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# EFFECTS OF BIODEGRADED WOOD ON RUMEN PERFORMANCE OF THE WEST AFRICAN DWARF GOAT

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Target Audience: Animal Scientists, policy makers, farmers.

## ABSTRACT

**Biodegraded wood was processed into fine particles and part of it pasteurised by heating. The pasteurised and unpasteurised samples were then subjected to rumen degradation using the nylon bag technique, so as to investigate their effects on dry matter degradability and rumen microflora, as well as the extent to which they would be utilized by rumen microorganisms.**

**The effect on dry matter degradability was found to be on an interaction between the level of inclusion of the biodegraded wood samples in the diet, whether the wood was pasteurised or not. An antagonistic effect was observed between the microflora found in the unpasteurised wood and those in the rumen. The effective in- sacco degradability of pasteurised and unpasteurised wood samples were 73.55% and 29.95%, respectively.**

**The study has thus shown that properly processed wood could be useful in ruminant nutrition .**

**Key words**: Biodegraded wood; rumen degradation; goat.

## DESCRIPTION OF PROBLEM

Wood, which is a hard fibrous substance in the trunk and branches of trees encloses a large amount of energy which however is only partially available to ruminants. This is because wood is highly lignified and, according to Chesson and Forsberry (1) lignification of the fine structure of polysacharides including the crystalinity of cellulose of plant cell wall are limiting factors to the degradation of plant cell wall in the rumen. Naga and El shazly (2) pointed out that one of the ways of improving the nutritive value of a feedstuff is by solubilizing or cracking the lignin layer coating the cell so as to enable enzymes of microbes of gastrointestinal tract to digest the cell content. According to Hartley and Jones (3), alkali treatment causes the dissociation of the lignin-carbohydrate complex present in plant cell wall. Chaudhury and Miller (4) found sodium hydroxide to be effective in modifying cell wall structure and thus improving the digestibility of straw by ruminants. Tien and Kirk (5) on the other hand discovered lignase in the extracellular fluid of the fungus, *Phanerochaete chrysoporium,* and found it capable of cleaving lignin as well

as synthetic polymers resembling lignin . By attempting to use this enzyme so as to improve barley straw Khazaal *et al.* (6) came to the conclusion that straw contains substances which are capable of inactivating lignase. In this context Morrison (7) suspected these to be phenolic in nature. Another way of disrupting the cell wall structure of plants is through the biologica l process of decay (8) Abdullah *et al.* (9) have shown some wood decaying edible fungi to be able to break down lignin and, in the process, improve the rumen degradability of the substrate. The cultivation of such fungi on sawdust among other substrates has already been outlined (10). Since lignin is the major limitation to the ruminal degradation of wood. It becomes logical to believe that its removal from wood should be able to improve on the utilization of such a wood by ruminants. Zafar *et al.* (8) obtained a degradability of 28% from naturally decayed wood. However , this appears to be lower than should be expected. This paper is therefore intended to highlight on some factors which could improve the reticulorumen degradability of biodegraded wood, as well as the effect of such a wood on dry matter degradation.

## MATERIALS AND METHODS

### Sample collection and preparation

A naturally decaying log of softwood was collected from the Forestry Research Institute of Nigeria , Ibadan, and the decayed portions scraped into fine particles. A portion of the scraped particles was pasteurised by heating at 80°C for two hours as already recommended (11). This was done by allowing the wood sample to boil in water and then transferring these into a Thermos flask to maintain the temperature. Water was them squeezed out of the wood with the help of a press and drying was enhanced by heating.

### The experimental animals

Two matured West African dwarf goats with stable ruminal cannulae of about 5 years of age were used for the experiment.The goats were housed in individual pens on wood shavings as bedding and were fed fresh Guinea grass and *Leucaena leucocephala ad libitum* supplemented with wheat bran. They had access to fresh clean, water salt lick and exercise. The area around the cannulae was cleaned after the withdrawal of samples from the rumen and was also disinfected weekly. The animals were sprayed weekly and dewormed once in two weeks.

These animal were under the experiment within the period of February and May, 1999 and the experiment was carried out at the International Livestock Research Institute situated within the International Institute of Tropical Agriculture in Akinyele Local Government Area, Ibadan , Oyo State, Nigeria (7°30'N, 30°54'E) .

## The experimental diets

Both the pasteurised and unpasteurised wood samples included into compounded diets at the rates of 0, 10, 20 and 30 % as shown in Table 1. The diets were then subjected to 48 h in-sacco degradation while the pure samples of both the pasteurised and unpasteurised wood samples were subjected to 96 h degradation as outlined by Bharsava and Ørskov (12) These were incubated in the rumen such that each animal carried all sample being compared at any point in time, the process being repeated so as to yield a total of four readings for each diet.

