EVALUATION OF PUMPKIN SEED MEAL AS A SOURCE OF PROTEIN FOR SWINE USING A DEPLETION-REPLETION TECHNIQUE [1]

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A reliable estimation of the value of a protein source for practical swine rations, by a conventional growth experiment, requires a considerable quantity of the respective protein source. As supply was limited, a depletion-repletion technique was used for the evaluation of the protein quality of expeller-extracted pumpkin seed oil meal.[4] Swine and rat experiments were conducted simultaneously using the same technique to compare the relative feeding value of pumpkin seed oil meal and expeller-extracted soybean oil meal.[5]

EXPERIMENTAL

Rats. Thirty-two growing rats averaging 93 gm body weight were fed individually a protein-free ration (table 1) ad libitum for a period of 8 days, during which an average weight loss of approximately 20% occurred. The animals (16 males and 16 females) were then randomly allotted by weight within sex to the 4 ration treatments. Soybean oil meal (SBOM) or

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[4] Expeller-processed, 40% crude protein, 22.3% crude fiber, 9.9% crude fat, 1.7% ash and 20.9% nitrogen-free extract; supplied by Central Iowa Bean Mill, Gladbrook, Iowa.

[5] Expeller-processed, 42.6% crude protein.

pumpkin seed oil meal (PSOM) was fed once daily in amounts equivalent to 1.0 or 1.5 gm of crude protein with free access to the protein-free ration which had been used for depletion. Consumption measurements of the protein-free diet were not taken. The protein allowance was readily consumed, except in a few cases on the high level of PSOM; but these were insignificant and no corrections were made.

Swine. Forty-eight crossbred pigs averaging 35 lbs. body weight and 63 days of age were individually fed a protein-free

TABLE 1

Ration composition for protein depletion of rats and for depletion and repletion of swine

INGREDIENT	DEPLETION RATIONS		12% PROTEIN SWINE REPLETION RATIONS [2]	
	Rat [1]	Swine [2]	Semi-purified basal	Corn basal
	%	%	%	%
Cornstarch	30.0	65.0	52.5	—
Dextrose	59.0	10.0	5.0	—
Sucrose	—	10.5	5.0	—
Corn	—	—	—	85.9
Pumpkin seed oil meal [3]	—	—	30.0	9.0
Lard	4.0	2.5	1.0	—
Beet pulp	—	4.0	—	—
Wood flock	2.0	2.0	1.0	—
Dicalcium phosphate	2.5	3.4	2.5	1.8
Calcium carbonate	—	—	0.4	0.7
Salt (Iodized)	0.4	0.5	0.5	0.5
Trace mineral premix [4]	0.1	0.1	0.1	0.1
Vitamin-antibiotic premix	2.0	2.0	2.0	2.0

[1] Calculated vitamins per pound of diet: vitamin A, 4500 I.U.; vitamin D_2, 900 I.U.; thiamine, 3.6 mg; riboflavin, 1.8 mg; niacin, 9.1 mg; calcium pantothenate, 3.6 mg; pyridoxine, 1.4 mg; alpha-tocopherol acetate, 45 mg; folic acid, 0.5 mg; menadione, 1.4 mg; para-amino benzoic acid, 0.5 mg; vitamin B_{12}, 4.5 μg.

[2] Calculated vitamins and antibiotic per pound of diet: vitamin A, 2000 I.U.; vitamin D_2, 500 I.U.; thiamine, 3 mg; riboflavin, 3 mg; niacin, 20 mg; calcium pantothenate, 6 mg; pyridoxine, 1.2 mg; alpha-tocopherol acetate, 10 mg; choline, 400 mg; folic acid, 9 μg; menadione, 3 mg; para-amino benzoic acid, 8 mg; vitamin B_{12}, 10 μg; chlortetracycline, 10 mg.

[3] Soybean oil meal replaced pumpkinseed oil meal in nitrogen equivalent amounts in the rations for half the animals.

[4] Contributed the following in milligrams per pound of complete ration: Fe, 32.0; Cu, 2.2; Co, 0.8; Zn, 37.1; Mn, 25.8; K, 3.4.

ration (table 1) ad libitum for a period of 12 days. Thirty-two animals with similar weight changes were selected and divided into 4 groups according to body weight. The animals were randomly allotted within each replication to the ration treatments. The 8 ration treatments consisted of a $2 \times 2 \times 2$ factorial arrangement of two types of diets (semi-purified and conventional) fed at two levels of protein (12% and 16%) in which the protein was from two sources (soybean oil meal and pumpkin seed oil meal). The ration ingredients were adjusted to approximate the same calculated level of minerals, trace minerals, vitamins and antibiotics. The composition of the protein-free and 12% protein pumpkin seed oil meal rations are presented in table 1. The animals were confined to individual metabolism cages with feed and water provided ad libitum for the 10-day repletion period.

Analysis of data. The repletion gain data for the rats and pigs and the feed required per pound of gain data for pigs were subjected to an analysis of variance as described by Snedecor ('56, chapters 10 and 11). Statements concerning statistical significance refer to a probability level of 5% or less.

