JOURNAL OF THE SCIENTIFIC AGRICULTURAL SOCIETY OF FINLAND
Maataloustieteellinen Aikakauskirja
Vol. 53: 52–56, 1981

Nutritive value for growing pigs of pekilo protein and torula yeast grown in spent sulphite liquour

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Abstract. The digestibility and nutritive value of pekilo protein (*Paecilomyces varioti*), and torula yeast (*Candida utilis*) were determined for four pigs weighing 35–50 kg. The proportion of pekilo or torula was 30 % of the barley-based diet. The crude fat was determined by the standard ether extraction method and by the HCl-ether method. The first method indicated a low fat content and a highly negative digestibility of fat, but the second showed that the pig is able to digest and absorb a large part of the ether-insoluble fat. The energy value thereby increased 14 % for pekilo and 12 % for torula over those obtained by the conventional ether method. The same energy value was obtained for barley by both methods.

The energy values (HCl-ether method) obtained for pekilo and torula were 0.96 and 0.95 F.U./kg DM (F. U. = 0.7 kg starch), or 13.41 and 12.98 MJ ME/kg DM, respectively. The protein values, corrected for nucleic acid nitrogen, were 434 and 358 g DCP/kg DM. The only significant difference between pekilo and torula was the DCP value ($P < 0.001$).

The nitrogen balances in the pekilo and torula trials were very high and identical (24.4 and 24.0 g N/d), confirming the value of these feeds as protein supplements to cereal feeds for pigs.

Introduction

Two kinds of single-cell protein (SCP), the mycelium forming microfungi pekilo (*Paecilomyces varioti*) and torula yeast (*Candida utilis*), are cultivated in the sulphite spent liquor of the pulping industry in Finland.

Pekilo and torula are much alike in composition (Table 1), but pekilo is rougher in texture. Now that production had been going on for several years, the process techniques and with them the quality of products have been stabilized.

The value of pekilo and torula in animal feeding is similar. Both have been successfully used as the sole protein supplement for growing pigs (BARBER et al. 1971, 1978, ALAVIUHKOLA et al. 1975, 1978, HANSSEN 1978), from the freshly weaned stage onwards (BOBROV et al. 1978). In the feeding of broilers and calves, however, some restrictions have had to be introduced (BECK and GROPP 1974, KIISKINEN 1978, KOSSILA and KIISKINEN 1978).

The amino acid composition and the protein value of pekilo and yeasts are well known, their energy values much less clear. Accordingly, the purpose of the present study was to determine the energy values of the domestic-produced pekilo protein and torula yeast for growing pigs. The digestible crude protein (DCP) values and the nitrogen balances were determined simultaneously.

Table 1. Chemical composition and digestibility coefficients for pigs of pekilo protein, torula yeast and barley.

	Org. matter	Crude protein	Crude fibre	Crude fat[1] 1	Crude fat[1] 2	NFE[1] 1	NFE[1] 2	Ash
Pekilo:								
% in DM	92.9	58.3	8.4	1.4	4.4	24.8	21.8	7.1
digest. %	77.1	82.7	69.5	− 166.6	53.1	74.5	64.0	50.2
Torula:								
% in DM	92.9	49.2	6.2	2.2	6.6	35.3	30.9	7.1
digest. %	73.1	80.9	54.8	− 69.7	67.0	70.4	60.0	56.4
Barley:								
% in DM	97.1	11.4	5.9	2.4	3.5	77.4	76.3	2.9
digest. %	86.3	86.2	28.2	82.9	56.6	90.8	92.1	65.9

[1] Crude fat = ether extract

[2] Crude fat = 4 N HCl + ether extract

Materials and methods

Pekilo and torula were products of the normal industrial production. Their compositions, and the composition of the barley used as basic feed in the trials, are shown in Table 1.

The digestibility trials were carried out with four castrated pigs weighing 35–50 kg. The proportion of pekilo or torula was 30 % of the barley-based diet. In the basic digestibility trial with barley, 16 % of skim milk powder was incorporated for protein supplement. The preliminary period was 10 days and the collection period 7 days. The details of the digestibility trials have been described in an earlier paper (SALO and ALAVIUHKOLA 1980).

Results and discussion

The crude fat was determined both as normal ether extract and as HCl-fat (boiling in 4 N HCl before extraction with ether). Digestibility coefficients and energy values were calculated on the basis of both fat determinations (Tables 1 and 2).

The digestibility coefficients found lie within the wide range presented in the literature, though at the lower end of the range (ANON. 1970, BREIREM and HOMB 1970, NEHRING et al. 1970, SCHULZ and OSLAGE 1976, ANON. 1979). The nutritive data for pekilo and torula agree very well with each other, better than the

Table 2. Energy values when crude fat is determined as ether extract (1), and as HCl-ether extract (2), and DCP values.

	Pekilo 1	Pekilo 2	Torula 1	Torula 2	Barley 1	Barley 2
FU./kg DM[1]	0.83	0.96	0.84	0.95	1.16	1.16
MJ ME/kg DM	12.54	13.41	11.90	12.98	14.91	14.95
DCP, g/kg DM	434[2]		358[2]		98	

[1] F.U. = 0.7 kg starch

[2] Corrected values, see text.

data in many experiments for two different batches of yeast. Perhaps the cultivation medium has a greater effect on the nutritive quality of SCP than does the strain of microbe. And perhaps the SCP from sulphite liquor has a little lower digestibility than the SCP from some other energy sources, as some literature data suggest (NEHRING et al. 1970, ANON. 1970).

