



UNIVERSITI PUTRA MALAYSIA

**EFFECT OF FUNGAL TREATMENT ON THE
NUTRITIVE VALUE OF WHEAT STRAW AND
ITS USE IN THE DIET OF DAIRY CATTLE**

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By

Hassan Fazaeli

**Thesis Submitted in Fulfilment of the Requirement for the Degree of
Doctor of Philosophy in the Faculty of Agriculture
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September 2001



DEDICATION

This thesis is dedicated to the Jihad Sazandegi of Islamic Republic of Iran, particularly those who remembered Allah at anytime and tried very strongly and those who martyred on the way of Jihad.



Abstract of thesis submitted to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the Degree of Doctor of Philosophy

EFFECT OF FUNGAL TREATMENT ON THE NUTRITIVE VALUE OF WHEAT STRAW AND ITS USE IN THE DIET OF DAIRY CATTLE

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September 2001

Chairman: Associate Professor Zainal Aznam Mohd Jelan Ph. D

Faculty: Agriculture

Experiments were conducted to study the growth ability and potential of some *Pleurotus* fungi to biodegrade wheat straw and to determine the effect of fungal treatment on the nutritive value of straw and its use in the diet of dairy cow. The results showed that there is a potential application of the fungi on wheat straw. Among the six cultures of *Pleurotus*, P-41, P-21, P-60 and P-31 had a significantly ($P < 0.05$) higher growth ability on wheat straw. Supplementation of wheat straw with 1 or 2% urea nitrogen did not enhance the colonisation and growth rate of the fungi.

Fungal treatment decreased NDF and ADF, increased the CP and nutrient digestibility of wheat straw. However, the cultures P-30, P-41 and P-60 showed significantly ($P < 0.05$) higher ability to degrade the cell wall components of the straw and improved the IVDMD, IVOMD and *in sacco* degradability.



Treatment of wheat straw with *Pleurotus* (P-41) either before (FTWS) or after mushroom production (SPWS) resulted in a significantly ($P < 0.05$) higher amount of nutrient intake (DMI, OMI and DOMI) when fed to bulls. The digestibility of DM and OM increased by more than 10% unit in the treated straw as compared to the untreated wheat straw. In comparison to the untreated straw, feeding fungal treated wheat straw resulted in a higher ruminal pH and ammonia nitrogen concentration that indicated an improvement in rumen fermentation. Improvement of nutritive value was higher in FTWS than the SPWS.

In a feeding trial, four diets containing 0, 10, 20 and 30% fungal (P-41) treated wheat straw was fed to lactating cows. They showed similar intake of DM, OM, DOM, CP, TDN and NE_L . All diets resulted in similar milk yield and milk composition, but the diets that contained 20 and 30% treated straw produced a significantly ($P < 0.05$) higher body weight gain. However, the best animal performance and feed efficiency were obtained when the treated straw was included at 20% of the total diet or 40% of the roughage.

When two diets containing 30% of untreated or fungal treated wheat straw were fed to late lactating cows, higher nutrient digestibility and intake of DM, OM, CP and ME were observed in the cows fed treated straw. There was 13% increase in FCM yield by cows fed treated straw. Daily body weight gain was 2.7 times in the treated straw diet as compared to the untreated straw group. Improvement in the animal performance reflects the availability of more digestible organic matter and energy from the wheat straw treated with the fungus.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**KESAN RAWATAN FUNGUS KE ATAS NILAI PEMAKANAN JERAMI
GANDUM DAN PEGGUNAANNYA DALAM RANGSUM LEMBU TENUSU**

Oleh

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September 2001

Pengerusi: Profesor Madya Zainal Aznam Mohd Jelan Ph.D

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Eksperimen telah dijalankan untuk mengkaji keupayaan pertumbuhan dan potensi fungus *Pleurotus* untuk melerai secara biologi jerami gandum dan untuk mengenalpasti kesan rawatan fungus keatas nilai pemakanan jerami dan penggunaannya di dalam makanan lembu tenusu. Keputusan menunjukkan terdapat potensi menggunakan fungus keatas jerami gandum. Diantara enam kultur *Pleurotus*, P-41, P-21, P-60, dan P-31 mempunyai keupayaan pertumbuhan yang tinggi ($P < 0.05$) keatas jerami gandum. Penambahan 1 atau 2% nitrogen urea keatas jerami gandum tidak menambahkan kadar kolonisasi dan pertumbuhan fungus.

