Digestibility and Structural Components of Some Tropical Grasses

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As tropical grasses are recognized to compensate the decreased production of temperate grasses in the summer season by their high level of dry matter yield in warm areas of Japan, the cultivation of them is spreading gradually. However, together with the various problems related to the cultivation practice, some problems involved in the utilization of them for animal feeding have been realized; One of the problems is that the digestibility of tropical grasses is considerably low in general and, as a consequence, the intake of them is often limited. To promote the utilization of tropical grasses, investigations to improve the nutritive vlaue and to find out suitable practices of utilization are required.

In the present paper the levels of digestibility and the contents of structural components which relate to digestibility of several tropical grasses introduced into Japan are reviewed, and some environmental and managemental factors which relate to or have effects on digestibility are discussed.

Levels of the digestibility and the contents of structural components

According to the data obtained in Fukuoka[1], Nagasaki[2] and Okayama[3] Prefectures, and to some unpublished data, the levels of the digestibility and the contents of structural components of two typical tropical grasses are as follows; with green panic (*Panicum maximum* var. *trichoglume*) digestibility ranges 38–70%, crude fiber 27–39%, CWC 56–78% and lignin 3–10%. With rhodesgrass (*Chloris gayana* Kunth) digestibility ranges 32–75%, crude fiber 25–36%, ADF 34–37% and lignin 12–13%. The digestibility of green panic and rhodesgrass grown in Australia was reported to be in the range of 49–64%[4] and 50–66%[5], respectively. This comparison suggests that the range of digestibility of both grasses is wider in Japan than in Australia. This wider range found in Japan is likely to be attributable to the fact that the first growth has rather higher digestibility but the regrowth harvested at about booting or heading stage shows sometimes considerably lower values. This may be related to the characteristic seasonal changes especially in atmospheric temperature in Japan; A rapid rise from late spring to summer and very high temperature in hot summer.

More works are needed in Japan to examine precisely this conception because the cultivation or digestion test methods are often different from those in Australia. But it is sure that the environmental conditions in Japan exert characteristic influences on the digestibility of tropical grasses.

Relations between digestibility and structural components

The contents of structural components, such as crude fiber, CWC, ADF, lignin and silica, are considered to have close relations to digestibility. The correlation between lignin and digestibility is not significant in some cases. As the distribution pattern of lignin in the tissues of plants differs among species, lignin contents in grasses showing the same digesti-

bility are not necessarily at the similar levels.

It may be said that the contents of crude fiber, CWC and ADF are good indicators in comparing digestibility among species, but lignin must be considered as a factor which cause a decline in digestibility with the advance of growth within a species.

Anatomical characters and digestibility

Anatomical characters of leaves of tropical grasses in comparison to temperate grasses are summarized as follows, according to the results of Sakurai[6] and Chonan[7]; 1) The parenchymal bundle sheaths occupy larger parts in tropical grasses than in temperate ones. 2) Tropical grasses have a larger total vascular tissue area. 3) The number of vascular bundles per leaf is larger in tropical species. 4) Tropical grasses have smaller mesophyll cells in size. 5) The total area occupied by mesophyll cells is smaller in tropical species.

Akin and Berdick[8] grouped the tissues into three categories according to the easiness of degradation by rumen microorganisms; 1) rapidly degraded (mesophyll and phloem) 2) slowly degraded (epidermis and parenchymal bundle sheath) 3) non-degraded (sclerenchyma and lignified vascular tissue).

In conclusion, tropical grasses generally have less amount of easily digestible tissues and more amount of slowly and non-digestible tissues than temperate grasses.

Effect of stage and age

With the advance of growth stage, the digestibility of tropical grasses decreases as well known in case of temperate grasses, but the rate of decline is more rapid. Though the digestibility at an early vegetative stage is as high as temperate species, it starts to drop at a rapid rate with the internodal culm elongation. This decline was studied in relation to its ontogenetical development or morphological characters. The proportion in weight to the whole plant of stem which is less digestible than leaves showed a rapid increase with the growth. The study on the tillering habits of buffelgrass[9] (*Cenchrus ciliaris* L.) is shown in Figs. 1 and 2. Tillers of an individual plant started to elongate almost simultaneously and by the heading stage the weight of culms had occupied about 50% of the whole plant weight. The digestibility of the culms was the lowest among different plant portions and declined at a rapid rate.

From these results, the increase in stem

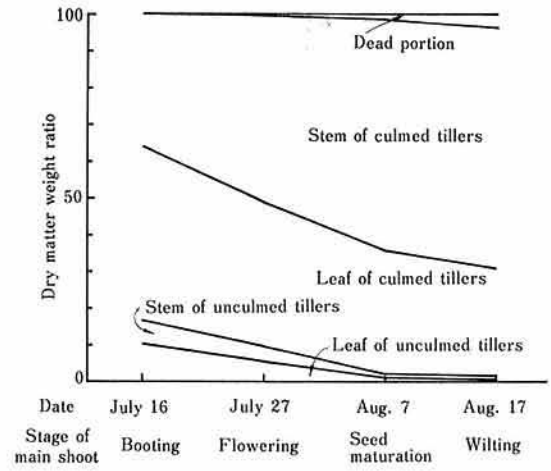

Fig. 1. Change of relative dry matter weight of plant portions with growth stage of buffelgrass (*Cenchrus ciliaris* L.).

