Carbohydrate Research, 27 (1973) 1–4

DIGESTION OF POLYSACCHARIDE CONSTITUENTS OF TROPICAL PASTURE HERBAGE IN THE BOVINE RUMEN

PART II. SPEAR GRASS (*Heteropogon contortus*)

R. F. H. DEKKER AND G. N. RICHARDS*

Department of Chemistry, James Cook University of North Queensland, Townsville (Australia)

(Received May 31st, 1972; accepted for publication, September 18th, 1972)

ABSTRACT

The digestion of the polysaccharide constituents of spear grass (*Heteropogon contortus*), namely hemicelluloses and cellulose, has been studied by enclosing samples in Terylene bags in the bovine rumen. Hemicelluloses (measured by total xylose content) and cellulose were digested slowly and incompletely (~30% and ~50%, respectively). The arabinose component of the hemicelluloses was digested slowly, but more extensively than the xylose component (*e.g.*, 45% and 30%, respectively). The resistance of these polysaccharides to complete digestion in the rumen appears to be due to physical protection by lignin.

INTRODUCTION

In Part I of this series[1], the relative rates and extents of digestion in the bovine rumen of the polysaccharide constituents of the tropical legume Townsville Stylo (*Stylosanthes humilis*) were reported. We have now extended this analysis to a tropical pasture grass, spear grass (*Heteropogon contortus*), which is the major, native pasture-grass in the beef-cattle region of tropical North Queensland.

The major polysaccharide constituents of spear grass have been shown[2] to be hemicelluloses and cellulose. The hemicelluloses are mainly arabino-4-*O*-methylglucuronoxylans[3], and both types of polysaccharide constituent were measured unequivocally by g.l.c. of the derived alditol acetates after hydrolysis[1]. The presence of (1→3)-glucans has not been sought systematically, but their occurrence in the leaf of a grass would be unusual.

EXPERIMENTAL

Animals, feeds, and feeding conditions. — Two rumen-fistulated steers (Droughtmaster breed) were housed in roofed pens and were fed once daily 4 kg of dry matter per animal, with a mixture of native pasture grasses containing at least 75% of spear grass (*Heteropogon contortus*) at the vegetative stage of growth. The spear grass when

*To whom communications should be addressed.

harvested was stored at −5°, and allowed to thaw prior to feeding. The animals were pre-conditioned on this ration for 4 days prior to the digestion experiment.

Digestion experiments. — Pure samples of spear grass at the vegetative stage of re-growth were harvested at 2.0 p.m. on February 11th, 1971, and preserved by freeze-drying. The freeze-dried preparation was utilised in the digestion experiments by enclosing ground samples (1 mm) in Terylene bags within the rumen as described earlier[4].

Analytical procedures. — The drying of samples, the determination of starch[5] and lignin, and the compositional analysis of total polysaccharides have been described in Part I of this series[1].

RESULTS AND DISCUSSION

The contents of each type of polysaccharide in the freeze-dried preparation of vegetative spear-grass are shown in Table I. Starch was present in small, but significant, amounts and some starch granules were lost from the forage on washing with water. Since we have previously shown that the starch in Townsville Stylo is rapidly and almost completely digested in the rumen, the digestion of the spear-grass starch was not studied. Pectic substances were not present in more than trace amounts (*cf.* ref. 2) and were not measured in the digestion experiments.

TABLE I

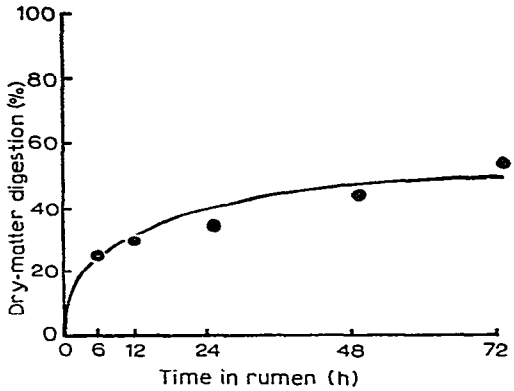
SUGAR RESIDUES IN POLYSACCHARIDES OF SPEAR GRASS (*Heteropogon contortus*)

Polysaccharide constituent[a]	*Content (% dry matter)*	*Polysaccharide constituent*[a]	*Content (% dry matter)*
Starch	0.47[b]	Mannose	trace
	0.26[c]	Cellulose[d]	31.7
Rhamnose	trace	Crude lignin	23.1
Arabinose	3.1	Lignin	16.2[e]
Xylose	12.3		
Galactose	trace		

[a]As "anhydro-glycose". [b]Unwashed forage sample. [c]Water-washed sample. [d]From glucose content, less starch. [e]Lignin corrected for ash and protein (%N × 6.25).

