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FATTENING HYLA RABBITS WITH A RESIDUAL SUBSTRATUM FROM THE PRODUCTION OF EDIBLE MUSHROOM *PLEUROTUS PULMONARIUS*

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SUMMARY : In order to close the technological chain : cereals - fungi - meat, the possibility of using the substratum of the production of *Pleurotus pulmonarius* in the nutrition of rabbits in investigated. Sixty male Hyla rabbits, aged 30 days divided in four equal group (A, B, C, D) were included in trial. They were fed 9 weeks *ad libitum* on one of the 4 pelleted feeds, comprising 0 %, 10 %, 20 or 30 %, respectively of the substratum left after production of *Pleurotus pulmonarius*. According to the results of the feeding part of the trial, the rabbits of all the groups consumed their diets and grew normally (23–24 g/day). Some occasional individual differences didn't influence significantly their average food conversion (3.9 - 4.2) nor total weight gain (P>0.05). The meat was organolepticaly good, as it was expected from the chemical analysis results. So fattening Hyla rabbits with diets partially composed of the substratum of the production of *Pleurotus pulmonarius* up to 30 % is justified because it doesn't influence significantly the investigated parameters.

RÉSUMÉ : **Engraissement de lapereaux Hyla avec le résidu de culture de la production de Pleurotes (*Pleurotus pulmonarius*).** *Pour fermer la chaine technologique : céréales - champignons - viande, l'utilisation du substrat servant à produire* Pleurotus pulmonarius *est envisagée, pour l'engraissement des lapins. L'expérimentation comprend 60 lapins mâles Hyla, répartis en 4 groupes égaux (A, B, C et D). Ils ont été nourris* ad libitum *pendant 9 semaines avec un aliment granulé qui comprenait 0 %, 10 %, 20 %, 30 % respectivement du substrat restant après la production des Pleurotes. Les résultats montrent que les lapins ont consommé cet aliment et grossi normalement (23–24 g/jour). Des différences individuelles occasionnelles n'ont pas influencé les indices de consommation ni le gain de poids total (P>0.05). La qualité organoleptique de la viande était bonne, ce qui est montré par les résultats de l'analyse chimique. On peut conclure que l'engraissemet des lapins Hyla avec des aliments contenant jusqu'à 30 % de substrat de culture de* Pleurotus pulmonarius *se justifie puisque les paramètres étudiés ne sont pas modifiés significativement.*

INTRODUCTION

In the production of corn, wheat, barley and other cereals, great quantities of so–called by–products are left over, e.g. corn stalks and straw, which can be used in many ways.

Among others, the use of straw in the nutrition of domestic animals becomes more and more important, but there are open questions in that field yet.

To accommodate the straw to feed the domestic animals is the object of a great number of investigations, comprehending many scientific fields, from chemistry and microbiology to trials with different animal species.

So, HARTLEY (1987) has reported that the cell membrane of straw consists mainly of cellulose, hemicellulose, lignin, and aromatic compounds, nitrogenous and mineral matters, including silica. Those walls of vegetable cells can be decomposed by the microbial population of animals digestive system only partially. The usefulness, especially the digestibility of straw, and particularly in monogastric animals, is poor. The digestibility of straw can be improved by physical and chemical treatment as well by means of fungi.

With a view to invent better possibilities to improve the usefulness of lignocellulosic materials, according to ZADRAZIL (1987) only some microorganisms and lignicole species of "higher" fungi are able to decompose all the polymers of the complex structure of cell membrane. LELLEY (1984) stated that the digestibility of lignocellulosic material can be considerably improved by means of fungi, whose mycelium has ability of growing trough without particular additives. Such fungi, when decomposing lignin, build into their own organism nitrogen. Owing to that ability of fungi, many species are industrially produced now, all over the world, to supplement the human nutrition