Table 1: Composition of the experimental feeds (kg).

| Ingredients | Diet I | Diet II | Diet II | Diet IV |
|---|---|---|---|---|
| Groundnut Cake | 20 | 20 | 20 | 20 |
| Palm Kernel Cake | 19 | 19 | 19 | 19 |
| Brewers Dried Grain | 20 | 20 | 20 | 20 |
| Wheat Bran | 10 | 10 | 10 | 10 |
| Rice Bran | 30 | 20 | 10 | 0.0 |
| Biodegraded Wood | 0 | 10 | 20 | 30 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 |
| Bone Meal | 0.50 | 0.50 | 0.50 | 0.50 |
| Mineral Vitamin Mix | 0.25 | 0.25 | 0.25 | 0.25 |
| TOTAL | 100 | 100 | 100 | 100 |

*Diets II, III, and IV were each replicated as to yield a diets with pasteurised wood and another with unpasteurised wood giving a total of seven diets.

## Analysis of materials

Dry matter degradability was determined by measuring the weight loss from the nylon bags suspended within the rumen for a predetermined length of time (48 h for the diets and 96 h for pure samples). The potential degradability of dry matter was calculated using the non linear model according to Ørskov and MacDonald (13) in which $p = a + b\,(1-e^{ct})$ where

| | | |
|---|---|---|
| p | = | degradation after time "t" |
| a | = | water solube dry matter fraction of feed |
| b | = | insolube but fermentable dry matter fraction of feed |
| c | = | rate constant of degradation of the b fraction |
| t | = | time of degradation |
| a + b | = | the potential extent of degradation |

**Statistical analysis**

All results were subjected to analysis of variance according to Steel and Torrie (14).

## RESULTS

No definite pattern was observed on the degradation of the various diets. The diets with 10, 20 and 30% pasteurised wood samples had degradability of 53.18, 58.11 and 58.37 % while those with unpasteurised samples had 56.56, 54.59 and 54.42%, respectively (Table 2).

**Table 2: Dry matter Degradability of Feeds**

| | | Wood in the Diet (%) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 10 | | 20 | | 30 | | |
| Animals | Replicate | P* | UP** | P* | UP** | P* | UP** | 0 |
| | 1st | 53.90 | 56.28 | 55.56 | 50.57 | 57.42 | 53.74 | 62.86 |
| Goat I | 2nd | 52.88 | 57.77 | 58.04 | 53.75 | 59.99 | 54.30 | 61.36 |
| | 1st | 52.18 | 56.97 | 58.43 | 54.30 | 58.37 | 55.17 | 60.24 |
| Goat II | 2nd | 53.74 | 55.22 | 60.41 | 59.74 | 57.69 | 54.46 | 63.15 |
| Means | | $53.18^{b}$ | $56.56^{ab}$ | $58.11^{ab}$ | $54.59^{b}$ | $58.37^{ab}$ | $54.42^{b}$ | $61.90^{a}$ |

a,b: Values along the horizontal column bearing different Superscripts differ significantly ($P<0.05$).

*P: Pasteurised Wood Samples

**UP: Unpasteurised Wood Samples.

The control diet (0% wood) was 61.90 % degradable (Table 2) and was statistically different from the diets with 20 and 30 % unpasteurised wood and 10 % pasteurised wood samples ($P<0.05$). All other diets did not differ statistically.

The rumen degradation characteristics of the pure wood samples over 96 hours (Table 3) showed that the dry matter degradability of the pasteurised wood sample (73.55 % ) was significantly different ($P<0.05$) from that of the unpasteurised sample (29.95%). Potentially, the degradability of both samples were 87.85 and 44.37% respectively and these were highly statistically different ($P<0.01$). The degradation rate of both samples, 6.20 g/kgh and 13.70 g/kgh for the pasteurised and unpasteurised samples, were also highly significantly different ($P<0.01$).

**Table 3: 96 hours Degradation Characteristics of Biodegraded Wood**

| Wood samples | Degradation Characteristics | | | | |
|---|---|---|---|---|---|
| | a | b | a+b | C g/kg | LAGTIME |
| Pasteurised Wood Samples | 14.30 | 73.55[d] | 87.85[d] | 6.20[d] | 1.75 |
| Unpasteurised Wood Samples | 14.42 | 29.95[e] | 44.37[e] | 13.70[e] | 1.10 |

a: Water solube dry matter fraction of feed

b: Insolube but fermentable dry matter fraction of feed

c: Rate constant of the degradation of the "b" fraction

a+b: Potential dry matter degradability of feed

d, e: Values in any vertical column with different superscripts differ significantly ($P<0.01$)

## DISCUSSION

The high lignin content of wood has for long discouraged investigation on its availability to ruminants. These results however showed that, if appropriately treated, wood could be a major feeding stuff for ruminants. The effective degradability of pastuerised wood samples together with the relative performance of the diets with 20 and 30 % pasteurised wood strongly reveal that rumen microbes can utilise the polysaccharide units of wood if subjected to biodegration which will make the nutrients in wood more accesible to the polysaccharidases of the rumen microbes. The results therefore are in support of the conclusions of earlier workers (2,3,4) that pre treatment of fibrous feeds makes the feedstuff available to enzyme activity so as to enhance its availability.

