



**THE UNIVERSITY OF ADELAIDE**

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

by

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<b>TABLE OF CONTENTS</b>	<b>PAGE</b>
Abstract.....	i
Declaration.....	iv
Acknowledgment.....	v
Abbreviations.....	vi
<b>CHAPTER 1: GENERAL INTRODUCTION.....</b>	<b>2</b>
<b>CHAPTER 2: LITERATURE REVIEW.....</b>	<b>5</b>
<b>2.1 INTRODUCTION.....</b>	<b>5</b>
<b>2.2 LOW QUALITY ROUGHAGES.....</b>	<b>6</b>
2.2.1 Availability of low quality roughages.....	6
2.2.2 General characteristics and nutritive potential of crop residues.....	7
2.2.3 Factors affecting straw quality.....	8
2.2.3.1 Genotype.....	8
2.2.3.2 Environment and management.....	11
2.2.4 Comparison of legume with cereal crop residues.....	13
2.2.5 Agronomic and nutritional evaluation of peas and pea straw.....	15
2.2.5.1 Peas - their importance.....	15
2.2.5.2 Pea straw.....	16
<b>2.3 THE RUMINANT ANIMAL.....</b>	<b>17</b>
2.3.1 Nutritional requirements.....	17
2.3.2 Factors influencing nutrient requirement for ruminants.....	19
2.3.2.1 Physiological state.....	19
2.3.2.2 Species of ruminant.....	20
2.3.3 Rumen ecology.....	21
2.3.3.1 Environmental conditions.....	21
2.3.3.2 Micro-organisms involved and their interactions.....	22
2.3.3.3 Supply of microbial nutrients.....	23
2.3.3.3.1 Supply of fermentable energy and effect of pH... ..	23
2.3.3.3.2 Supply of nitrogen.....	24
2.3.3.3.3 Mineral supply.....	24
<b>2.4 UTILISATION OF FIBROUS ROUGHAGES BY RUMINANTS.....</b>	<b>25</b>
2.4.1 Introduction.....	25
2.4.2 Fibre.....	26
2.4.2.1 Categories.....	26
2.4.2.2 Correlation between fibre and digestibility/degradability...	27
2.4.2.3 Nutritional attributes.....	28
2.4.3 Factors associated with the utilisation of low-quality roughages.....	29
2.4.3.1 Rumen fermentation pattern.....	29
2.4.3.2 Influence of dietary constituents.....	30
2.4.3.2.1 Soluble carbohydrates.....	30

2.4.3.2.2	Protein levels.....	31
2.4.3.3	Nutrient balance and efficiency of utilisation.....	32
2.4.3.3.1	Availability of essential nutrients.....	33
2.4.3.3.2	Synchronisation of available nutrients.....	34
2.4.3.3.3	Efficient utilisation of low quality roughages.....	35
<b>2.5</b>	<b>THE EFFECT OF YEAST CULTURE SUPPLEMENTATION ON THE UTILISATION OF LOW QUALITY ROUGHAGES BY RUMINANTS.....</b>	<b>37</b>
2.5.1	Introduction.....	37
2.5.2	Yeast culture.....	38
2.5.2.1	Definition.....	38
2.5.2.2	Constituents.....	38
2.5.2.3	Principles underlying the mode of action of yeast culture when fed to animals.....	39
2.5.3	Aspects of manipulating ruminal fermentation patterns.....	45
2.5.4	Effect of yeast culture supplementation in livestock.....	47
2.5.4.1	Rumen microbes.....	49
2.5.4.2	Digestibility and degradability patterns.....	51
2.5.4.3	Rumen fermentation end-products.....	53
2.5.4.3.1	Rumen pH.....	53
2.5.4.3.2	Volatile fatty acid composition.....	54
2.5.4.3.3	Rumen ammonia concentration.....	55
<b>2.6</b>	<b>DEGRADATION OF AGRICULTURAL RESIDUES USING FUNGI.....</b>	<b>55</b>
2.6.1	Introduction.....	55
2.6.2	Plant cell wall in relation to biodegradability.....	56
2.6.2.1	Cell wall structure.....	56
2.6.2.2	Cell wall components.....	57
2.6.2.3	Interface between plant tissue and cellulolytic organisms.....	58
2.6.3	Lignocellulose degradation and utilisation.....	59
2.6.3.1	Microbiological technique.....	59
2.6.3.2	Production of edible fungi.....	60
2.6.3.3	Cultivation of oyster mushroom ( <i>pleurotus sp</i> ).....	61
2.6.3.4	The effect of mushroom cultivation on feeding value of straw in livestock diets.....	62
2.6.3.4.1	Nutritional attributes.....	62
2.6.3.4.2	Digestibility.....	63
<b>2.7</b>	<b>REVIEW CONCLUSION.....</b>	<b>64</b>
	<b>CHAPTER 3: SAMPLING AND CHEMICAL ANALYTICAL METHODS</b>	<b>67</b>
3.1	Animal and housing.....	67
3.2	Metabolism studies.....	67
3.2.1	Feeds and feeding.....	67
3.2.2	Sample collection.....	68
3.2.2.1	Feeds.....	68
3.2.2.2	Faeces.....	68

