Effect of harvest stage and additives on fermentative and nutritional quality from dual-purpose sorghum (*Sorghum bicolor*) silage in livestock production systems

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Abstract

To address the shortage of animal feed in Burkina Faso, we looked at the potential for producing silage from forage sorghum and the main factors affecting the fermentation process. The aim of this study was to evaluate the chemical composition, fermentation quality, and microbial dynamics of silage prepared from dual-purpose sorghum (*Sorghum bicolor*, variety Sariaso 16) harvested at two stages of maturity (soft dough and mature stover) under Sudanian agro-ecological conditions in Burkina Faso. Sorghum forage was ensiled with different additives (molasses, salt, molasses + salt) and compared with untreated control silages. Results revealed that sorghum harvested at the soft dough stage had higher levels of crude protein (3.79), metabolizable energy (7.64), and digestibility (52.37), while mature stover stage showed higher fiber. In general, forages harvested at the soft dough had better nutritional quality and lower fiber levels than those harvested at the mature stover. After 120 days of ensiling, the combination of molasses and salt as additives improved the best fermentation profile, characterized by lower pH, higher lactic acid production, reduced microbial spoilage (yeasts, molds, and aerobic flora), and improved nutritive value compared to control silages. The study concludes that harvesting sorghum at the soft dough stage and treating it with molasses plus salt enhances silage quality, offering a viable strategy for improving livestock feed and addressing fodder shortages in Burkina Faso.

Key words: additives, Burkina Faso, fermentation, growth stage, silage, sorghum.

Introduction

In Sahelian countries such as Burkina Faso, livestock feed is mainly based on natural grazing with some supplementation (Sanfo et al. 2020). Dependence on natural grazing exposes the livestock sector to the spatio-temporal insufficiency of fodder, which is a real brake on livestock productivity in tropical zones such as Burkina Faso (Zampaligré and Schlecht, 2017; Bilal et al. 2021; Toe et al. 2022). The increased severity of the rainy season in these regions has a direct impact on the livestock farming systems practiced, as natural pastures fluctuate with climatic patterns and are continuously shrinking due to the expansion of cultivated land, growing herd sizes, and rapid urbanization. These dynamics exacerbate serious conflicts between farmers and herders over the exploitation of the scarce natural resources available (Zougmoré et al. 2016). In addition, the crop residues collected and preserved by farmers are generally of mediocre quality, and the high cost of commercial feed is also noted, which is used as a supplement to make up for shortages of natural resources (Sanou et al. 2016).

Faced with this situation, growing fodder crops and using suitable conservation methods would be a better alternative for overcoming the shortage of good quality fodder throughout the year and maintaining the production capacity of livestock farming systems.

Fodder crops are of very high quality for animals and have the advantage of retaining their nutritional value if harvesting and storage conditions comply with the required standards (Zampaligré et al. 2021). Among locally available fodder crops, dual-purpose sorghum can be used to make silage for subsequent feeding to livestock. The use of silage in animal feed during the dry seasons of the year is a way of maintaining ruminant herds (Bilal et al. 2021). This practice can also help farms to control the feeding of ruminants to ensure a continuous supply of meat and dairy products for human consumption. The production of silage from dual-purpose sorghum is an interesting option to explore. In addition, a number of studies have shown that the use of additives in the manufacture of silage increases the quality of the silage (Muck et al. 2018)

The main objective of this study was to analyze the chemical and microbiological composition of sorghum forage ensiled with additives at two stages of development in Burkina Faso.

Materials and methods

Study area

This study was conducted at the research station of the Institute of Environment and Agricultural Research (INERA) in Saria. The research station in Saria is located in the northern Sudanian agroecological zone of Burkina Faso. It extends between 12°16′ and 12°17′ North latitude and between 2°09′ and 2°08′ West longitude.

Silage preparation

Sorghum **(***Sorghum bicolor***)** at two stages of maturity: soft dough (Figure 1) and mature stover stage (Figure 2) was harvested and treated with two types of additives (salt and molasses). The sorghum variety used was Sariaso 16, an improved dual-purpose variety. The harvested stalks were ground using a chopper (130DX, ARS Co., Ltd, Osaka, Japan) to facilitate compaction and fermentation. Ensiling was made by packing approximately 1672 g of chopped material at soft dough stage and 1342 g of chopped material at mature stover stage into silos cylindrical tubes (50 cm x 10 cm) (Figure 3). Ensiling was made for each harvest stage four treatment groups with three (03) repetitions per treatment were carried out: control (without additives); molasses 5% fresh matter; salt 4% fresh matter; salt 4% + molasses 5% fresh matter. A total of twenty-four (24) silos were used. The silos were stored at room temperature in a dark building. After 120 days of ensiling, the silos were opened for analysis of chemical composition, fermentation quality and microbial population.

