# Desmanthus silage: a potential feed resource for the Northern Australian cattle industry

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**Abstract**
*Desmanthus spp.,* is an introduced legume genus high in CP and ME and that is well adapted to the neutral to alkaline clay soils in the seasonally dry environments of northern Australia. As a monoculture crop with irrigation some cultivars can produce 20t DM/ha. To be useful as a feed resource, however, it needs to be capable of being harvested and conserved. We investigated the ensilability of five cultivars of Progardes *Desmanthus* that differed in morphology and growth habit. *Desmanthus* produced acceptable silage based on concentrations of lactic acid and pH and had nutritive characteristics similar to values reported for Lucerne (*Medicago sativa*) silage.

**Keywords**
Tropical legumes, crude protein, metabolizable energy, feedlot\

## Introduction
Adding value to Northern Australia's beef cattle industry, such as by backgrounding, lot feeding and supplementation of heifers, breeders and weaners, will depend on an increase in the availability of high-quality, relatively low-cost, conserved forages. *Desmanthus,* an introduced legume genus adapted to clay (Vertisol) soils in the seasonally dry environments of northern Australia is both resilient in these environments and high in CP and ME (Gardiner, 2016). As a monoculture crop with irrigation, it can produce at least 20t DM/ha per year. This study investigated the fermentative and feed quality characteristics of five cultivars (four species) of *Desmanthus* (cv's JCU 2 D.virgatus;, JCU 4 D.bicornutus;, JCU 6 D.bicornutus;, JCU 7 D.leptophyllus; and JCU 9 D.pernambucanus) compared to forage sorghum (FS), *Leucaena leucocephala* cv Redlands (LLR) and the literature values of lucerne (*Medicago sativa*) and maize (*Zea mays*) silages.

## Methods
*Harvest*
The FS and Desmanthus cultivars JCU2, 4, and 7 were grown at Majors Creek just south of Townsville, Australia (19°39'6.26"S; 146°53'1.57"E) and harvested mid-morning when at early to mid-flowering stage of growth (Figure 1) using a flail forage harvester set at 30cm above ground level. Desmanthus cultivar's JCU 6 and 9 were grown at Mareeba, Australia (17°1'28.83"S; 145°25'6.68"E) and were harvested mid-morning when at vegetative (pre-flowering) stage of growth using a petrol operated reciprocating pruner held at 10 to 20 cm above ground level and then chopped in to 2 to 5 cm lengths using the pruner. The LLR was grown at CSIRO Lansdown Research Station, Australia (19°39'29.2"S; 146°50'35.4"E). Leaf including the petioles as well as green flexible stems were harvested by hand. All harvested and chopped material was allowed to wilt to 30 to 40% moisture content prior to ensiling by being spread out into a single 5 to 10 cm layer on large tarpaulins inside a shed under high powered oscillating fans to provide ventilation while being turned every 3 to 4 hours.

*Ensiling*
Ten kg of chopped and wilted material was then inoculated with Pioneer® Brand Nutrivail® 11CFT (comprising *Lactobacillus buchneri* and *L. plantarum* at $1.1x10^{11}$ Colony Forming Units/g). Inoculation was achieved by dispersing 150 mg inoculum in 1 L tap water and applying 100 mL of this solution uniformly over 10 kg's of wilted forage with mixing. A final dosage of 1.5 mg inoculum/kg of wilted forage was achieved; which is 1.5 times the recommended minimum rate of application. The inoculated forage was then packed firmly using a compacting tool (Figure 2a) into purpose built silo tubes (Figure 2b) consisting of 1 meter lengths of 100 mm PVC pressure pipe fitted with airtight screw caps (approx. 0.0086 $m^3$) at one end (bottom) and a one-way valve for release of fermentation gases at the other end (top). The compacting tool consists of a 1 m length of 80 mm PVC pipe capped at both ends and fitted with a 250 mm handle made of irrigation pipe fittings. The packed tubes were then stored at 22°C in a temperature-controlled room for at least 60 days prior to being opened for sampling.

*Sampling*
The silo tubes were opened 61 to 72 days following packing and sealing into the silage tubes, the contents were removed by hand and arranged in order of removal from the tube on a clean plastic sheet. The silage was sampled at 10 locations to produce a representative sample weighing 400-600g. This sample was mixed, placed in labelled zip seal bags and then stored in ice prior to being stored in a freezer at -20°C. A 200 g subsample was then placed in a zip lock bag and packaged with dry ice before being sent to Forage Lab Australia for chemical analysis by NIR.

Figure 1. Progardes Desmanthus cv JCU4 in phase 3 of growth (early flowering).


Figure 2. PVC silage compacting device (a.) and ensiling tube (b.)

*Chemical analysis*
Chemical analysis by NIR was performed on each sample to determine content of DM, lactic and acetic acids, total VFA, $NH_3$-CP equiv., ME, CP, soluble protein, rumen degradable protein, ADF-protein, starch, ADF, NDF, lignin, ash, Ca, P and Mg and pH. Wet chemistry was not available for these analytes due to transport restrictions in response to the COVID 19 pandemic.