Rawatan fungus telah mengurangkan NDF dan ADF, meningkatkan CP dan pencernaan nutrien jerami gandum. Walau bagaimanapun, kultur P-30, P-41 dan P-60 menunjukkan keupayaan yang tinggi ($P < 0.05$) untuk melerai komponen dinding sel jerami dan memperbaiki IVDMD, IVOMD dan peleraian secara *in sacco*.

Merawat jerami gandum dengan *Pleurotus* (P-41) samaada sebelum (FTWS) atau selepas penghasilan cendawan (SPWS) menghasilkan amaun pengambilan nutrien (DMI, OMI dan DOMI) yang lebih tinggi ($P < 0.05$) apabila diberi makan kepada lembu. Pencernaan DM dan OM telah meningkat lebih daripada 10% dalam jerami yang dirawat dibandingkan dengan jerami gandum yang tidak dirawat. Dalam perbandingan dengan jerami tanpa rawatan, pemberian makan jerami gandum yang dirawat menghasilkan pH ruminal dan kepekatan nitrogen dari amonia yang tinggi yang menunjukkan pembaikan dalam fermentasi rumen. Pembaikan dalam nilai pemakanan adalah lebih tinggi dalam FTWS daripada SPWS.

Di dalam kajian pemberian makanan, empat rangsum mengandungi 0, 10, 20 dan 30% jerami gandum yang telah dirawat dengan fungus (P-41) telah diberi kepada lembu-lembu tenusu yang sedang diperah susu. Ia menunjukkan pengambilah DM, OM, DOM, CP, TDN dan NEL adalah serupa. Kesemua rangsum menunjukkan penghasilan susu komposisi susu yang serupa, tetapi rangsum yang mengandungi 20 dan 30% jerami yang dirawat menghasilkan kenaikan berat badan yang tinggi ($P < 0.05$). Bagaimanapun, prestasi haiwan yang terbaik dan kecekapan makanan telah dicapai apabila jerami yang dirawat dimasukkan pada paras 20% daripada jumlah rangsum atau 40% daripada bahan serat.

Apabila dua rangsum mengandungi 30% jerami yang dirawat atau tanpa rawatan fungus diberi makan kepada lembu tenusu perahan peringkat akhir, pencernaan nutrien dan pengambilan DM, OM, CP dan ME adalah lebih tinggi pada lembu yang memakan jerami yang dirawat. Sebanyak 13% peningkatan dalam

penghasilan FCM oleh lembu yang diberi makan jerami yang dirawat. Pertambahan berat badan harian adalah 2.7 kali pada kumpulan jerami yang dirawat berbanding dengan kumpulan jerami yang tidak dirawat. Pembaikan prestasi haiwan menggambarkan kesediaan lebih banyak bahan organik terhadap dan tenaga daripada jerami gandum yang dirawat dengan fungus.

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TABLE OF CONTENTS

	Page
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	v
ACKNOWLEDGEMENTS	viii
APPROVAL SHEETS	x
DECLARATION FORM	xii
LIST OF TABLES	xvii
LIST OF FIGURES	xx
LIST OF ABBREVIATIONS	xxi

