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THE NUTRITIVE VALUE FOR GROWING PIGS OF SINGLE CELL PROTEIN (SACCHAROMYCES CEREVISIAE) PRODUCED FROM SULPHITE SPENT LIQUOR

By

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NÆSS, BJØRN and PER SLAGSVOLD: *The nutritive value for growing pigs of single cell protein (Saccharomyces cerevisiae) produced from sulphite spent liquor.* Acta vet. scand. 1973, *14*, 160—167. — The effects on growing pigs of substituting 4.5 and 9 % of soy bean meal with a corresponding amount of single cell protein produced from sulphite spent liquor in a diet based on cereals and fish meal have been studied. The concentration of lignosulphonic acids in the single cell protein product was found to be 0.6 % ± 0.2 % (m. ± s). No differences in the weight gain, feed conversion ratio or fat thickness of the pigs, as compared with the controls, were observed when fed single cell protein-containing diets from about 29 to 80 kg in the course of 11 weeks. Nor were any effects found on addition of 0.15 % of methionine to the diets.

nutritive value; single cell protein; Saccharomyces cerevisiae; growing pigs; lignosulphonic acids.

Fermentation of sulphite spent liquor, in order to remove and utilize the sugars present, has been carried out at several wood pulp factories in Norway for many years. Ethyl alcohol is produced in these plants (*Evju* 1971, *Gauslaa* 1971) using the yeast Saccharomyces cerevisiae, which ferments mainly hexoses (*van der Walt* 1970). The yeast mass produced by this more or less anaerobic process has to some extent been dried and mixed in animal fodder, mainly because of the relatively high concentration of B-vitamins.

With the growing interest in measures to decrease the pollution of the recipient by waste products and to conserve natural resources, increasing use of the fermentation of the sulphite spent liquors may be a step forward, provided that new possibilities for the utilization of the products are found.

The aim of the present work was to study the use of fodder yeast as a source of protein (single cell protein) for growing pigs, when given in relatively high concentrations, and substituting for conventional proteins in cereal and fish meal based diets to growing pigs, and to study the effects of adding methionine to the diet.

MATERIALS AND METHODS

Pigs. Thirty-six weaned Norwegian Landrace pigs of both sexes, initially weighing 29.0 kg ± 3.6 kg (m. ± s), were randomly selected from several sources and divided into 6 groups of 6 pigs each.

Single cell protein (SCP). The SCP was kindly supplied by Borregaard A/S, Sarpsborg, Norway. The analytical data of the SCP product were as follows: Dry matter 88.9 %, crude protein 41.6 %, ash 4.5 %, Ca 0.62 %, K 0.40 %, Na 0.06 % and P 0.26 %.

Protein quality of the SCP. The protein quality of the SCP was kindly examined by Halvor Holm, Johan Throne-Holst's Institute for Nutrition Research, University of Oslo, Blindern, Norway, using rats. For comparison, a diet consisting of fish meal and extracted soy bean meal and a diet consisting of fish meal and SCP were also examined, the results being given in Table 1.

T a b l e 1. Protein quality of different proteins (m. ± s) tested in rats.

Parameter of protein quality	Diets		
	single cell protein	fish meal/ soy bean meal (nitrogen ratio 3/12)	fish meal/ single cell protein (nitrogen ratio 3/12)
Biological value	55.81 ± 3.75	72.22 ± 3.00	62.37 ± 1.84
True digestibility	74.12 ± 2.49	87.53 ± 2.52	79.08 ± 3.14
Net protein utilization	41.34 ± 2.55	63.24 ± 3.81	49.35 ± 3.27
Protein efficiency ratio	1.25 ± 0.19	2.95 ± 0.13	2.09 ± 0.19

Table 2. The diet compositions for the various groups of pigs.

		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Herring meal	(%)	3.5	3.5	3.5	3.5	3.5	3.5
Single cell protein	(%)	0	0	6.0	6.0	12.0	12.0
Soy bean meal (extracted)	(%)	9.0	9.0	4.5	4.5	0	0
Barley meal	(%)	72.5	72.5	71.0	71.0	69.5	69.5
Corn meal	(%)	12.0	12.0	12.0	12.0	12.0	12.0
Mineral premix*	(%)	2.77	2.77	2.77	2.77	2.77	2.77
Methionine	(%)	0	0.15	0	0.15	0	0.15
Calculated** digestible raw protein	(%)	12.66		12.66		12.65	

* The amounts of minerals added were (g/100 kg fodder): Ca, 720; P, 155; NaCl, 340; Fe, 4; Mn, 6.5; Zn, 4.5; Cu, 1.3; Co, 0.1; J, 0.1.

** According to figures given by *Breirem & Homb* (1970).

Diet composition. During the final 8 days before the experiment was started, the pigs were gradually adapted from the conventional feed to the final diet listed in Table 2.