*Data analysis*
NIR data was collated and sorted and transferred to IBM SPSS 25. Data was subjected to GLM analysis using univariate measures to test mean differences. Separation of means were done using Tukeys HSD for complete data sets and Gabriel for unequal data sets.

**Results**
Due to budget limitations fresh samples of forage for ensiling were not sent for NIRS analysis. Note there were no available NIR database for the *Desmanthus* silages. Fermentative and nutritive parameters of the silages are shown in Tables 1 and 2 while additional nutritive information are shown in Table 3. A high positive correlation of 0.8 ($P<0.01$; two-tailed) was detected between DM content and pH level of the silages.

**Table 1 Means of silage fermentation parameters by NIRS compared to Lucerne and Maize silage**

| Silage/Parameter | DM (%) | pH | Lactic acid (%DM) | Total VFA (%DM) | Acetic acid (%DM) | $NH_3$-CPE (%CP) |
|---|---|---|---|---|---|---|
| JCU 2 | 33.2cd | 5.2bc | 0.3a | 2.6b | 2.3 | 12.7b |
| JCU 4 | 35.5d | 5.2bc | 0.6a* | 3.2b | 3 | 12.8b |
| JCU 6 | 27.2b | 5.3c | 0.2a* | 0.3a | 0.3* | 12.0a |
| JCU 7 | 28.9bc | 5.4cd | 0.1a! | 0.1a | ** | 12.0a |
| JCU 9 | 29.5bc | 5.0b | 2.2a! | 4.0b | 1.8! | 13.3b |
| FS | 18.1a | 4.4a | 0.9a | 6.9c | 6 | 12.2b |
| LLR | 37.2d | 5.5d | 0.5a! | 2.0ab | 1.7 | 9.8a |
| Grand Mean | 29.9 | 5.2 | 0.7 | 2.9 | 2.9 | 2.1 |
| SD | 6.1 | 0.4 | 0.7 | 2.2 | 1.8 | 0.4 |
| Sig (P<0.05) | 0.00 | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 |
| Lucerne | 33.6[x] | 4.6[x] | 6.0[x] | | 2.7[x] | 0.4[y] |
| Maize | 31.7[u] | 3.9[u] | | | 2.0[v] | 0.03[v] |

[abcd] Means within columns with similar superscripts are not significantly different at *P>0.05*
[!] N=2, [*] N=1 [**] N=no detection in sample, DM = Dry matter; VFA = Volatile Fatty Acids; $NH_3$-CPE = Ammonia Crude Protein Equivalent; [u]Stockdale (1995); [v]Stockdale & Beavis (1994); [w]Feedipedia (2016); [x]Etheridge *et al.,* (1992); [y]Etheridge *et al.,* (1993)

**Table 2: Means of silage nutritive values by NIRS compared to Lucerne and Maize silage**

| Silage/Parameters | ME (MJ/kg DM) | CP (% DM) | Soluble Protein (% DM) | RDP (% DM) | ADF Protein (% DM) | Starch (% DM) |
|---|---|---|---|---|---|---|
| JCU 2 | 8.4[a] | 14.2[a] | 6.3[a] | 10.3[a] | 2.1[c] | 0.9[a] |
| JCU 4 | 7.7[a] | 14.0[a] | 6.4[a] | 9.2[a!] | 2.2[c] | 0.7[a] |
| JCU 6 | 9.9[b] | 20.5[b] | 10.1[c] | 15.3[b] | 2.2[c] | 0.8[a] |
| JCU 7 | 9.9[b] | 19.5[b] | 9.7b[c] | 14.6[b] | 1.9[bc] | 1.1[a] |
| JCU 9 | 9.8[b] | 19.4[b] | 13.2[d] | 16.3[b] | 1.5[ab] | 2.0[b] |
| FS | 8.7[a] | 11.0[a] | 7.1[ab] | 9.1[a] | 1.4[a] | 1.9[b] |
| LLR | 10.9[b] | 20.4[b] | 8.30[b] | 14.4[b] | 1.9[bc] | 2.6[b] |
| Grand Mean | 9.3 | 17 | 8.7 | 12.9 | 1.9 | 1.4 |
| SD | 1.1 | 3.8 | 2.4 | 2.9 | 0.3 | 0.7 |
| Sig (P<0.05) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Lucerne | 8.9[z] | 19.1[z] | | | 3.8[x] | |
| Maize | 10.8[w] | 6.9[w] | | | 5.5[u] | |

[abcd] Means within columns with similar superscripts are not significantly different at *P>0.05,* ME = Metabolizable Energy; CP = Crude Protein; RDP = Rumen Degradable Protein; ADF = Acid Detergent Fibre; [u] Stockdale (1995); [w] Feedipedia (2016); [x] Etheridge *et al.,* (1992); [z] Feedipedia (2012)

