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Assessing the feeding value of pea straw and evaluating biological methods to improve its utilisation by ruminants

by

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Dedication

Dedicated to the family of **MOHAMED SAID**

May this work serve as an inspiration to
them

ABSTRACT

Although crop residues have been acknowledged as potential feed for ruminants, there is still limited information available on the feeding value of some crop residues. For example, the use of diets based on legume crop residues has received little attention compared to their cereal counterpart. Globally, it is apparent that the production of legumes is increasing every year, indicating that research should be directed towards improving utilisation of fibrous crop residues of legume origin as livestock feed. This study provides information on the significance of pea straw as a ruminant feed and the potential of two biological techniques for improving its feeding value.

Experiment One

In a preliminary study for this thesis, feed values for four cereal stubbles (triticale, wheat, oat and barley) and pea stubble were ranked, based on chemical analysis, to assess their potential nutritional benefit for ruminants. Pea stubble contained significantly higher levels of ADF and ADL than any of the cereal feeds analysed. However, the higher level of N observed in pea stubble in this research, ~~and similar levels in previous studies,~~ suggest that when supplemented with energy (and if its digestiblity ~~was~~ could be improved), pea stubble could be utilised as a valuable component of feed for ruminants.

Experiment Two

An experiment was conducted to study the effect on nutrient (DM, OM, N, ADF and energy) digestibility and nitrogen balance in sheep of replacing proportions of lucerne hay in the diet with different levels of pea straw. A diet containing an intermediate level of pea straw (a proportion of 40:30 pea straw:lucerne hay) had a nitrogen balance that was similar to (expressed in g/d) and even significantly higher (in g/kg N intake) than that obtained with

low levels of pea straw (25:45 pea straw:lucerne hay). The diet containing a high level of pea straw (55:15 pea straw:lucerne hay) had the lowest nitrogen balance, but it was still positive. Hence, pea straw can be substituted for lucerne hay to the extent of 30% without serious detriment.

Experiment Three (A)

A study on improving the utilisation of low quality roughages was based on assessment of two biological methods using pea straw as the basal subtrate: addition of dried yeast culture; and cultivation of mushroom on the straw for subsequent utilisation of the spent straw. Several trials were conducted to evaluate the effect of addition of yeast culture (*Saccharomyces cerevisiae*) on a number of rumen fermentation parameters in sheep fed a diet based on pea straw sourced from South Australia. A nutrient digestibility study conducted with Australian Merino wethers showed a significant increase in *in vivo* digestibility of ADF. Although non significant, *in vivo* digestibility of N, OM and energy appeared to be improved. *In vitro* OM digestibility of the same diet, and particularly the pea straw component containing yeast culture, showed a significant increase. In another trial, it was found that *in vitro* DM digestibility of pea straw with added yeast culture tended to be improved at all levels of urea compared to those containing no yeast. This suggests that dietary composition factors such as nitrogen level could influence the mode of action of yeast culture.

Experiment Three (B)

Since there are differences in the chemical composition and nutritive value of straws and other fodders from one region to another, a third trial was conducted in Ethiopia to investigate the effect of addition of yeast culture to pea straw grown under tropical

conditions. This was aimed to complement the studies conducted in South Australia. Results from this experiment showed that *in sacco* DM degradability of pea straw containing yeast culture appeared to be improved, probably because of a reduced lag time for the initiation of fibre digestion observed during the study. Pea straw sourced from Ethiopia contained higher ADF and ADL levels than that sourced from South Australia (67 % vs 56.5 % and 13 % vs 9.6 %). Although a similar proportion of pea straw (55%) to lucerne hay (15%) to oaten grain (30%) was used to compose the diet, the Ethiopian and the South Australian diets contained 1.2 and 1.57 % N respectively. Although no significant improvement in the digestibility of nutrients of a pea straw-based diet with yeast culture was observed, it is likely that this reflects the poorer quality of the pea straw sourced from Ethiopia than that from South Australia (Experiment 3a). Hence, nutritional responses from the addition of yeast culture in improving roughage utilisation would depend greatly on the physical and chemical nature of such feeds.

Experiment Four

The second biological technique evaluated in this research was treatment of the roughage prior to feeding. Although the cultivation of mushrooms on straw-based substrates is an old agricultural practice, subsequent use of the degraded straw for livestock feed could be an innovative development. The study conducted was aimed at assessing the effects of the basidiomycetes (*Pleurotus cornucopiae*) on pea straw through measurement of chemical composition and *in vitro* DM digestibility (DMD). Pea straw was inoculated with spawns of *Pleurotus cornucopiae* for 60 days. *In vitro* DMD of the pea straw was enhanced due to degradation by *P. cornucopiae* which seems to result from changes in chemical composition, especially a reduction in the fibre fractions (neutral and acid detergent fibres) and an increase in N content.

Declaration

This work contains no experimental material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

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Abbreviations

1. Nutritional terms

ADF	acid detergent fibre
NDF	neutral detergent fibre
ADL	acid detergent lignin
NDF-N	nitrogen bound to neutral detergent fibre
DM	dry matter
OM	organic matter
in vitro	in glass
in vivo	in animal
in sacco	in bag
IVDMD	*in vitro* dry matter digestibility
IVOMD	*in vitro* organic matter digestibility
PD	potential disappearance of DM
W	body weight
LW	live weight
$W^{0.75}$	metabolic body weight
CWC	cell-wall constituents
VFA	volatile fatty acid
NPN	non-protein nitrogen
RDP	rumen degradable protein
GE	gross energy
DE	digestible energy
ME	metabolisable energy
N	nitrogen
P	phosphorus
S	sulphur
NH_3-N	ammonia-nitrogen

2. Others

ANOVA	analysis of variance
°C	degrees centigrade
h	head
d	day
g	grams
kg	kilograms
MJ	mega joule
s.d	standard deviation
SEM	standard error of means
s.e.d	standard error of difference of means

3. Organisations or institutions

FAO	Food and Agriculture Organisation of the United Nations
ILCA	International Livestock Centre for Africa