumen to diet. Numerous restrictions, including feed ingredients, can affect susceptibility to acidosis. The evolution of the average quantity of voluntary feed intake in DM/calf/day during the trial period was 9.8 ± 0.1 kg for group C and 9.8 ± 0.07 kg for the group LY (p > 0.6) during the first week of control. After the 10th week, there was an increase in intake, with the largest advance before the end of the trial 9.1 versus 9.3 kg DM/calf/day for the C group and LY group with a slight dominance in the C group. Over the overall period, the two diets generated a particular eating behaviour (Table 3). In fact, the values of the total dary matter intake recorded 85.4 ± 0.05 kg and 86.5 ± 1.1 kg DM/calf for the LY and C groups, respectively. Incorporating live yeast as a feed additive has no important effect on this parameter (p > 0.3). We are consistent with the results of Desnoyers (2008), Sauvant and Giger-Reverdin (2015) and Sauvant and Peyraud (2010) who found that live yeast supplementation does not affect the amount of feed intake. A study by Moncoulon and Auclair (2001) showed that incorporating S. cerevisiae live yeast in the diet reduced the quantity of dry matter intake by 2.6%. During this trial, the live body weight of calves derived from 444 ± 29 kg to 603 ± 34 kg for the C group and from 459 ± 17 kg to 658 ± 18 kg for the LY group at the end of the trial, without significant dominance between the two groups (p > 0.19).

According to Table 2, the calves that did not receive S. cerevisiae live yeast achieved a weight gain of 159.4 ± 8.6 kg compared to 198.5 ± 7.5 kg for those of the LY group. The statistical analysis shows that body weight gains differ (p < 0.004) between the two groups with a significant difference of 39.1 kg between the average values obtained.

Regarding the mean ADG, statistical analysis shows a notable difference only for the ADG at the fourth week (p < 0.05) and mean daily gain ADG (p < 0.003) that has undergone a remarkable improvement at 1.9 ± 0.08 kg/day for calves of the LY group against 1.5 ± 0.08 kg/day for the C group. These results are consistent with those of Majdoub-Mathlouthi et al. (2011), who showed that the addition of live yeast to fattening bulls fed poor forage increased the ADG of 39.6% with a significant gain (p < 0.01) of the body weight at the end of this trial. An improvement in the limits of ruminal fermentation interprets these rises. Moncoulon and Auclair (2001) and Sauvant and Peyraud (2010) proved that the influence of live yeast is more effective for diets rich in concentrate and for animals with a greater feed intake. Moncoulon and Auclair (2001) and Sauvant and Peyraud (2010) have shown that the influence of live yeast is more effective with diets rich in concentrate and for animals with a greater food intake. That is to say, that in the case of acidogenic regimes distributed in farms carried out intensively. The intake of live yeast can modify the physicochemical limits of the rumen in a beneficial way for the animal by allowing the synthesis of a greater quantity of AGV and significant increases (p < 0.01) of the accumulation of acetate and propionate while maintaining a high pH. In addition, decreasing the lactic acid concentration and increasing the propionic acid concentration, improving the digestibility of the organic matter, and then induce an increase in weight gain. The results from Table 3 showed that the diet supplemented with live yeast caused on average a significant decrease in the FCR to those got with the control diet 7 ± 0.4 and 9 ± 0.8 kg DM feed intake/kg gain for C and LY groups. The effect of this feed additive on FCR is important (p < 0.05) on this experimental model, suggesting that live yeast improved rumen conditions and the efficacy of microbial flora in the rumen (Maamouri et al., 2016). The results obtained from this trial show the capacity of this feed additive to exert an effect on calves growth and this with the improvement of feed efficiency (FCR), as has been demonstrated throughout the trial (Sauvant & Giger-Reverdin, 2015; Cano Lopez et al., 2010).

### Table 4

The limits a, b, c and (a + b) of non-linear model of gas production and estimated limits from gas produced at 24 h: comparison of the two trial diets (C) and (LY)

| Items                        | Group    | C       | LY      | SEM      | p-Value |
|------------------------------|----------|---------|---------|----------|---------|
| a (ml)                       |          | −3.1± 1.6 | −2.7± 2  | 0.410−4  | <0.0001 |
| b (ml)                       |          | 109.6± 15 | 113.6± 11| 0.410−5  | <0.0001 |
| c (h−1)                      |          | 0.02± 0.0006 | 0.03± 0.0006 | 0 | <0.0001 |
| a+ a + b (ml)                |          | 106.5± 0.003 | 110.9± 0.001 | – | <0.0001 |
| Prod gas 24 h (ml)           |          | 42.7± 8.8 | 56.0± 10.8| 15.3 | 0.4 |
| Total gas (ml)               |          | 63.7± 2.5 | 64.3± 0.6 | 2.9 | 0.5 |
| OMd (%)                      |          | 73.6± 2.8 | 76± 1.4 | 4.9 | 0.2 |
| ME (kcal)                    |          | 1919± 332 | 2419± 407 | 576 | 0.4 |
| VFA (mmol/syringe)           |          | 1.27± 0.07 | 1.33± 0.04 | 0.004 | 0.2 |
| N-NH₃ (mg/ml)                |          | 0.16± 0.04 | 0.20± 0.02 | 0.0009 | 0.1 |

Note: Mean values with different letters in the same row are significantly different at p < 0.05.

Abbreviations: C, control diet; LY, diet supplemented with live yeast; ME, metabolised energy; N-NH3, nitrogen ammonia produced by the diets; OMd, organic matter digestibility; SEM, standard error mean; VFA, volatile fatty acids.
5 | CONCLUSION

In conclusion, we mentioned a considerable advance in the total ADG during the trial. In addition, significant increases in FWG with the supply of live yeast S. cerevisiae. The intake is lower with the supply of live yeast from the middle to the end of the test, but without a noticeable difference. The mean FCR was lower for the live yeast group. We did not note any changes in ruminal fluid pH and faeces fermentation parameters. Live yeast as a probiotic effect results in rumen comfort of animals receiving this additive in the feed, which has been shown to improve their performance.

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ANIMAL WELFARE STATEMENT

The authors confirm that they have followed the Committee of Animal Experiments (CEEA), of Tunisia for the protection of animals used for scientific purposes.

AUTHOR CONTRIBUTIONS

Conceptualization, data curation, formal analysis, investigation, methodology, validation, visualization, writing-original draft and writing-review & editing: Omar Maamouri. Conceptualization, validation, visualization, writing-original draft and writing-review & editing: Mondher Ben Salem.

DATA AVAILABILITY STATEMENT

The author has provided the required data availability statement and, if applicable, included functional and accurate links to said data therein.
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