In addition to protein the microbe products contain about 35 % carbohydrates and 4—10 % fat. The composition of both these groups differs greatly from that of conventional feeds.

The carbohydrates resemble the hemicellulose of higher plants in solubility, but their composition is quite different. The principal units are glucose and mannose, whereas xylose and arabinose, the essential polysaccharide components of higher plants, are wholly lacking. Hexoseamines are also typical of the microbe products. Sugar and starch, on the other hand, occur only in traces and solubilities in the amyloglucosidase and pepsin incubations are small (SCHULZ and OSLAGE 1976, SALO 1977). The digestion of yeast cell wall polysaccharides by the digestive enzymes of the calfs small intestine is very small (GAILLARD and WEERDEN 1976). Consequently, yeast and pekilo have proved to be a somewhat problematic feed for calves (SCHULZ and OSLAGE 1976, KOSSILA and KIISKINEN 1978). The division of the cell wall compounds into crude fibre and nitrogen free extracts is artificial and serves no purpose here, as can be seen from the digestion coefficients, which are almost identical for the two groups. Moreover, the crude fibre sontent of SCP depends essentially on the filtration technique (SALO 1977).

The pigs proved to digest the carbohydrates of pekilo and torula rather well — with the assistance of the bacterial flora of their large intestine. Not so well, however, that the energy values approached those of the common cereal grains.

The crude fat is another group that differs from that of conventional feeds. The fat content is variable and can rise several-fold, when the SCP is hydrolysed with 4 N HCl before extraction with ether (SCHILLER et al. 1972, SALO 1977, HANSSEN 1978).

The digestibility coefficients found here suggest that the alimentary canal of pig hydrolyses more fat into an ether soluble form than can be absorbed into the blood circulation, resulting in a highly negative digestion coefficient (Table 1). On the other hand, the pig does digest a good part of the ether insoluble fat, with the result that the energy values calculated by the HCl-fat method are 12—14 % higher (Table 2) — and in all probability truer — than the values arrived at by the conventional ether method. In respect to barley there is no difference in energy value between these two fat determination methods: the HCl -method shows a higher fat content, and lower digestibility correspondingly.

The digestible crude protein values of Table 2 are corrected for nucleic acid nitrogen. It is well known that 10—20 % of the nitrogen of yeasts is included in the nu-

Table 3. Nitrogen balances of various digestibility trials.

Diet	DCP, g/F.U.	N-balance g N/d
Barley — Skim milk powder	122	18.2
Barley — Pekilo	190	24.4
Barley — Torula	167	24.0

cleic acids (SCHULZ and OSLAGE 1976, ROTH and KIRCHGESSNER 1980), and the same is true for the pekilo (SALO 1978). Further, it is known that the pig digests about 95 % of the nucleic acid nitrogen, but less than one third of it is retained in the body, the rest being excreted in the urine (ROTH and KIRCHGESSNER 1977, 1980). The DCP values of Table 2 are roughly corrected on the basis of this knowledge (15 % content and 30 % utilization).

The palatability of pekilo and torula was good at the 30 % level of the diet. The retention of nitrogen was very high, considering that the normal restricted feeding was used (Table 3). The results only strengthen the many earlier findings that pekilo and yeast are very promising protein supplements to cereal feeds for pigs.

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Ms received January 22, 1981

SELOSTUS

Sulfiittijäteliemessä viljeltyjen kotimaisten mikrobituotteiden rehuarvo lihasialla

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Pekilon ja silvan (torula-hiiva) rehuarvo määritettiin neljällä 35–50 kg painoisella lihasialla sulavuuskokeessa, missä perusrehuna oli ohra ja pekiloa tai silvaa oli 30 % dieetistä. Raakarasva määritettiin sekä virallisen rehuanalyysin eetterimenetelmällä että 4 N HCl-keiton jälkeen eetterillä. Edellisellä saatiin matala rasvapitoisuus ja vahvasti negatiivinen sulavuuskerroin. Jälkimmäinen osoitti, että sika pystyy sulattamaan niin paljon eetteriin liukenematonta rasvaa, että HCl-eetterimenetelmällä tulee pekilolle 14 % ja silvalle 12 % parempi – ja nähtävästi oikeampi – ry-arvo. Ohralle sen sijaan saatiin sama energia-arvo kummallakin rasvamäärityksellä. Menetelmän tarkistus lienee siten tarpeen vain joillakin erikoisilla rehuilla, kuten juuri mikrobituotteilla.

Todetut energia-arvot olivat pekilolle ja silvalle 0.96 ja 0.95 ry/kg ka tai muuntokelpoisena energiana 13.41 ja 12.98 MJ ME/kg ka. Srv-arvoihin tehtiin nukleiinihappokorjaus, mikä alensi arvoja noin 10 %. Korjatut arvot olivat pekilolle 434 ja silvalle 358 g srv/kg ka. Valkuaisarvo oli ainoa, missä nämä kaksi rehua merkitsevästi poikkesivat toisistaan ($P<0.001$).

Typpitaseet olivat pekilo- ja silvakokeissa korkeat (24.4 ja 24.0 g N/d) vahvistaen aikaisempia tuloksia, että nämä mikrobituotteet sopivat hyvin lihasian ainoaksikin valkuaisrehuksi.