**Table 3: Means of silage fibre and mineral content by NIRS compared to Lucerne and Maize silage**

| Silage/Parameters | ADF | NDF | Lignin | Ash (%DM) | Ca (%DM) | P (%DM) | Mg (%DM) |
|---|---|---|---|---|---|---|---|
| JCU 2 | 43.8[b] | 52.7[b] | 10.5[c] | 9.1[b] | 1.6[bc] | 0.2[a] | 0.4[b] |
| JCU 4 | 48.4[b] | 58.7[bc] | 11.3[c] | 8.9[b] | 1.5[b] | 0.2[a] | 0.4[b] |
| JCU 6 | 33.4[a] | 44.0[a] | 8.6[b] | 7.8[ab] | 1.6[bcd] | 0.3[b] | 0.4[b] |
| JCU 7 | 33.2[a] | 44.1[a] | 8.0[b] | 8.2[b] | 1.6[bcd] | 0.3[b] | 0.4[bc] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| JCU 9 | 32.3[a] | 39.3[a] | 7.6[b] | 9.2[b] | 1.8[cd] | 0.4[b] | 0.5[c] |
| FS | 41.8[b] | 65.3[c] | 4.5[a] | 11.4[c] | 0.5[a] | 0.3[b] | 0.2[a] |
| LLR | 29.0[a] | 36.2[a] | 7.65[b] | 6.43[a] | 1.8[d] | 0.3[b] | 0.4[b] |
| Grand Mean | 37.4 | 48.6 | 8.3 | 8.7 | 1.5 | 0.3 | 0.3 |
| SD | 7.1 | 10.1 | 2.1 | 1.5 | 0.4 | 0.1 | 0.1 |
| **Sig (**P<0.05) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Lucerne | 28.9[x] | 40.3[x] | 7.9[z] | 11.4[z] | 1.5[z] | 0.3[z] | 0.2[z] |
| Maize | 30.2[u] | 49.2[u] | 2.7[w] | 3.7[w] | 1.9[w] | 1.7[w] | 1.1[w] |

[abcd] Means within columns with similar superscripts are not significantly different at *P>0.05*
ADF = Acid Detergent Fibre; NDF = Neutral Detergent Fibre; [u] Stockdale (1995); [w] Feedipedia (2016); [x] Etheridge *et al.,* (1992); [z] Feedipedia (2012)

## Discussion

FS had very low DM content and pH while the *Desmanthus* silages were within range of legume silages stipulated by Kung *et al.,* (2018). JCU 9 stood out as the better *Desmanthus* silage, being the sole cultivar harvested at vegetative stage. JCU 9 had numerically lower pH, higher starch content, ADF and NDF content and increased lactic acid bacteria (LAB) activity. *Desmanthus* silages were able to maintain high ME and CP values similar to fresh values and comparable to Lucerne (*Medicago sativa*). It is acknowledged that the various Desmanthus cultivars were grown at different sites and were harvested at slightly different stages of growth. Repeating the trial at one site and one stage of growth would be preferable.

## Conclusion

While wet chemistry is needed to verify our results, we believe that the nutritive value of Desmanthus silage is comparable to Lucerne silage based on its contents of CP and ME, particularly for cv JCU 9, and that it can be made into silage of acceptable quality and palatability. As Northern Australian beef cattle farmers continue to look for management options to close the dry season feed gap and add value to their livestock, the use of the high biomass/quality tropical legumes described here as silage is promising.

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## References

Etheridge M.O, Stockdale CR. & Cranwell PD (1993). Influence of method of conservation of lucerne on factors associated with voluntary intake in sheep. Australian Journal of Experimental Agriculture, 33(4), 417-423.

Etheridge MO, Stockdale CR Cranwell PD (1992) Effect of ensilation of lucerne on voluntary intake, digestibility, and eating and rumination behaviour in sheep. Australian Journal of Experimental Agriculture 32, 315-318.

Feedipedia (2016) Maize silage Retrieved from (https://www.feedipedia.org/node/13883)

Feedipedia (2012) Alfalfa silage retrieved from (https://www.feedipedia.org/node/11746)

Gardiner CP (2016). Developing and commercializing new pasture legumes for clay soils in the semiarid rangelands of northern Australia. *In*: Lazier, J.R. and Ahmad, N. (eds.). Tropical Forage Legumes. CABI 2016.

Kung Jr.L, Shaver RD, Grant RJ & Schmidt RJ. (2018). Silage review: Interpretation of chemical, microbial, and organoleptic components of silages. Journal of dairy Science, 101(5), 4020-4033.

Stockdale CR (1995) Maize silage as a supplement for pasture-fed dairy cows in early and late lactation. Australian Journal of Experimental Agriculture 35, 19-26.

Stockdale CR & Beavis GW. (1994). Nutritional evaluation of whole plant maize ensiled at three chop lengths and fed to lactating dairy cows. Australian Journal of Experimental Agriculture, 34(6), 709-716.