Analysis of silage fermentation

The pH of the silage juice samples was measured using a portable pH meter (Hanna instruments) previously calibrated with standard buffer solutions pH = 4 and 7. 10 g of each silage sample was homogenized with 90 ml of distilled water for 5 minutes (Cai, 2004). The silage juice obtained was then homogenized again and the pH of the extract was immediately measured using a portable pH meter**.** Titratable acidity was determined by using the principle on the neutralization of organic acids with sodium hydroxide in the presence of phenolphthalein. To do this, two to three drops of phenolphthalein were added to 25 ml of silage juice; the mixture was then homogenized using a stirrer. The 0.1 N NaOH solution (10 ml mixed with 100 ml distilled water) was used for titration. Titration was stopped when the persistent pink coloration appeared.

Chemical composition and energy analysis

The samples were oven-dried at 105°C for 24 hours to determine the DM content. The dry matter content of the samples was determined using the AOAC (1990) method. The dried samples were ground and sieved for chemical analysis. The chemical content of the various samples was determined by near infrared spectrometry using the NIRS FOSS DS 2500 F model spectrometer at the INERA laboratory. The ILRI prediction equations were used to determine the contents of crude protein (CP), organic matter (OM), Ash, metabolizable energy (ME)

Figure 1: Sorghum (*Sorghum bicolor*) at soft dough stages of maturity

Figure 2: Sorghum (*Sorghum bicolor*) at stover stage

Figure 3: Silos

and *in vitro* digestible organic matter (IVDOM) and fibers (neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL).

Microbial analysis

The following germs were counted: Aerobic bacteria, lactic acid bacteria, yeasts and molds and total coliforms in fresh and ensiled sorghum, using the methodology described by Cai *et al.* (1999). 10 g of each sample was homogenized with 90 ml of sterile physiological water (0.9% NaCl) for 5 minutes. The mixture (1ml) was taken for serial dilutions from $10^{-1}$to $10^{(-)\ (5)}$ in 9 ml tubes of sterile saline water (0.9% NaCl). Each dilution was inoculated twice and the agar plates received 100 µL of each dilution. Aerobic bacteria were counted on Plate Count Agar (PCA). Lactic acid bacteria were enumerated on Man, Rogosa, and Sharpe (MRS) agar. Yeasts and molds were counted on Sabouraud chloramphenicol medium**.** Coliforms were counted on VRBL agar (crystal violet and neutral red lactose agar). The plates were incubated at 30°C for 2 to 4 days under aerobic conditions. Colonies were counted as the number of viable microorganisms in colony-forming units (cfu)/g of fresh matter (FM).

Statistical analysis

The data collected on chemical composition, fermentation quality and microbial population were entered into an Excel 2016 spreadsheet. These data were then subjected to analysis of variance (ANOVA) and the

significance of the differences between the means was compared using Tukey's test at the p=5% probability threshold using R4.1.1 software. Version 2019.

Results

The pH, lactic acid level, chemical and bromatological composition and microbial population of fresh sorghum harvested at the soft dough and at the mature stover stage are presented in Table 1.

Before ensiling, the pH was 6.96 and 7.41 respectively at the soft dough and mature stover stage stages. The level of CP, ME, IVDOM were higher in soft dough than in mature stover stage, while the level of DM, fiber (NDF and in ADF and ADL), ash and pH showed the opposite pattern. Lactic acid levels and microbial populations (aerobic bacteria, coliform bacteria, yeasts and molds) in soft dough and mature stover stage did not differ significantly before ensiling. However, aerobic bacteria dominated all forage groups prior to ensiling.

Fermentation characteristics

The fermentative characteristics of soft dough and mature stover stage ensiled after 120 days are presented in Table II. After fermentation, soft dough ensiled after 120 days presented a pH level of 4.04 for a production level of 14.10 g/kg of lactic acid compared with a pH level of 4.17 for a production level of 8.62 g/kg of lactic acid for the forage after grain harvesting (Table 2). Analysis of variance revealed a highly significant difference between forage types (harvest stages) and treatments (additives) for pH, lactic acid production and DM content ($p<0.05$).