Pasteurisation had effectively destroyed the wood microflora such that only the rumen microbes could have been responsible for the degradation of the pasteurised samples. They however needed to adjust themselves to this new feedstuff as revealed by the longer lag time for pasteurised samples, as well as its slower degradation rate (Table 3). The fact that pasteurised wood, which is less accesible and slower to degrade, had a higher effective degradability than the unpasteurised sample suggests that the latter still possesed some form of limitation (6) which can be over come through pasteurisation. This limitation could either be the presence of toxins which could have been washed away during pasteurisation, or the presence of microorganisms in biodegraded wood which posses the ability to antagonize the rumen microbes. The second alternative seems to be more correct because, if the limitation was due to toxins in the wood, then the pasteurised wood would have had a shorter lag time and a higher degradation rate since its toxins would have been washed away.

An antagonism between wood and rumen microflora is probably the major factor limiting the utilization of unpasteurised wood samples. When comparing diets with 20 and 30 % biodegraded wood samples, it can be observed that the pasteurised samples performed better than the unpasteurised

time lag in Table 3 were readily accessible to microbes and were degraded faster. This shorter lag time and higher rate of degradation could best be ascribed to the presence of viable microorganisms in unpasteurised wood which were readily active in the rumen, thus continuing their degradative activites on the wood. Being adapted to wood polysaccharides, these microbes could rapidly act on the wood samples so as to enhance their degradation such that both wood and rumen microorganisms had to interact for the utilization of the substrate. According to Nisbet and Martin (15) such interaction of microorganisms has the ability to stimulate lactate utilization. The flattening of the degradation curve of unpasteurised wood sample (Fig 1) indicates that the ability of both microflora to co-habitate and utilise wood polysaccharides tend to reduce over time, thus strongly indicating an antagonism between them.

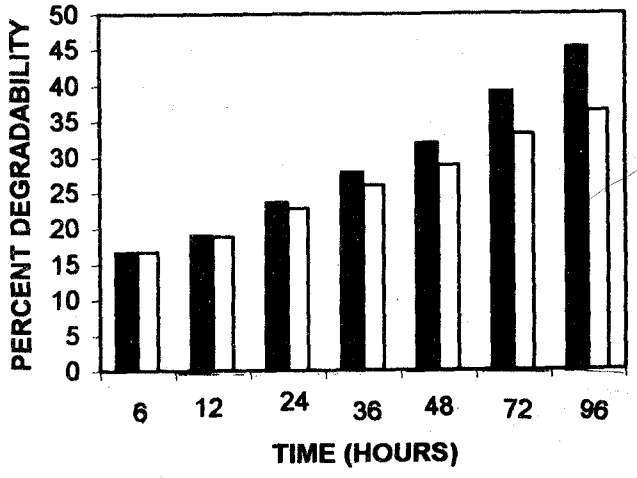


Fig. 1. Degradability of pasteurised (black columns) and unpasteurised (white columns) wood samples in 96 hours.

Fig. 1. Degradabilityof pasteurised (black columns) and unpasteurised (white columns) wood samples in 96 hours.

The diet with 10% unpasteurised wood appeared to perform better than 20 and 30 % unpasteurised wood probably because the proportion of wood sample was low. The major difference between the performance of the pasteurised and unpasteurised wood samples could therefore be attributed to the presence of viable microorganisms in the unpasteurised wood samples which antagonise those in the rumen (8,16,17). A small amount of these wood particles are "diluted" in the diet as this seems to be an important factor in the utilization of wood by rumen microbes. By comparing the degradability of all samples, it becomes obvious that the utilization of biograded wood is

based on an interaction between the level at which it is included in the diet, whether it is pasteurised or not. The need to pasteurised the biograded wood is also largely important, as this will permit a higher inclusion of the processed wood in the diet. This work has also stressed on the need to ensure when compounding feeds for ruminants, that the minimum level of inclusion of any fiber type should be large enough to stimulate rumen microbes to degrade it as "dilution" of fiber types tends to limit their utilization.

## CONCLUSION

The results presented in this work have shown, that when adequately processed, wood could be one of the major feed resources for ruminants. It is now left to researhers to see how this potential can be packaged for proper routine utilization.

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