CHAPTER

1	GENERAL INTRODUCTION	
1.1	Statement of the Problem	1
1.2	Importance of the Wheat Straw Treatment by Fungi	3
1.3	General Aim of the Project	4
1.4	Specific Objectives of the Project	4
2	LITERATURE REVIEW	
2.1	Introduction	5
2.2	Structural Characteristics of Straw	7
2.3	Nutritive Value of Straw	9
2.4	Straw Treatments	
2.4.1	Physical Treatments	10
2.4.2	Chemical Treatments	11
2.4.3	Using of Treated Straw in Ruminant Nutrition .	15
2.5	Appli	
2.6	Biological Treatment of Straw	
2.6.1	Biological Degradation of Lignin	19
2.6.2	Lignolytic Enzymes	20
2.7	Fungal Treatment	24
2.8	Treatment Straw with <i>Pleurotus</i> Fungi	
2.8.1	Growing of <i>Pleurotus</i> spp. on Sstraw	31
2.8.2	Enzymatic Activity of <i>Pleurotus</i> spp.	31
2.8.3	Effect of <i>Pleurotus</i> spp. on the Nutritive Value of Straw	32
2.9	Summary	34



3	GROWTH CHARACTERISTICS OF <i>PLEUROTUS</i> FUNGI ON WHEAT STRAW AND BASAL MEDIA	
3.1	Introduction	35
3.2	Materials and Methods	
3.2.1	Experiment I	37
3.2.2	Experiment II	41
3.3	Results	
3.3.1	Experiment I	42
3.3.2	Experiment II	49
3.4	Discussion	
3.4.1	Experiment I	59
3.4.2	Experiment II	61
3.5	Conclusion	65
4	EFFECT OF FUNGAL TREATMENT ON THE CHEMICAL COMPOSITION, <i>IN VITRO</i> DIGESTIBILITY AND <i>IN SACCO</i> DEGRADABILITY OF WHEAT STRAW	
4.1	Introduction.....	67
4.2	Materials and Methods	
4.2.1	Treatments	70
4.2.2	Cultures	70
4.2.3	Treating of Wheat Straw	70
4.2.4	Preparation of Spawn	72
4.2.5	Spawning	74
4.2.6	Fermentation	74
4.2.7	Preparation of Biomass	76
4.2.8	Chemical Composition of Biomass	76
4.2.9	Digestibility Studies	77
4.2.10	<i>In sacco</i> Degradability	77
4.2.11	Experimental Design	79
4.3	Results	
4.3.1	Effect of Treatments on Chemical Composition	80
4.3.2	Effect of Pre-treatment	83
4.3.3	<i>In Vitro</i> Digestibility	85
4.3.4	<i>In sacco</i> Degradability	86
4.4	Discussion	
4.4.1	Effect of Fungi	94
4.4.2	Effect of Pre-treatment	100
4.5	Conclusion	102
5	EFFECT OF FUNGAL TREATMENT ON THE DIGESTION AND FERMENTATION OF WHEAT STRAW	
5.1	Introduction	104
5.2	Materials and Methods	106



5.2.1	Treating Wheat Straw	106
5.2.2	Animals and Treatments	110
5.2.3	Digestibility Determination	112
5.2.4	Rumen Liquor Parameters	112
5.2.5	Statistical Methods	113
5.3	Results	
5.3.1	Digestibility	114
5.3.2	Nutrient Intake	114
5.3.3	Ruminal Measurements	116
5.4	Discussion	
5.4.1	Digestibility	119
5.4.2	Nutrient Intake	120
5.4.3	Ruminal Measurements	121
5.5	Conclusion	122

6 UTILISATION OF FUNGAL TREATED WHEAT STRAW BY DAIRY COWS

6.1	Introduction	124
6.2	Materials and Methods	
6.2.1	Treatment of Wheat Straw	126
6.2.2	Animal and Management	126
6.2.3	Diets	126
6.2.4	Feeding	131
6.2.5	Experimental Design	131
6.2.6	Measurements	133
6.3	Results	
6.3.1	Diet Composition	134
6.3.2	Digestibility	135
6.3.3	Nutrient Intake	135
6.3.4	Animal Performance	139
	Discussion	
6.4.1	Diets Composition and Digestibility	143
6.4.2	Nutrient Intake	144
6.4.3	Animal Performance	145
6.4.4	Efficiency of the Diets	147
6.5	Conclusion	148

7 COMPARING THE FUNGAL TREATED WITH UNTREATED WHEAT STRAW IN THE DIET OF DAIRY COWS

7.1	Introduction	149
7.2	Materials and Methods	
7.2.1	Animals	150
7.2.2	Diets.....	150
7.2.3	Measurements.....	151
7.2.4	Statistical Analyses	151