Vitamins were given as follows (per kg feed): Vitamin A 3000 i.u., vitamin D_3 375 i.u., vitamin E 30 mg and vitamin B_2 3 mg. The feeds were mixed by Møllesentralen i/s, Oslo, Norway.

Housing and feeding. The experiments were conducted within closed buildings, with the pigs confined in pens, with 4 animals in each, and with arrangements for individual feeding. The pigs were hand-fed twice a day and given adequate water supply. The amount of feed given to each pig was according to the standards given by *Heje* (1972). The animals were weighed once a week. The duration of the feeding experiment was 77 days.

Fat thickness measurements. After 10 weeks of the experiment, the pigs were examined for fat thickness using the ultra sonic equipment and the standardized procedures of Norsk Svineavlslag, Hamar, Norway. Measurements were performed at 4 different defined places on the backs of the pigs.

Analyses for lignosulphonic acids. Water soluble components of SCP were isolated by adding 100 ml of distilled water to 10 g of SCP and, after shaking thoroughly for 30 min., the solution

was centrifuged for 10 min (2500 × g). The supernatant was used without further purification for the analyses of lignosulphonic acids by the colourimetric Pearl-Benson method (*Pearl & Benson* 1940), which is specific for lignosulphonic acids and lignin in solution (*Pearl* 1967). Various concentrations of sodium lignosulphonate in tap water were used as standards. The sodium lignosulphonate was kindly supplied by Alwatech A/S, Oslo, Norway.

For the determination of the amount of peptide-precipitating lignosulphonic acids present in the solution, the agar precipitation method (*Næss* 1971) was used.

RESULTS

The concentration of lignosulphonic acids in the SCP product used in this work was estimated to be 0.6 % ± 0.2 % (m. ± s). The concentration of peptide-precipitating lignosulphonic acids was found to be 1600 ± 50 diffusion units per g SCP product.

The results of the feeding experiments are summarized in Fig. 1 and in Table 3. The mean weight (kg) of the pigs at the end of the experiment was 79.6 ± 6.3 kg, and the feed eaten per kg gained weight was 2.97 ± 0.15 kg. No significant differences were found in the weight gain, or feed conversion ratio, for the pigs receiving 0 %, 6 % and 12 % of SCP in the feed, substituting 0 %, 4.5 % and 9 % of soy bean meal, respectively ($P > 0.05$). Nor was any significant difference in the weight gain and feed

Table 3. Start and final live-weights of the pigs, daily weight gains, feed conversion ratios, and back fat thicknesses (m. ± s).

	Pigs receiving				
	0 % SCP (groups 1 and 2)	6 % SCP (groups 3 and 4)	12 % SCP (groups 5 and 6)	0 % methionine (groups 1, 3 and 5)	0.15 % methionine (groups 2, 4 and 6)
Start weight (kg)	28.9 ± 3.3	28.5 ± 3.6	29.6 ± 4.8	29.7 ± 3.7	28.3 ± 4.2
Final weight (kg)	79.2 ± 6.0	79.0 ± 6.3	80.7 ± 6.7	81.7 ± 6.2	77.7 ± 6.3
Daily weight gain (kg)	0.65	0.66	0.65	0.68	0.64
Feed eaten/ gain (kg/kg)	3.01	2.89	3.01	2.91	3.04
Back fat thickness (mm)	11.8	12.6	12.7	12.7	12.0