The rest of substratum (straw, hay etc...) can be used efficiently in feeding domestic animals. According to ZADRAZIL (1987) the digestibility of wheat straw following the production of *Pleurotus spp.* is increased by 60–65 %, and by 40–70 % following growth of *Stropharia rugosoannulata* mycelium. HENICS (1987) gave to steers meals in which hay has been replaced by the rest of the production of *Pleurotus* in day diet of 0, 3.0, 4.5 and 6.0 kg, respectively. He established that in experimental steers the pH of rumen contents was higher and the total content of volatile fatty acids lower. For final body weight, daily weight gain, food consumption, and carcass characteristics, there were no significant differences between the experimental steers and the controls. Similar conclusions are made by RAI *et al.* (1989) who gave to sheep rice straw treated with different chemical substances and the fungus *Coprinus fimentarius*. Straw incubated with *Coprinus fimentarius* has shown a slightly better digestibility than the chemically treated one. MUZIC *et al.* (1990) have investigated the digestibility of wheat straw after the commercial production of *Pleurotus pulmonarius*. They have ascertained that the New Zealand rabbits digested crude protein 39.0 %, crude fat 47.6 %, crude fiber 21.2 %, nitrogen–free extract 20.2 % and organic matter 22.0 %.

BOZAC *et al.* (1991) researched the possibility of using the substratum left over after the production of Pleurotus in the nutrition of fattening rabbits. The share of substratum in fodder mixes was 10 %, 20 % and 30 %. It was shown that all three levels of substratum can be useful in rabbit meals, without disadvantageous effects, and that there were no significant differences among above mentioned levels, as in final body weight and in food conversion, so in basic chemical indices of thigh muscles and of lumbar part of muscle *longissimus dorsi*. Further, it is to be emphasized that some investigated properties have shown a great coefficient of variation, what is considered as a consequence of relatively small number of tested rabbits, as well of occurrence of ill–health in some rabbits.

From the mentioned investigations it can be concluded that including the exhausted substratum after the production of *Pleurotus spp.* in the nutrition of rabbits is justified. But some questions left open yet, e.g. the level of crude fiber in the rabbit meal made with the mentioned substratum, which is changing with the prolongation of the picking of fungi. Another open question is to establish the reaction of different categories and breeds of rabbits in the same sense.

MATERIALS AND METHODS

Sixty Hyla male rabbits divided in four groups (A, B, C, D) fifteen animals per group, were included in the trial. The rabbits were one month old, of comparable body weight (mean per group from 616 to 632 g).

The rabbits were placed in cages, four respective and three units per cage (4 + 4 + 4 + 3), whose disposition eliminated the position effect. The cages were placed in an air-conditioned room, with temperature between 18° to 24° C. and relative humidity between 60 % and 70 %.

The rabbits were fed and watered *ad libitum* during nine weeks. Pelleted fodder mixes (without binder) were balanced, with the standard fodder and the wheat straw grown through by mycelium (the substratum from the commercial production of *Pleurotus pulmonarius*).

The exhausted substratum contained water 11.38 %, crude fat 1.33 %, crude protein 6.79 %, crude fiber 27.52 %, nitrogen free extract 48.42 % and ash 4.56 %. The proportions of the substratum were as follows : A = 0 %, B = 10 %, C = 20 %, D = 30 % for the 4 groups respectively. The composition of diets is shown on Table 1.

Table 1 : Composition of pelleted diets (%)

	Diets			
Ingredients	A	B	C	D
Corn meal	27.0	27.7	23.7	19.8
Soybean oil meal	0	0	9.0	13.9
Sunflower oil meal	16.0	14.0	5.0	1.5
Fish meal	1.0	4.0	4.0	5.0
Wheat middlings	6.0	2.0	2.0	0
Swine fat	4.2	4.2	5.2	6.5
Substratum	***0***	***10.0***	***20.0***	***30.0***
Dehydrated alfalfa meal	40.0	31.3	24.3	16.5
Barley meal	5.0	6.0	6.0	6.0
Salt	0.3	0.3	0.3	0.3
Vitamin–mineral mix	0.5	0.5	0.5	0.5
Total	100	100	100	100

Table 2 : Chemical analysis of experimental diets.