3.2.2.3	Urine.....	69
3.3	Chemical composition of feeds and faeces.....	69
3.4	Analytical procedures.....	69
3.4.1	Sample preparation.....	69
3.4.2	Dry matter, organic matter and Ash.....	69
3.4.3	ADF and NDF.....	70
3.4.4	ADL and cellulose.....	70
3.4.5	Hemicellulose.....	70
3.4.6	Gross energy.....	71
3.4.7	<i>In vitro</i> digestibility of DM and OM.....	71

## CHAPTER 4: EXPERIMENT ONE

### COMPARISON OF CROP RESIDUES FOR RUMINANT FEED

4.1	SUMMARY.....	73
4.2	INTRODUCTION.....	73
4.3	MATERIALS AND METHODS.....	75
4.3.1	Stubble samples.....	75
4.3.2	Chemical analysis.....	75
4.3.3	Statistical analysis.....	76
4.4	RESULTS.....	76
4.5	DISCUSSION.....	77
4.6	CONCLUSION.....	78

## CHAPTER 5: EXPERIMENT TWO

### EFFECT OF DIETS CONTAINING DIFFERENT RATIOS OF PEA STRAW:LUCERNE HAY ON NUTRIENT DIGESTIBILITIES AND NITROGEN BALANCE IN AUSTRALIAN MERINO WETHERS

5.1	SUMMARY.....	80
5.2	INTRODUCTION.....	81
5.3	MATERIALS AND METHODS.....	82
5.3.1	Animals and housing.....	82
5.3.2	Feeds and feeding management.....	83
5.3.3	Sample collection.....	84
5.3.4	Chemical analysis.....	84
5.3.5	Statistical analysis.....	85
5.4	RESULTS.....	85
5.4.1	Dietary constituents and chemical composition.....	85
5.4.2	Nutrient digestibility.....	85
5.4.3	Nitrogen balance.....	86
5.5	DISCUSSION.....	88
5.6	CONCLUSION.....	91

## CHAPTER 6: EXPERIMENT THREE

### YEAST CULTURE SUPPLEMENTATION IN SHEEP DIET BASED ON PEA STRAW

#### PART A

##### YEAST CULTURE SUPPLEMENTATION OF PEA STRAW FOR AUSTRALIAN MERINO SHEEP

6A.1	SUMMARY.....	95
6A.2	INTRODUCTION.....	96
6A.3	MATERIALS AND METHODS.....	97
6A.3.1	Trial 1.....	97
6A.3.1.1	Animal study.....	97
6A.3.1.2	Sample collection.....	99
6A.3.1.3	Chemical analysis.....	99
6A.3.1.4	Statistical analysis.....	99
6A.3.2	Trial 2 <i>In vitro</i> digestibility study.....	100
6A.3.3	Trial 3 <i>In vitro</i> digestibility study.....	100
6A.4	RESULTS.....	101
6A.4.1	Trial 1.....	101
6A.4.1.1	<i>In vivo</i> digestibility.....	101
6A.4.1.2	Nitrogen utilisation.....	102
6A.4.2	Trial 2.....	103
6A.4.3	Trial 3.....	104
6A.5	DISCUSSION.....	105
6A.6	CONCLUSION.....	107

#### PART B

##### YEAST CULTURE SUPPLEMENTATION OF TROPICAL PEA STRAW FOR ETHIOPIAN MENZ SHEEP

6B.1	SUMMARY.....	107
6B.2	INTRODUCTION.....	108
6B.3	MATERIALS AND METHODS.....	109
6B.3.1	Trial 1.....	109
6B.3.1.1	Animals, design and diet.....	109
6B.3.1.2	Experimental measurements.....	111
6B.3.1.3	Chemical analyses.....	111
6B.3.1.4	Statistical analyses.....	112
6B.3.2	Trial 2.....	112
6B.3.2.1	Animals, design and diet.....	112
6B.3.2.2	Nylon bag incubation procedure.....	113
6B.3.2.3	Statistical analysis.....	114
6B.4	RESULTS.....	114
6B.4.1	Trial 1.....	114

6B.4.1.1	Nutrient digestibility and nitrogen utilisation.....	114
6B.4.1.2	Rumen characteristics.....	116
6B.4.2	Trial 2.....	122
6B.5	DISCUSSION.....	125
6B.6	CONCLUSION.....	126

## CHAPTER 7: EXPERIMENT FOUR

### CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF PEA STRAW SUBJECTED TO FUNGAL FERMENTATION

7.1	SUMMARY.....	129
7.2	INTRODUCTION.....	130
7.3	MATERIALS AND METHODS.....	130
	7.3.1 Straw fermentation.....	130
	7.3.2 Chemical analyses.....	131
	7.3.3 <i>In vitro</i> digestibility study.....	131
	7.3.4 Statistical analysis.....	132
7.4	RESULTS.....	132
7.5	DISCUSSION.....	135
7.6	CONCLUSION.....	137