The rate of digestion of the spear grass on a dry-matter, weight-loss (DMD) basis is shown in Fig. 1, which shows that spear grass is poorly digested in the rumen (~50% after 73.5 h in the rumen), when compared with other tropical pasture herbages, *e.g.*, Townsville Stylo (*Stylosanthes humilis*)[1].

Digestion of pentoses is shown in Fig. 2. These results are rather different from those obtained previously in digestion of the legume Townsville Stylo[1], where 80% of the total arabinose and ~40% of the total xylose were digested within 2 days. The lower values for spear grass in this work (~45% and ~30%, respectively) are



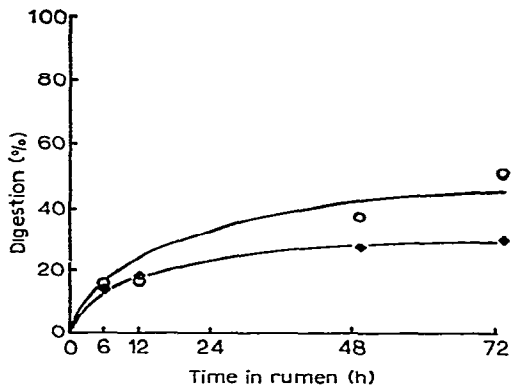


Fig. 1. Dry-matter digestibility of spear grass.

Fig. 2. Digestion of major hemicellulose constituents. ○, Arabinose; ◆, xylose.

probably associated with the virtual absence of pectic substances in the grass. The legume contained large amounts of pectic substances which were extensively digested (~80% in 2 days)[1]. The arabinose is present in both pectic substances and hemicelluloses, and the high value for arabinose digestion in the legume results mainly from the extensive digestion of these pectic substances. We may conclude, therefore, that the spear-grass values of 45% and 30% digestion of arabinose and xylose also approximate to the true values for digestion of the hemicellulose components in Townsville Stylo.

The digestion of cellulose is shown in Fig. 3, and these results are quite similar to those found for Townsville Stylo[1]. We conclude, therefore, that both cellulose and hemicelluloses are about equally and incompletely digested in both spear grass and Townsville Stylo. The content and apparent digestion of lignin are also similar in both forages, although we have concluded earlier[1] that these values for lignin may be misleadingly high because of mechanical losses of solid particles from the Terylene bag.

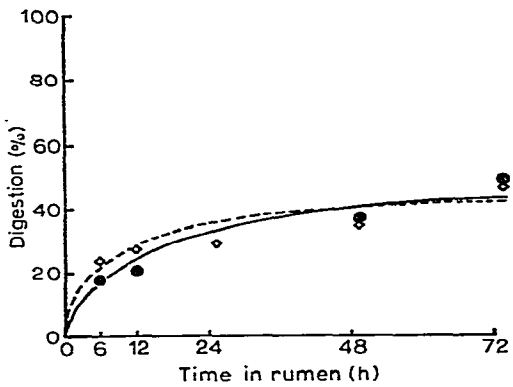


Fig. 3. Digestion of cellulose and apparent digestion of lignin. ●, Cellulose; ◊, lignin.

The major factor in restricting the digestion of hemicelluloses and cellulose in spear grass is probably physical protection by lignin in the cell wall[6], and we have recently confirmed with other forages[7] that progressive removal of lignin leads to an increase in the extent of digestion of both types of polysaccharide. However, spear grass is a relatively poor forage, compared with Townsville Stylo, not because of any significant difference in lignin content, but because it is relatively deficient in readily accessible nutrients such as protein, pectic substances, and starch. As a result, the content of hemicelluloses and cellulose is higher and the DMD is lower because these components are only partly digested.

ACKNOWLEDGMENTS

This work was supported by the Rural Credits Development Fund of the Reserve Bank of Australia. The authors thank C.S.I.R.O. Division of Tropical Pastures, Pastoral Research Laboratory, Townsville, for arranging access to fistulated cattle, and animal facilities.

REFERENCES

1 R. F. H. DEKKER, M. J. PLAYNE, AND G. N. RICHARDS, *Carbohyd. Res.*, 22 (1972) 173.
2 J. D. BLAKE AND G. N. RICHARDS, *Aust. J. Chem.*, 23 (1970) 2353.
3 J. D. BLAKE AND G. N. RICHARDS, *Aust. J. Chem.*, 23 (1970) 2361.
4 M. J. PLAYNE, M. N. MCLEOD, AND R. F. H. DEKKER, *J. Sci. Food Agr.*, 23 (1972) 925.
5 R. F. H. DEKKER AND G. N. RICHARDS, *J. Sci. Food Agr.*, 22 (1971) 441.
6 *E.g.*, R. W. BAILEY AND J. C. MACRAE, *J. Agr. Sci.*, 75 (1970) 321, and references therein.
7 R. F. H. DEKKER AND G. N. RICHARDS, *J. Sci. Food Agr.*, 24 (1973) in press.