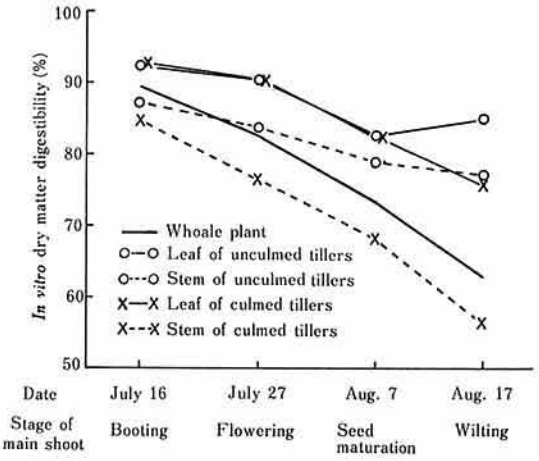

Fig. 2. *In vitro* dry matter digestibility of plant portions and whole plant of buffelgrass.

weight proportion and the rapid decline of its digestibility can be taken as the major factors causing the change of the whole plant digestibility. The change of digestibility of stems depends upon the chnage in the proportion of its constituent tissues, and the change of the digestibility of each tissue. It was shown that the weight proportion of the epidermis, the lignified parenchyma and the vascular bundles increased with the advance of growth.

Temperature effect

Environmental temperature has been reported to have pronounced effects on the contents of structural components and digestibility. A significant positive correlation coefficient was found between crude fiber content and the mean growth temperature[10]. Some works were done to show the cause of its adverse effect on digestibility. Increase in temperature may stimulate lignification directly[6]. But it is more likely in practice that the effect is caused indirectly through the temperature effects on the growth process; A higher temperature usually accelerates the rates of leaf appearance and senescence, stimulates the true stem formation, and depresses the formation of new tillers, resulting in the more rapid aging. All these phenomena produce a plant of lower digestibility; The digestibility of an individual leaf decreases at a rapid rate, culm elongation has a crucial negative effect on digestibility, and plants are lacking of young and leafy tillers.

Tropical grasses which grow under the increasing temperature and are harvested in summer, may be concluded to have inevitably lower digestibility.

Precipitation effect

Crucial water deficit was shown to have a negative effect on digestibility, but under normal field conditions no significant correlation was found between crude fiber content and the total precipitation[10].

Time of sowing

As temperature has such a pronounced effect on digestibility, the choice of sowing time is a possible practice to obtain a harvest of better nutritive value. The result of a pot experiment with colored guineagrass (*Panicum coloratum* L. cv. Solai) grown untill the 9th leaf stage, shown in Table 1, revealed that the plants sown in May attained the highest yield and digestibility. The plants sown in April had lower digestibility than the

Table 1. Effects of time of sowing on growth and *in vitro* dry matter digestibility of colored guineagrass (*Panicum coloratum* L. cv. Solai) harvested at the 9th leaf stage

Items	Plant sown on April 26	Plant sown on May 16	Plant sown on June 5
Growth period (days)[1]	45	39	38
Plant height (cm)	39	49	54
Number of tillers per pot[2]	25.2	25.9	12.4
Plant weight (g/pot)			
Main shoot	1.4	1.5	1.9
Tillers	2.4	3.0	1.6
Whole plant	3.8	4.5	3.5
Digestibility (%)			
Main shoot	85	86	76
Tillers	82	85	78
Whole plant	83	85	77

1) Number of days after germination
2) Three plants were grown in a pot

plants sown in May, though the mean growth temperature was the lowest. This may be caused by the aging effect resulted from the extended growth period to reach the cutting stage. The plants sown in June which grew under the highest mean temperature resulted the lowest digestibility. In order to obtain harvests of better quality, it is necessary to confirm this result under field conditions.

Cutting time and frequency

Though it is possible to overcome the adverse effect of the aging by applying short cutting intervals, tropical species to be used for hay, silage or green fodder, are usually harvested in practice at an advanced stage of growth with an aim of obtaining the maximum digestible dry matter yield in a season. Studies are needed with respective species to find out the stages or intervals of cutting which give harvests of not so low digestibility and which ensure good regrowths to attain the highest total digestible dry matter yield.

Fertilization

Nitrogen application is another cultural practice which has been tried to improve the nutritive value of tropical grasses. But most of the published data[2,3,10] show that normal level of N application does not generally influence the content of crude fiber, ADF and lignin, and digestibility, though higher application was observed to have a negative effect on crude fiber content with dallisgrass (*Paspalum dilatatum* Poir.) and 2nd cutting of rhodesgrass, and a positive effect on the digestibility of young bahiagrass (*Paspalum notatum* Flügge).

Conclusion

In this paper, some factors influencing the digestibility of tropical grasses are discussed briefly. More detailed work will make it possible to quantitfy the degree of combined effects of these factors. And studies on effects of crop management on digestibility will offer a means to harvest grasses of better quality. Furthermore, it is hoped that these studies will supply useful information for breeding programs to improve the nutritive value of tropical grasses.

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