7.3	Results	
7.3.1	Diet Composition	154
7.3.2	Digestibility of the Diets	154
7.3.3	Nutrient Intake	157
7.3.4	Animal Performance	158
7.4	Discussion	
7.4.1	Diets Composition and Digestibility	162
7.4.2	Nutrient Intake	163
7.4.3	Animal Performance	164
7.4.4	Feed Efficiency	165
7.5	Conclusion	166
8	GENERAL DISCUSSION AND CONCLUSIONS	167
	REFERENCES	177
	APPENDICES	196
	BIODATA OF THE AUTHOR	253



LIST OF TABLES

		Page
2.1	Enzyme profiles of some fungi and their activities.....	23
2.2	High capacity fungi to increase digestibility (<i>in vitro</i>) of wheat straw.	26
3.1.1	The average surface area (cm ²) covered by mycelium of different species in all substrates.....	44
3.1.2	The average surface area (cm ²) covered by mycelium on different substrates.....	45
3.1.3	Mean (± se) cumulative growth of various cultures (cm ²) on different media during three weeks of incubation.....	47
3.1.4	Mean (± se) growth rate of various cultures on different media during each period of incubation, based on the surface (cm ²) area covered by mycelium.....	48
3.2.1	Mean (± se) growth rate of the mycelium on the different substrate based on the surface area (cm ²) covering of the substrate.....	49
3.2.2	Average (± sd) growth rate of the mycelium of different cultures based on the surface area covering (cm ²) of the substrate.....	52
3.2.3	Average (± se) cumulative growth of cultures on the various substrate based on the surface area covering (cm ²) by mycelium.....	54
3.2.4	Average (± sd) specific growth rate of mycelium (cm ²) on different substrates	55
3.2.5	Average (± sd) DM and OM losses of untreated or urea treated wheat straw after fermentation by fungi (based on the % of initial weight).....	57
3.2.6	Effect of different cultures on average (± se) DM and OM loss of untreated or urea treated wheat straw (based on the % of initial weight)	58
4.1	Average (± sd) chemical composition of untreated and fungal treated wheat straw.....	81
4.2	Average (± sd) cell wall component of untreated and fungal treated wheat straw (% of DM basis).....	82



4.3	Effect of the pre-treatment (pasteurisation) on the average (\pm sd) chemical composition (% DM) of fungal treated wheat straw.....	84
4.4	<i>In vitro</i> digestibility (mean \pm sd) of untreated and fungal treated wheat straw (based on the % of DM).....	86
4.5	Average (\pm sd) degradability (%) of DM at different incubation times and ADF degradation at 48h incubation.....	88
4.6	Average (\pm sd) degradability (%) of OM at different incubation times.....	89
4.7	Effect of treatment on the DM degradability parameters (mean \pm sd) of wheat straw.....	90
4.8	Effect of fungal treatment on the OM degradability parameters (mean \pm sd) of wheat straw.....	91
5.1	Effect of fungal treatment on the average (\pm sd) nutrient intake and <i>in vivo</i> digestibility of wheat straw	115
5.2	Effect of the treatments on the average (\pm sd) pH of the rumen liquor.....	117
5.3	Effect of treatments on the average (\pm sd) ammonia concentration in rumen liquors (mg/100ml).....	118
6.1	Chemical composition (%) of feedstuffs used in the experimental diets.....	128
6.2	Formulation of the experimental diets (DM basis).....	129
6.3	Composition of the formulated diets based on the estimation.....	130
6.4	Mean (\pm sd) of chemical compositions and the energy content of the diets.....	136
6.5	Mean (\pm sd) of <i>in vivo</i> digestibility of the nutrients and gross energy of the diets (%).....	137
6.6	Average (\pm sd) nutrient intake by the cows fed different diets.....	138
6.7	Effects of diets on the average (\pm sd) milk yield and composition and body weight gains.....	140
6.8	Efficiency of the diets and animal performance.....	142