The soft dough silage treated simultaneous soft doughy with molasses and salt had the best fermentation profile, with the lowest pH (3.69) and the highest lactic acid production (18.38g/kg). On the other hand, mature stover stage/Control silages presented the least appreciable fermentative profile with the highest pH (4.76) for a mediocre production of lactic acid (7.83g/kg).

The silages treated simultaneously with molasses and salt had the best fermentation profile (3.70 for pH and 13.91g/kg for lactic acid). The least appreciable fermentative characteristics were obtained with the control silages (without treatment) characterized by the lowest lactic acid level (9.55g/kg) and a higher pH level (4.56).

Forages ensiled at the post-grain harvest stage and treated with molasses plus salt and those treated only with salt presented the highest DM level (39% DM). The lowest DM level was obtained with mature stover stage/Control. In general, sorghum silage treated (molasses, salt, molasses plus salt) had a higher DM than sorghum silage. Sorghum silage treated simultaneously with molasses and salt showed significant DM levels (36%MS). Reduced DM levels were observed with control sorghum silage (31%MS) ($p< 0.05$). In addition, mature stover stage silages had higher DM levels (38% MS) than soft dough silages (30%MS) ($p< 0.0001$).

Chemical composition

Analysis of variance revealed a significant difference ($p<0.05$) between forage treatments and forage type for forage bromatological composition at the 5% threshold.

The results revealed that soft dough/molasses+salt presented the best level of CP, ME, and IVDOM against reduced levels of fiber (NDF, ADF and ADL) (Table 3). It is therefore the group with the nutritional value closest to that of fresh fodder compared with the other groups. The least appreciable nutritional value was obtained with mature stover stage/Control silage, which is described by a lower level of CP, ME and IVDOM, compared with high fiber values (Table 3).

Table 1: pH, chemical composition, microbial population of soft dough and mature stover stage before ensiling.

	Soft dough	Mature stover stage	probability
pH	6.96 ±0.25	7.41± 0.22	<0.05*
Lactic acid (g/kg MF)	5.76±3.32	4.56±0.92	ns
DM (%)	31% ± 5%	38% ± 3%	<0.0001***
CP (% DM)	7.46±0.42	3.13±0.56	<0.0001***
IVDOM (% DM)	54.56±0.56	52.21±1.66	<0.05*
ME (mJ kg -1 DM)	7.93±0.09	7.19±0.25	<0.05*
ADF (% DM)	35.70±1.27	37.16±1.39	<0.05*
ADL (% DM)	4.03±0.08	4.26±0.08	<0.05*
NDF (% DM)	65.29±1.83	68.56±1.52	<0.05*
Microbial population (log 10 cfu g −1 FM)			
Lactic acid bacteria	1.47 x 10^6	1.34 x 10^6	ns
Aerobic bacteria	1.23 x 10^8	1.43 x 10^8	ns
Coliforms	ND	1.17 x 10^4	ns
Yeasts and molds	1.66 x 10^7	1.42 x 10^6	ns

***: Very highly significant;**Highly significant,*Significant, ns: not significant at the 5% probability level.
DM: dry matter, lactic acid: lactic acid, pH: hydrogen potential. ADF = acid detergent fiber, ADL = acid detergent lignin, CP =Crude protein, ME = metabolizable energy, NDF = neutral detergent fiber, IVDOM: in vitro digestible organic matter. cfu/g FM: colony size unit per gram of fresh matter; ND: not detected, ns: not significant.

Table 2: Fermentation characteristics of soft dough and mature stover stage silages after 120 days of ensiling.

Treatment	Lactic acid (g/kgMS)	pH	DM (%)
Soft dough			
Control	11,27[a]	4.37[ab]	27[a]
Molasses	14.14[ab]	3,98[a]	29[ab]
Salt	12.60[ab]	4.22[ab]	29[ab]
Molasses+Salt	18,38[b]	3,69[a]	33[ac]
Mature stover stage			
Control	7,83[a]	4,76[b]	34[ac]
Molasses	8,57[a]	4,01[a]	38[bc]
Salt	8,63[a]	4.14[ab]	39[c]
Molasses+Salt	9,43[a]	3,70[a]	39[c]
Additives mean			
Control	9,55[a]	4,56[b]	31[a]
Molasses	11.36[ab]	3.99[ab]	34[ab]
Salt	10.62[ab]	4.18[ab]	34[ab]
Molasses+Salt	13,90[b]	3,70[a]	36[b]
Harvest stage mean			
Soft dough	14.10	4.17	30
Mature stover stage	8.62	4.04	38
Additive (A)	<0,05*	<0,05*	<0,05*
Harvest stage (H)	<0,0001***	0,553	<0,0001***
A x F	<0,0001***	<0,05*	<0,0001***