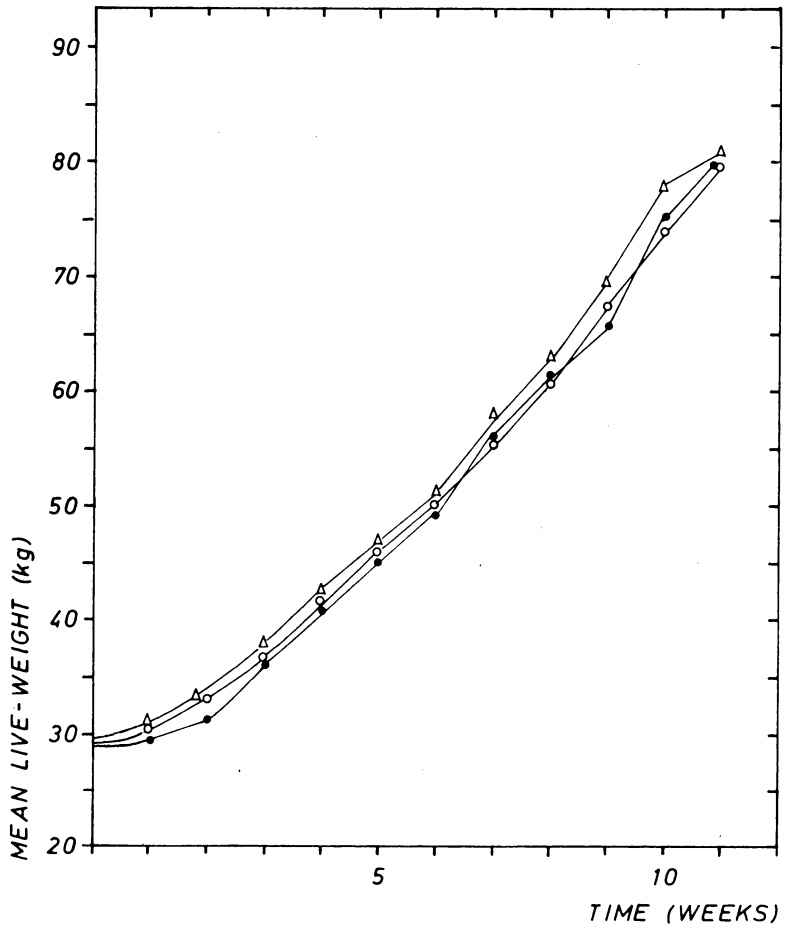

Figure 1. Live-weight of pigs receiving 6 % (●——●) and 12 % (△——△) single cell protein in the diet, and of the control pigs (○——○).

conversion ratio found for the pigs receiving 0.15 % of methionine, and the pigs not receiving this amino acid supplement in the diet ($P > 0.05$). The thickness of the fat on the backs of the pigs did not vary significantly between the groups of pigs receiving 0 %, 6 % and 12 % of SCP, or between the groups of pigs receiving 0 and 0.15 % of methionine as measured by the ultra sonic method ($P > 0.05$). The mean fat thickness was 12.4 ± 2.0 mm. The pigs thrived throughout the experimental period, except one of the controls, which died suddenly after 7 weeks of the experiment as a result of intestinal torsion.

DISCUSSION

Under the conditions used in the present investigation, it was found that substitution of 4.5, and 9.0 %, of soy bean meal by a corresponding amount of SCP, did not influence the weight gain, feed conversion ratio and fat thickness of growing pigs as compared with the controls. This was in spite of the fact that the SCP used had low values for protein quality, when used alone as the protein source, and in a mixture with soy bean meal when fed to rats. However, the feeding experiment with pigs shows the supplementary effect of SCP for other types of protein. The protein content in the cereals used should not be forgotten in this connection.

Most literature concerning SCP (e.g. *Mateles & Tannenbaum* 1968) states that the concentration of sulphur amino acids is low in SCP. No differences in the weight gain, feed conversion ratio and fat thickness were seen, however, in the present investigation using diets without, and with, the addition of 0.15 % of methionine. This may be explained by the presence of fish meal in the feed, which has high concentrations of sulphur amino acids (*Breirem & Homb* 1970).

The presence of animal protein in the SCP diet may also be considered to be important for the content of vitamin B_{12}, as this vitamin is not present to any extent in yeasts and cereals (*Wuest & Perlman* 1968).

It is interesting to notice that the concentrations of lignosulphonic acids in SCP produced from sulphite spent liquor may be considerable (about 0.6 % in the present work). However, even using as high a concentration as 12 % of SCP in the diet of the pigs, the final amount of lignosulphonic acids in the feed (about 0.07 %) is insignificant in comparison to the levels of lignosulphonic acids resulting in undesirable effects on pigs (*Næss & Fjølstad* 1973).

The results of the present work are of interest because they indicate that a relatively large amount of SCP can be used as a protein source in pig feeding and not just as a source of B-vitamins, which has been the major purpose when adding SCP to certain concentrates used in Norway up to the present. However, most authors do not recommend the use of concentrations as high as 12 % SCP in the diets of pigs. Thus *Pietz* (1967) states that 2.5—5 % SCP (Candida utilis) is suitable in diets for ani-

mals, generally. These figures are low compared with the acceptable amount of Saccharomyces cerevisiae SCP fed to pigs in the present experiments.

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SAMMENDRAG

Fórverdien til griser i vekst av encelleprotein (Saccharomyces cerevisiae) produsert fra sulfittlut.

En har studert virkningen på griser i vekst av å bytte ut 4,5 og 9 % soyamel med encelleprotein produsert fra sulfittlut i en diett, basert på cerealier og fiskemel. Innholdet av ligninsulfonsyrer i en-

celleproteinet ble funnet å være 0,6 % ± 0,2 % (middel ± s). Det ble ikke funnet noen virkning på tilvekst, fórutnyttelsesgrad eller fetttykkelse hos grisene i forhold til kontrollene når de ble fóret opp fra ca. 29 til 80 kg i løpet av 11 uker. En fant heller ingen virkning av å tilsette 0,15 % metionin til dietten.

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