Diets	A	B	C	D
(% as fed)				
Water	10.1	10.4	10.5	10.6
Crude protein	17.2	17.2	17.1	17.3
Crude fat	6.9	6.8	7.5	8.5
Crude fiber	14.1	14.1	14.1	14.3
Crude ash	6.0	5.7	5.4	5.1
Nitrogen free extract	28.4	31.3	33.7	35.4
Calcium	0.63	0.72	0.70	0.71
Phosphorus	0.54	0.54	0.45	0.41
Methionine + Cystine *	0.57	0.57	0.53	0.51
Lysine *	0.67	0.72	0.80	0.87
Tryptophan *	0.29	0.26	0.25	0.23
M.E. * (MJ/kg)	10.1	10.1	10.1	10.1

* Calculated data

The substratum the rabbits were fed was a residue obtained from the commercial production of *Pleurotus pulmonarius*. That production involves sowing the thermically treated moistened wheat straw with mycelium. The development of the mycelium was performed in polyethylene bags at 22° C., fruit bringing in three waves (yield 20 %) altogether lasting 45 days. The straw exhausted by fungi was then dried (humidity 12 %) and finely ground into flour by means of hammer hill, finally mixed together with other fodders into experimental diets. The experimental diets were chemically analyzed for water, crude protein, crude fat, crude fiber, crude ash, calcium and phosphorus by standard techniques of Association of Official Analytical Chemists (1980). The nutritive value and the chemical analysis of experimental diets are shown in Table 2. The amino acids contents were calculated according to WPSA 1992.

The body weight, food consumption and state of health were observed for nine weeks. Then, the experimental rabbits were killed, and particular organs and the whole carcass, processed according to the slaughter–house standards, inspected by veterinary service. The carcass was cooled 24 hours at 2°C., and the standard chemical analysis (A.O.A.C., 1980) of leg muscles and m. *longissimus dorsi* conducted. Organoleptic evaluation of meat was performed by a tasting commission using hedonistic points–system (WEIR, 1960).

All results were subjected to standard statistical analysis by Statgraphic (1986) programme for personal computers.

Table 3 : Average body weights of rabbits during trials (*number*, mean in g and coefficient of variation)

Group	Stat. data	Weeks 0	1	2	3	4	5	6	7	8	9
A	*n*	*15*	*15*	*14*	*14*	*14*	*14*	*14*	*14*	*14*	*14*
	$\bar{x}$	616	661	866	1002	1181	1376	1572	1793	1732	2044
	V	3.7	11.0	8.1	9.1	9.7	9.9	12.6	13.6	14.3	15.5
B	*n*	*15*	*14*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*
	$\bar{x}$	626	685	840	950	1053	1280	1494	1764	1839	2038
	V	6.3	7.3	8.5	9.4	9.3	6.4	8.1	8.3	10.7	12.9
C	*n*	*15*	*14*	*14*	*13*	*13*	*13*	*13*	*13*	*13*	*13*
	$\bar{x}$	617	743	909	980	1143	1337	1581	1821	1849	2123
	V	6.2	13.5	10.0	15.5	15.6	13.9	13.3	13.2	13.8	15.8
D	*n*	*15*	*15*	*15*	*15*	*15*	*15*	*15*	*15*	*15*	*15*
	$\bar{x}$	632	737	905	981	1129	1353	1573	1801	1881	2120
	V	4.9	9.7	8.6	12.0	11.6	10.6	10.2	10.0	10.4	12.4
	P<0.05		A:C A:D B:D	B:C B:D		A:B	A:B				

Table 4 : Average daily weight gain, feed conversion ratio and mortality observed during the trial (none of the differences were significant).