****: Very highly significant;**Highly significant,*Significant,* ns: not significant, *Within the same column, figures followed by the same letter are not significantly different from each other at the 5% probability threshold. a. lactic: lactic acid; DM: dry matter, pH: hydrogen potential*

Table 2: Chemical and energy composition (in % DM) after 120 days of ensiling

Treatment	OM (%)	CP (%)	Ash (%)	IVOMD (%)	ADF (%)	ADL (%)	NDF (%)	ME (%)
Soft dough								
Control	93.54[ac]	3.18[ac]	8.79[a]	51.72[ab]	39.17[ab]	4.83[ab]	70.90[ac]	7.57[ac]
Molasses	93.74[bc]	3.53[bc]	8.78[a]	53.28[b]	37.48[ab]	4.56[a]	67.51[ab]	7.8[c]
Salt	94.06[c]	4.03[bc]	10.48[b]	51.62[ab]	37.9[ab]	4.77[ab]	67.86[ac]	7.50[bc]
Molasses+Salt	94.40[c]	4.41[c]	10.50[b]	52.84[b]	36.15[a]	4.51[a]	64.37[a]	7.68[ac]
Mature stover stage								
Control	92.42[a]	1.99[a]	8.81[a]	47.70[a]	43.60[b]	5.23[b]	74.43[c]	6.99[ab]
Molasses	92.78[ab]	2.11[a]	9.01[a]	48.54[ab]	42.31[ab]	4.99[b]	71.54[bc]	7.12[ac]
Salt	93.95[c]	2.66[ab]	10.91[b]	46.89[a]	42.93[b]	5.04[b]	71.98[bc]	6.81[a]
Molasses+Salt	93.55[bc]	2.95[ab]	11.07[b]	48.65[ab]	40.62[ab]	4.84[ab]	68.11[ac]	7.08[ac]
Additives mean								
Control	92.98[a]	2.49[a]	8.80[a]	49.23[a]	41.37	5.07[b]	72.67[b]	7.20[a]
Molasses	93.25[a]	2.82[a]	8.90[a]	50.91[b]	40.11	4.88[ab]	69.92[ab]	7.46[b]
Salt	93.81[ab]	3.68[b]	10.70[b]	49.13[a]	40.20	4.88	69.53[ab]	7.10[a]
Molasses+Salt	94.18[b]	3.35[b]	10.78[b]	50.75[b]	38.38	4.83[a]	66.24[a]	7.38[b]
Harvest stage mean								
Soft dough	93.93	3.79	9.54	52.37	37.67	4.65	67.66	7.64
Mature stover stage	93.17	2.43	9.95	47.95	42.36	5.03	71.52	6.99
Additive (A)	<0.01**	<0.05*	<0.000***	<0.05*	0.477	0.66	<0.05*	<0.05*
Harvest stage (H)	<0.01**	<0.00***	<0.05*	<0.000***	0.000***	<0.05*	<0.01**	<0.000 ***
A x H	0.000***	0.000***	0.000***	0.000***	0.000***		<0.01**	<0.01**

****: Very highly significant; **Highly significant, *Significant ns: not significant, Within the same column, figures followed by the same letter are not significantly different from each other at the 5% probability threshold.*

OM: organic matter; CP: crude protein; ME: metabolizable energy; IVOMD: in vitro digestibility of organic matter; NDF: neutral detergent fiber; ADF: acid detergent fiber; ADL = acid detergent lignin.

In general, soft dough and mature stover stage ensiled after 120 days having received treatment presented a better level of CP, ME and IVDOM values against reduced levels of NDF, ADF and ADL (Table III) compared to soft dough/Control and mature stover stage/Control ensiled.

Soft dough/molasses+salt and mature stover stage/molasses+salt had reduced fiber levels (Table III) compared with high levels of CP, ME and IVDOM in the other sorghum silage groups (Table III).