CHAPTER 8:	GENERAL CONCLUSION.....	139
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REFERENCES.....	142
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## LIST OF TABLES

### TABLE

1.	Beneficial effects of the addition of yeast culture to livestock feeds.....	47
2.	Chemical analysis of stubbles harvested from the Adelaide Plains (South Australia).....	77
3a.	Percent constituent and chemical composition of diets containing 25:45 (A), 40:30 (B) and 55:15 (C) pea straw:lucerne hay.....	83
3b.	Chemical composition (g/kg DM) and <i>in vitro</i> digestibility (%) of pea straw and lucerne chaff.....	84
3c.	Mean intake and digestibility of nutrients of the diets containing 25:45 (A),40:30 (B) and 55:15 (C) pea straw:lucerne hay in Australian Merino sheep.....	86
3d.	Nitrogen (N) utilisation in Australian Merino wethers fed diets containing 25:45 (A),40:30 (B) and 55:15 (C) pea straw : lucerne hay.....	87
4a.	Composition of diets with or without yeast culture offered daily to Australian Merino wethers.....	98
4b.	Chemical composition of dietary ingredients and the whole basal diet fed to the Australian Merino wethers (DM basis).....	98
4c.	Nutrient intake and digestibility of DM, OM, acid detergent fibre (ADF) and energy by Australian Merino wethers fed a pea straw-based diet with or without yeast culture (n=6).....	101
4d.	Nitrogen economy in Australian Merino wethers fed a pea straw-based diet with or without yeast (n=6).....	102
4e.	<i>In vitro</i> OM digestibility of pea straw-based diet and its individual constituents with or without the addition of yeast culture.....	103
5a.	Daily offer of a pea straw-based diets to Ethiopian Menz sheep.....	110
5b.	The chemical composition of dietary ingredients and whole diet with or without the addition of yeast culture fed to Ethiopian Menz sheep.....	110
5c.	Nutrient intake and digestibility of a pea straw-based diet with or without the addition of yeast culture in Ethiopian Menz sheep.....	115
5d.	Nitrogen utilisation of a pea straw-based diet with added yeast culture in Ethiopian Menz sheep.....	116

5e.	Effect of addition of yeast culture on rumen characteristics (mean over 24 hours), dry matter degradability over 0-120 hours ( $T_0$ - $T_{120}$ ) (g/kg) and degradability constants (g/kg) of pea straw in Ethiopian Menz sheep fed a pea straw-based diet.....	123
6a.	The chemical composition of untreated and fungi treated (spent) pea straw.....	133
6b.	<i>In vitro</i> DM and OM digestibility of untreated and fungi treated pea straw.....	135

## LIST OF FIGURES

### FIGURE

I	A scheme depicting the mode of action of fungal feed additives for ruminants.....	44
II	Effect of addition of yeast culture on <i>in vitro</i> DM digestibility of pea straw with different levels of urea added.....	104
III	Effect of addition of yeast culture on rumen pH in Ethiopian Menz sheep fed a straw-based diet.....	117
IV	Effect of addition of yeast culture on rumen $NH_3$ -N in Ethiopian Menz sheep fed a pea straw-based diet.....	118
V	Effect of <sup>addition of</sup> yeast culture on concentrations (mmol/L) of volatile fatty acid (VFA) in Ethiopian Menz sheep fed pea straw-based diet.....	119
VI	Effect of <sup>addition of</sup> yeast culture on dry matter (DM) disappearance of a pea straw in Ethiopian Menz sheep fed a pea straw-based diet.....	124
VII	DM digestibility (DMD) and corresponding nitrogen (N) content of spent pea straw as a function of <i>Pleurotus</i> growth.....	134

## LIST OF APPENDICES

### APPENDIX

I	Formulating diet based on pea straw for mature wethers on maintenance.....	160
II	Analysts of variance.....	161
III	Publications.....	169

## LIST OF PLATES

### PLATE

1.	Sheep in separate pens during the adaptation period.....	175
2.	Sheep with faecal bags fastened with harnesses in metabolism crates with metal mesh floor to allow passage of urine.....	176
3.	Parts of pea straw that were used in the experiments.....	177
4.	Pea straw fully covered with white mould growth of <i>Pleurotus cornucopiae</i> (about 20 days after incubation).....	177
5.	First flush of mushroom ( <i>P. cornucopiae</i> ) on pea straw (40 days after incubation).....	178
6.	Individual fully grown <i>P. cornucopiae</i> on pea straw.....	178

## **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, <sup>from cereal stubbles</sup> and similar levels in previous studies, suggest that when supplemented with energy (and if its digestibility <sup>could be</sup> ~~was~~ 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 substrate: 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.

Neijat Mohamed  
February 20,1995.

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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
<i>in vitro</i>	in glass
<i>in vivo</i>	in animal
<i>in sacco</i>	in bag
IVDMD	<i>in vitro</i> dry matter digestibility
IVOMD	<i>in vitro</i> organic matter digestibility
PD	potential disappearance of DM
W	body weight
LW	live weight
W <sup>0.75</sup>	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 <sub>3</sub> -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