Universität Rostock Traditio et Innovatio

In vitro ensilability of Jack Bean (*Canavalia ensiformis*) and Cowpea (*Vigna unguiculata*) grains sole or mixed with Sorghum (*Sorghum bicolor*) grains: an alternative for low input pig feeding systems

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INTRODUCTION

- Seeds of under utilized legumes currently receive increased attention, as they are more adapted to adverse environmental conditions, highly resistant to diseases and pests and of good nutritional quality.
- Ensiling could be a valuable technique for conservation and the improvement of the nutritional value of these feedstuffs.
- The Rostock Fermentation Test[1,3] (RFT) was performed to evaluate the ensilability of jack bean and cowpea grains, sole or mixed with sorghum.

MATERIALS AND METHODS

1. Ripe seeds of jack bean, cowpea and sorghum were hand harvested, sun dried and milled (4 mm mesh size).
2. Four treatments were applied in triplicate: control, molasses (4 % on FM base), *Lactobacillus plantarum* (LAB, $3x10^5$ cfu/g FM), molasses + LAB. Sorghum was mixed with legume grains to reach 20 or 24 % of crude protein in the mix.
3. 50 g of milled grains were mixed with 200 ml of distilled water and additives in beakers (600 ml), the incubation temperature was set at 30 ºC.
4. pH was measured after 0, 14, 18, 22, 26 and 38 h.
5. Ammonia (NH_3), volatile fatty acids, lactic acid (LA) and ethanol were analyzed after 38 h in the filtrates of RFT.

RESULTS AND DISCUSSION

- Cowpea showed higher levels of water soluble carbohydrates (WSC), less buffer capacity (BC) and a higher WSC/BC quotient than jack bean (Table 1).
- Sorghum showing a low BC, a better performance for the mixed silages was expected, although the content of WSC was only marginal.
- As a good fermentation quality can be expected with a WSC/BC quotient between 3 and 5[2], the necessity of additives was evident.

Table 1: Selected parameters to estimate ensilability in the grains used

Grain	WSC (g/100g DM)	BC (g LA/100g DM)	WSC/BC quotient (-)
Jack bean	0.00	8.96	0.00
Cowpea	2.29	6.30	0.38
Sorghum	0.18	3.13	0.09

- In cowpea the use of an inoculant showed a remarkable effect in pH reduction independent of molasses addition or mixing with sorghum (Fig. 1).

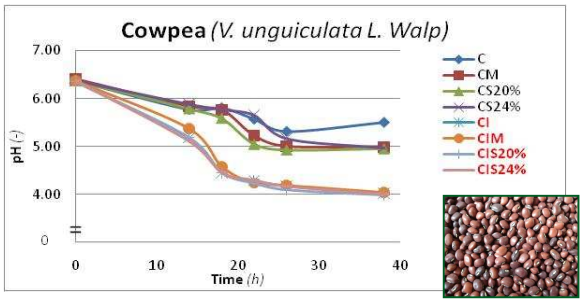

Fig 1: pH development during incubation of RFT for cowpea grains sole or mixed with sorghum

- The inoculated variants showed the highest lactic acid (LA) concentrations and the lowest contents of undesired fermentation parameters (acetic acid, butyric acid, ethanol and NH_3) in the filtrates of RFT after 38 h of incubation (Table 2).

Table 2: Effect on fermentation parameters in filtrates after 38 h of different variants of RFT with cowpea grains *(n=3)*

	C	CM	CS20%	CS24%	CI	CIM	CIS20%	CIS24%
Lactic acid *(%DM)*	0.00^{a} ±0.00	2.40^{c} ±0.40	0.22^{a} ±0.11	1.95^{b} ±0.21	6.83^{f} ±0.04	6.85^{f} ±0.13	4.34^{d} ±0.03	4.75^{e} ±0.13
Acetic acid *(%DM)*	1.76^{f} ±0.00	1.41^{e} ±0.11	1.04^{c} ±0.01	1.21^{d} ±0.03	0.67^{a} ±0.00	0.62^{a} ±0.05	0.62^{a} ±0.00	0.81^{b} ±0.05
Butyric acid *(%DM)*	1.64^{c} ±0.16	1.20^{b} ±0.30	1.85^{c} ±0.16	0.93^{b} ±0.26	0.00^{a} ±0.00	0.00^{a} ±0.00	0.00^{a} ±0.00	0.00^{a} ±0.00
NH_3 *(%DM)*	$0,30^{f}$ ±0.03	$0,23^{e}$ ±0.01	$0,14^{c}$ ±0.00	$0,18^{d}$ ±0.00	$0,07^{a}$ ±0.00	$0,08^{a}$ ±0.01	$0,10^{b}$ ±0.00	$0,13^{c}$ ±0.00
Ethanol *(%DM)*	$1,53^{f}$ ±0.19	$0,99^{e}$ ±0.00	$0,52^{c}$ ±0.06	$0,74^{d}$ ±0.03	$0,16^{a}$ ±0.00	$0,15^{a}$ ±0.00	$0,30^{b}$ ±0.01	$0,34^{b}$ ±0.03