Microbiological population

The soft dough and mature stover stage microbial population ensiled after 120 days is presented in Table IV. The number of aerobic bacteria and yeasts and molds was significantly different between the different forage groups ($p < 0.05$). Soft dough/molasses + salt silage showed the lowest level of Aerobic bacteria (4.96×10^3cfu/g FM). On the other hand, the highest microbial population of aerobic bacteria was obtained with the control silage (6.50×10^5cfu/g FM).

In general, the treatments carried out had a significant effect on the evolution of the microbial population of aerobic bacteria. Soft dough and mature stover stage ensiled with molasses and salt showed the lowest aerobic bacteria population (6.98×10^4cfu/g FM) compared with the control of soft dough and mature stover stage ensiled (6.07×10^5cfu/gFM). In addition, soft dough silage showed a low level of aerobic bacteria (1.46×10^5cfu/g FM) compared with mature stover stage silage (3.53×10^5cfu/g FM) (Table IV).

In terms of yeast and mold counts (Table IV), all groups of treated silages showed reduced yeast and mold counts compared to control silages. Soft dough/Control silages showed a higher number of microbial populations (3.13×10^4cfu/g FM) than the other groups. The lowest number was observed in soft dough/molasses+salt silage (1.11×10^3cfu/g FM).

Forages treated simultaneously with molasses plus salt showed the lowest yeast and mold microbial population (2.92×10^3cfu/g FM) compared with a high yeast and mold microbial population for the silage groups that received no treatment (1.79×10^4cfu/g FM). The results did not reveal a significant difference between the harvesting stages and the treatments for the number of lactic acid bacteria and coliforms ($p>0.05$), but the results do show that lactic acid bacteria dominated all the silage groups, especially soft dough silage.

Discussion

The treatments and the harvest stage had a significant effect on the pH ($P<0.05$), lactic acid production ($P<0.05$) and DM level ($P<0.05$) of the silage, but not on the number of lactic acid bacteria. However, the increased production of lactic acid and the fall in the pH level in the treated silages reflect an improvement in the activities of the lactic acid bacteria following the treatments carried out. The results showed that all groups of treated silages had a pH level within the acceptable range (3.5 to 4.5) for good quality silage in the tropics (Cai et al. 2020). The silages treated simultaneously with molasses and salt had the lowest pH levels and the highest acidity levels compared with the control silages, in contrast to the silages not treated with additives. Our results corroborate with those of Lukkananukool et al (2019); Hartutik et al, (2021 and Luo et al (2021) who found that molasses rich in nutrients (total carbohydrates, non-fibrous carbohydrates, total digestible nutrients,) easily fermentable by lactic acid bacteria improved the quality of forage fermentation by stimulating the activities of lactic acid bacteria, thus avoiding dry matter losses.

Compared with the silage stage, soft dough ensiled after 120 days showed high levels of lactic acid. Our results are similar to those obtained by Cai et al. (2020) and Korombé et al. (2023) who found that fermentation quality is a function of the maturity stage of the plant material.

Mature stover stage showed high dry matter values compared to soft dough stage. Our results corroborate with those of Cai et al. (2020) and Terler et al. (2021) who found that dry matter level was a function of harvest stage. The high level of dry matter in ensiled mature stover stage after 120 days is linked to the growth of the cell walls and the drop in the water level of the plant material due to maturity. However, the treatments carried out had a significant effect on the level of dry matter during the storage process. The highest levels of dry matter were obtained with forages treated simultaneously with molasses and salt. According to Korombé et al. (2023), the addition of salt (NaCl) reduces dry matter losses during preservation by reducing undesirable microorganism activity.

The different treatments and harvest stages also had a significant effect on the chemical composition of the sorghum forage ($P<0.05$). Soft dough forages ensiled after 120 days showed significant levels of CP, ME and IVDOM against reduced levels of fiber (NDF, ADF ADL) compared to mature stover stage forages ensiled after 120 days, which is in allowed with the results of Cai et al. (2020), Gao et al. (2019) and Korombé et al. (2023) who found that fermentation quality is a function of the maturity stage of the plant material.

The addition of molasses and/or salt to silages improved the level of CP, ME and IVDOM while causing a decrease in the level of fiber ($P<0.01$) compared to control silages. Our results corroborate those reported Luo et al. (2021) who found that molasses, by stimulating the activity of lactic acid bacteria, best conserved the nutrient level of the plant material, and with those of Korombé et al. (2023) who observed a significant level of nutrients in salted silages compared with control forages.