Group		A	B	C	D
Daily weight gain (g/day)	$\bar{x}$	23.3	23.0	24.6	24.0
	cv	25.2	20.6	25.8	19.5
Feed conversion ratio	$\bar{x}$	3.88	4.19	3.82	3.89
Mortality (%)	$\bar{x}$	66	19.3	13.3	0

RESULTS AND DISCUSSION

During the whole trial five rabbits died, one in the A group (second week), two in the B group (first and second week) and two in the C group (first and third week). In the experimental group D, fed diets with 30 % substratum, there was no mortality. By autopsy it was established that the rabbits died of non infectious mucoid enteritis.

The average body weight of tested rabbits is given in Table 3. Significant differences were observed at the end of the first week, when the rabbits of A group (the control) were about 11 % lighter than those ones of C and D groups, and while the rabbits of B group (10 % substratum) were about 8 % lighter than those one of D group.

In the second week only the B rabbits (10 % substratum) were significantly lighter than those of C and D groups ($P<0.05$). During the fourth and fifth week the controls were considerably heavier than the rabbits of B group. But these differences among average body weights disappeared in the further course of the trial and the end of the ninth week of fattening, the rabbits of C group were only 1-4 % heavier than the others. In Table 4, the average daily gain, food conversion and mortality rate are given. From the analysis of daily gains and final body weights it is evident that the rabbits of all groups are grown comparably, the little better weight gain and higher final body weight of the rabbits of C and D groups, fed substratum 20 an 30 % respectively, weren't significant ($P>0.05$). The Hyla rabbits of all groups have consumed the same quantity of pellets per kilo of weight gain. The average value can be considered too high in comparison with standard conditions. It is no doubt a consequence of a two-days power cut (heating and light), that caused stress reaction of animals, respective bad weight gain in the eighth trial week (Table 3).

At the end of the ninth week of the feeding trial the rabbits were slaughtered, according to slaughter-house standard processes and cooled 24 hours at 2° C. Ten right legs and ten right *m. longissimus dorsi* of all groups, as the most valuable meat portions were subjected to the chemical analysis of meat (Table 5).

The data relative to leg muscles are very similar among the groups, the only significant difference ($P<0.05$) was relative to proportion of fat for the group

Table 5 : Chemical composition of thigh muscle and *m. longissimus dorsi* (MLD) of Hyla rabbits.

Group	A		B		C		D	
Stat. data	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V
Water								
Thigh	75.63	1.77	76.21	2.27	76.10	2.09	75.81	2.92
MLD	76.21	1.34	76.77	0.43	76.07	1.17	76.36	1.13
Fat								
Thigh	3.59^{ab}	54.60	2.45^{a}	68.57	4.09^{ab}	47.43	4.62^{b}	60.82
MLD	1.35^{ab}	17.04	1.21^{a}	45.45	2.12^{b}	54.25	1.68^{ab}	49.40
Proteins								
Thigh	19.59	3.32	20.14	9.48	18.66	11.68	19.10	3.51
MLD	21.38	2.53	20.89	3.73	20.71	5.21	20.81	4.04
Ash								
Thigh	1.06	4.72	1.09	15.60	1.04	15.79	1.08	32.81
MLD	1.09	0.92	1.11	7.21	1.09	7.34	1.13	7.08

a, b on the same line numbers with different superscript letter are significantly different ($P<0.05$).

B and D. Nearly the same can be applied to *m. longissimus dorsi*, where a significant difference (P<0.05) between the proportions of fat in the group B and C was observed.

Those differences are very probably due to the individual variations between rabbits, including the fact that the group B had the worst food conversion rate and that at the end of trial it was unsignificantly lighter (Table 4).

The data of chemical analysis show the expected greater quantity of fat in leg muscles of all groups and by analogy the greater quantity of protein and ash in *m. longissimus dorsi* of tested rabbits.

According to the organoleptic tests performed, the meat of all the groups of rabbits had a pleasant odour and a desirable colour. No sign of watery quality nor softness (PSE meat) were observed. On the basis of our investigations it can be concluded that fattening the rabbits with diets partially composed of the substratum of *Pleurotus pulmonarius* production is justified.

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