[a,b] Values with different superscripts in the same row are significantly different (P<0,05)
C *(control)*, CM *(cowpea+molasses)*,CS20%*(cowpea+sorghum (20% CP))*,CS24%*(cowpea+sorghum (24% CP))*, I *(inoculants)*

- In jack bean the effect of an inoculant on the reduction of pH was not as pronounced as it was in cowpea (Fig. 2).
- It is likely that there are characteristics in the composition of jack bean limiting the development of LAB. Anti-nutritional factors could be among them.

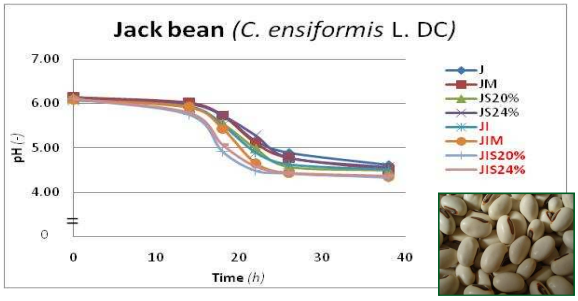

Fig 2: pH development during incubation of RFT for jack bean grains sole or mixed with sorghum

- The variants with sorghum reduced pH slightly faster when additives were used, but did not improve silage quality compared to grains solely ensiled (Table 3).

Table 3: Effect on fermentation parameters in filtrates after 38 h of different variants of RFT with jack bean grains *(n=3)*

	J	JM	JS20%	JS24%	JI	JIM	JIS20%	JIS24%
Lactic acid *(%DM)*	2.26^{a} ±0.23	2.80^{c} ±0.00	2.23^{a} ±0.02	2.36^{ab} ±0.09	3.71^{d} ±0.05	4.63^{e} ±0.06	2.51^{b} ±0.01	2.86^{c} ±0.01
Acetic acid *(%DM)*	1.14^{bc} ±0.26	1.28^{c} ±0.05	0.83^{b} ±0.03	0.90^{b} ±0.05	0.93^{b} ±0.09	0.45^{a} ±0.36	0.84^{b} ±0.00	1.01^{bc} ±0.00
Butyric acid *(%DM)*	0.05^{ab} ±0.02	0.01^{b} ±0.03	0.05^{ab} ±0.01	0.03^{a} ±0.01	0.00^{a} ±0.00	0.01^{a} ±0.00	0.00^{a} ±0.00	0.00^{a} ±0.00
NH_3 *(%DM)*	0.11^{e} ±0.01	0.12^{f} ±0.02	0.07^{b} ±0.01	0.08^{c} ±0.00	0.09^{d} ±0.00	0.09^{d} ±0.00	0.06^{a} ±0.00	0.07^{b} ±0.00
Ethanol *(%DM)*	0.34^{b} ±0.04	0.36^{b} ±0.04	0.19^{a} ±0.03	0.25^{ab} ±0.01	0.18^{a} ±0.07	0.15^{a} ±0.00	0.19^{a} ±0.02	0.22^{a} ±0.00

[a,b] Values with different superscripts in the same row are significantly different (P<0.05)
J *(control)*, JM *(jack bean+molasses)*, JS20%*(jack bean+sorghum (20% CP))*, JS24% *(jack bean+sorghum (24% CP))*, I *(inoculant)*

- The combination of molasses and inoculant as additives resulted in the best fermentation quality similar to cowpea silages.

CONCLUSIONS

1. RFT showed that it is possible to produce good silages using grains of cowpea and jack bean, but the use of additives is necessary.
2. The ensilability for cowpea is better than for jack bean.
3. Molasses improved fermentation when inoculants were used only for jack bean. In cowpea the WSC content was sufficient.
4. Mixed silages are beneficial for producing balanced rations and the possibility to harvest sorghum earlier, but the silage quality is not improved.

REFERENCES

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