UNIVERSITI PUTRA MALAYSIA

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HASSAN FAZAELI

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By

Hassan Fazaeli

Thesis Submited in Fulfilment of the Requirement for the Degree of
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September 2001

DEDICATION

This thesis is dedicated to the Jahad 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 Jahad.

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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HASSAN FAZAELI

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

HASSAN FAZAELI

September 2001

Pengerusi: Profesor Madya Zainal Aznam Mohd Jelan Ph.D

Fakulti: Pertanian

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 mengambarkan kesediaan lebih banyak bahan organik terhadam dan tenaga daripada jerami gandum yang dirawat dengan fungus.

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I certify that an Examination Committee met on 16th November 2001 to conduct the final examination of Hassan Fazaeli on his Doctor of Philosophy thesis entitled "Effect of fungal treatment on the nutritive value of wheat straw and its use in the diet of dairy cattle" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree Regulations 1981). The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Mohd Ridzwan Abd. Halim Ph.D
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Zainal Aznam Mohd Jelan Ph.D
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Liang Juan Boo Ph.D
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Homayoun Mahmoudzadeh Ph.D
Assistant Professor
Faculty of Veterinary Medicine
University of Tehran
(Member)

Aslan Azizi Ph.D
Agricultural Engineering Research Institute
Ministry of Agriculture, Iran
(Member)

MOHD GHAZALI MOHAYIDIN Ph.D
Professor/Deputy Dean of Graduate School
Universiti Putra Malaysia

Date: 23 NOV 2001

This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement of the degree of Doctor of Philosophy.

AINI IDRIS Ph.D
Professor
Dean of Graduate School
Universiti Putra Malaysia

Date: 10 JAN 2002

DECLARATION

I hereby declare that this thesis is on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

Hassan Fazaeli

Date: 4th September 2001

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LIST OF ABBREVIATIONS

AOAC	Association of official analytical chemist
ADF	Acid detergent fibre
Ad lib	*Ad libitum*
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_2O_2	Dihydrogen dioxide
IBW	Initial body wieght
IVDMD	*In vitro* dry matter digestibility
IVOMD	*In vitro* organic matter digestibility
Kg	Kilogram
Mcal	Mega calorie
Mn	Manganez
N	Nitrogen
NaOH	Sodium hydroxide
NDF	Neutral detergent fibre
NEE	Net energy efficiency

NH3	Ammonia
NFE	Nitrogen free extract
NH3-N	Ammonia nitrogen
NH_4 (HCO_3)	Ammonium hydrogen carbonate
NH_4 CL	Ammonium cloride
NE_L	Net energy lactation
NE_LI	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