Table 4: Microbial population of soft dough and mature stover stage silages after 120 days of ensiling**.**

Treatment	Microbial population (cfu/g FM)			
	Lactic acid bacteria	Aerobic bacteria	Yeasts and moulds	Coliforms
Soft dough				
Control	3,32 x 10^6	5.65 x 10^{5b}	3.13 x 10^{4b}	ND
Molasses	4,88 x 10^6	7.52 x 10^{3a}	8.85 x 10^{3a}	ND
Salt	1,65 x 10^6	5.89 x 10^{3a}	4.32 x 10^{3a}	3,64 x 10^2
Molasses+Salt	7,90 x 10^7	4.96 x 10^{3a}	1.11 x 10^{3a}	2,98 x 10^2
Mature stover stage				
Control	5,26 x 10^5	6.50 x 10^{5b}	4.47 x 10^{3a}	ND
Molasses	7,46 x 10^6	3.91 x 10^{5ab}	3.95 x 10^{3a}	3,33 x 10^2
Salt	6,01 x 10^6	2.36 x 10^{5ab}	4.15 x 10^{3a}	5,76 x 10^3
Molasses+Salt	1,07 x 10^7	1.35 x 10^{5ab}	4.73 x 10^{3a}	ND
Additives mean				
Control	1,92 x 10^6	6.07 x 10^{5b}	1.79 x 10^{4b}	ND
Molasses	6,17 x 10^6	1.99 x 10^{5a}	6.40 x 10^{3a}	1,67 x 10^2
Salt	3,83 x 10^6	1.21 x 10^{5a}	4.23 x 10^{3a}	2,90 x 10^3
Molasses+Salt	4,48 x 10^7	6.98 x 10^{4a}	2.92 x 10^{3a}	1,49 x 10^2
Harvest stage mean				
Soft dough	2,15 x 10^7	1,46 x 10^5	1,14 x 10^4	1,65 x 10^2
Mature stover stage	6,86 x 10^6	3,53 x 10^5	4,33 x 10^3	1,52 x 10^3
Additive (A)	Ns	<0,01**	<0,05*	Ns
Harvest stage (H)	Ns	<0,05*	<0,05*	Ns
A x H	Ns	<0,01**	<0,05*	Ns

***: Very highly significant;**Highly significant,*Significant, ns not significant Within the same column, figures followed by the same letter are not significantly different from each other at the 5% probability threshold.

Silage treated with molasses or molasses plus salt showed a satisfactory level of in vitro digestibility of organic matter and metabolizable energy compared with control silage or silage treated only with salt. This can be explained by the fact that the addition of molasses stimulated hydrolysis of the cell wall, making it more digestible. Furthermore, molasses is above all a

source of energy (soluble sugar), which explains the improvement in the energy level of silage following the addition of molasses (Kang et al. 2018).

In this study, the treatments carried out as well as the maturity stage of the plant material had a significant effect on total flora colonies and molds and yeasts ($p<0.05$). Mature stover stage ensiled after 120 days showed a higher level of total flora than soft dough harvested silage ensiled after 120 days. Our results are similar to those of Cai et al. (2020).

Yeast and mold numbers were higher in soft dough silages ensiled after 120 days compared to mature stover stage silages ensiled after 120 days. This is consistent with the results of Cai et al. (2020) who found that the development of these microorganisms was affected by the maturity of the plant material. The high number of yeast and molds in soft dough forages ensiled after 120 days may be linked to their ability to tolerate acidic environments, their sensitivity to moisture, and the high level of nutrients in these forages.

The silages treated with molasses and/or salt contained the lowest numbers of total flora, molds and yeasts compared with the control silages. This could be explained by the fact that the growth of yeasts and molds was inhibited by the salt and by the rapid acidification of the medium following the addition of molasses, which improved the fermentation process (Vu et al. 2019). This indicates that salting the forage reduces the development of these undesirable microorganisms during the fermentation process.

Conclusion

This study revealed that the additives (molasses and salt) used improved the fermentation process and preserved the plant material as well as possible. The study shows that sorghum harvested in the milky phase and treated with molasses plus salt as an additive could improve the quality of silage to improve animal feed. It could thus constitute an important database for developing strategies to combat spatio-temporal fodder shortages in Burkina Faso.

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