7.1	Formulation of the experimental diets (DM basis).....	152
7.2	Estimated composition of the diets (DM basis).....	153
7.3	Average (\pm sd) nutrient components (% DM basis) of the actual diets.....	155
7.4	Average (\pm sd) nutrient digestibilities (%) of the diets fed to the experimental cattle.....	156
7.5	Effect of diet on the average (\pm sd) nutrient intake.....	157
7.6	Effect of the diet on the average (\pm sd) milk production and composition	159
7.7	Effect of diets on the average (\pm sd) efficiency and body weight.....	161



LIST OF FIGURES

	Page
2.1 Various processing methods of straw.....	14
2.2 Lignolytic enzymes and their activity.....	21
2.3 Mechanism of the oxidative activation of enzymes.....	22
3.1 Prepared fungi mother cultures.....	39
3.2 Fungi cultures prepared in plates and used for inoculation.....	39
3.3 Comparison of growth of fungi cultures on wheat straw.....	51
3.4 Mycellial running of the fungi on wheat straw.....	51
4.1 Prepared spawn in milk bottles.....	73
4.2 Packed straw after spawning	75
4.3 Fermentation chamber.....	75
4.4 Fistulated bulls used for <i>in sacco</i> experiment.	78
4.5 The DM degradability curves of untreated and fungal treated straw with four cultures, calculated from the equation	92
4.6 The OM degradability curves of untreated and fungal treated straw with four cultures, calculated from the equation.....	93
5.1 Barrel used for pasteurisation.....	107
5.2 Growth of mushroom (P-41) on wheat straw.....	109
5.3 Treated straw after mushroom was harvested	109
5.4 Fistulated bulls used in <i>in vivo</i> experiment	111

LIST OF ABBREVIATIONS

AOAC	Association of official analytical chemist
ADF	Acid detergent fibre
Ad lib	<i>Ad libitum</i>
AERI	Agricultural engineering research institute of Iran
AHP-WS	Alkaline hydrogen peroxide treated wheat straw
ASH	Non-organic compounds
BW	Body weight
BWG	Body weight gain
C	Carbon
°C	Degree Celsius
Ca	Calcium
CaO	Calcium oxide
Ca (OH) ₂	Calcium dihydroxide
CF	Crude fibre
CL	Cellulose
cm ²	Square centimeter
C/N	Carbon nitrogen ratio
CP	Crude protein
CPI	Crude protein intake
d	Day
DE	Digestible energy



DM	Dry matter
DMD	Dry matter digestibility
DMI	Dry matter intake
DOMI	Digestible organic matter intake
EE	Ether extract
FCM	4 percent fat corrected milk
FTWS	Fungal treated wheat straw
g	Gram
GE	Gross energy
GLM	General linear model
h	hour
H	hydrogen
HCL	Hemi cellulose
H ₂ O ₂	Dihydrogen dioxide
IBW	Initial body wieght
IVDMD	<i>In vitro</i> dry matter digestibility
IVOMD	<i>In vitro</i> organic matter digestibility
Kg	Kilogram
Mcal	Mega calorie
Mn	Manganez
N	Nitrogen
NaOH	Sodium hydroxide
NDF	Neutral detergent fibre
NEE	Net energy efficiency



NH ₃	Ammonia
NFE	Nitrogen free extract
NH ₃ -N	Ammonia nitrogen
NH ₄ (HCO ₃)	Ammonium hydrogen carbonate
NH ₄ CL	Ammonium chloride
NE _L	Net energy lactation
NE _L I	Net energy lactation Intake
NRC	National Research Council
NS	Non-significant
NVI	Nutritive value index
OM	Organic matter
OMD	Organic matter digestibility
OMI	Organic matter intake
P	Phosphorous
Pasteurisation	Heating of wet substare to provide favorate conditions for mycellial running
PDA	Potato dextrose agar
pH	Hydrogen ion concentration
SAS	Statistical analytical system
SEM	Standard error of mean
SD	Standard deviation
SNF	Solid non fat
SOL	Significant observed level
SO ₂	Sulfur dioxide