RESULTS AND DISCUSSION

Rats. A summary of the repletion gains made by rats is presented in figure 1. On the average, rats fed PSOM as the source of protein gained 44% less than those fed SBOM. The performance on the higher level of protein (1.5 gm/day) was superior to that on the lower level (1.0 gm/day) within each source of protein. However, increasing the daily allowance of PSOM protein improved gains only slightly, whereas increasing the allowance of SBOM protein increased total gain markedly. These differences between sources of protein, levels of protein, and the source $\times$ level interaction were statistically significant.

Swine. The results obtained with swine (table 2 and fig. 2) correspond well with those obtained with rats, here again showing a definite inferiority of PSOM as compared to SBOM. The average repletion gain on the PSOM rations was 62% less

than that on the SBOM rations. Increasing the level of protein in the SBOM rations from 12 to 16% improved gains markedly, whereas increasing the level of protein in the PSOM rations resulted in a slight depression in gains. This interaction between source of protein and level of protein, as well as the above mentioned difference between sources of protein, was statistically significant.

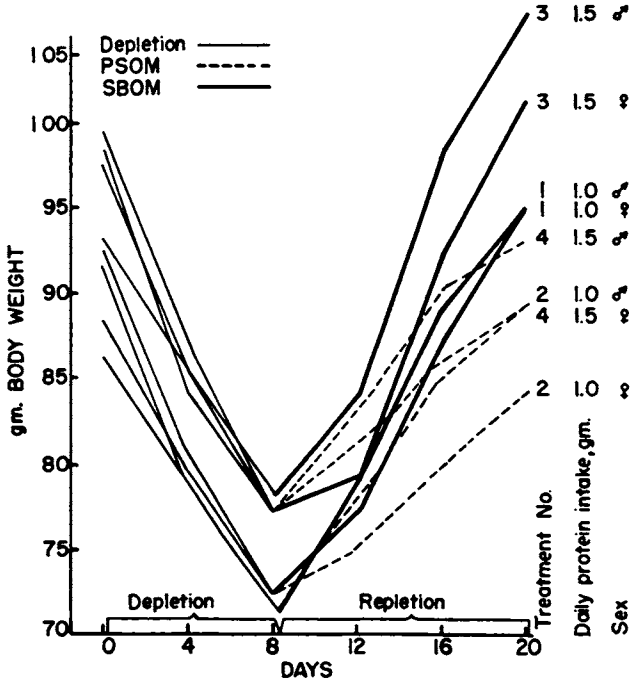

Fig. 1 Body weight changes in rats during depletion and during repletion on two levels of soybean oil meal and pumpkin seed oil meal protein.

The marked difference between the sources of protein was also reflected in the feed required per pound of repletion gain. The pigs fed the SBOM rations required significantly less feed to produce a pound of gain than did the pigs fed the PSOM rations. Increasing the level of protein in the SBOM (both types) rations and in the conventional type PSOM rations improved feed conversion; however, increasing the level of protein in the semi-purified PSOM ration appeared to be

detrimental, indicating that the factor or factors contributing to the poor performance of PSOM protein could not be overcome by increasing the level of protein from PSOM alone.

TABLE 2

Summary of average daily gain, daily feed and feed required per pound of repletion gain for swine

TYPE OF RATION	PROTEIN LEVEL	PROTEIN SOURCE	TREATMENT NUMBER	DAILY GAIN	DAILY FEED	FEED/ GAIN
	%			*lbs.*	*lbs.*	*lbs.*
Semi-purified	12	SBOM	1	0.93	3.26	3.50
		PSOM	2	0.40	2.20	5.50
	16	SBOM	3	1.18	2.44	2.07
		PSOM	4	0.38	2.36	6.20
Corn	12	SBOM	5	0.98	2.39	2.44
		PSOM	6	0.55	2.36	4.29
	16	SBOM	7	1.60	3.63	2.27
		PSOM	8	0.48	1.26	2.62
		Main comparisons:				
	Type of ration					
	Semi-purified			0.72	2.56	4.32
	Corn			0.90 [1]	2.41	2.91 [2]
	Protein level					
	12%			0.72	2.55	3.93
	16%			0.91 [1]	2.42	3.29
	Source of protein [3]					
	Soybean oil meal			1.17 [1]	2.93	2.57 [2]
	Pumpkinseed oil meal			0.45	2.04	4.65

[1] Significantly faster gains.
[2] Significantly less feed required per pound of gain.
[3] Source of protein × level of protein interaction significant.

No attempts were made to investigate the reasons for the poor quality of PSOM. The low feeding value may be due to a low biological value of its protein. Performance was only slightly improved by combination with corn protein; however, the two protein sources could well be limiting in the same amino acids. A low digestibility *per se* might exist, which may be aggravated by the high fiber content, since up to 8.8% of crude fiber was contributed to the rations by the PSOM.

Also, processing conditions may have influenced the protein value, although both meals were expeller-processed by the same plant. Toxic or inhibitory factors cannot be excluded, especially as the higher levels of PSOM protein resulted in slightly decreased gains in swine fed both basal rations. However, Nehring ('49) reported that pumpkin seed oil meals were

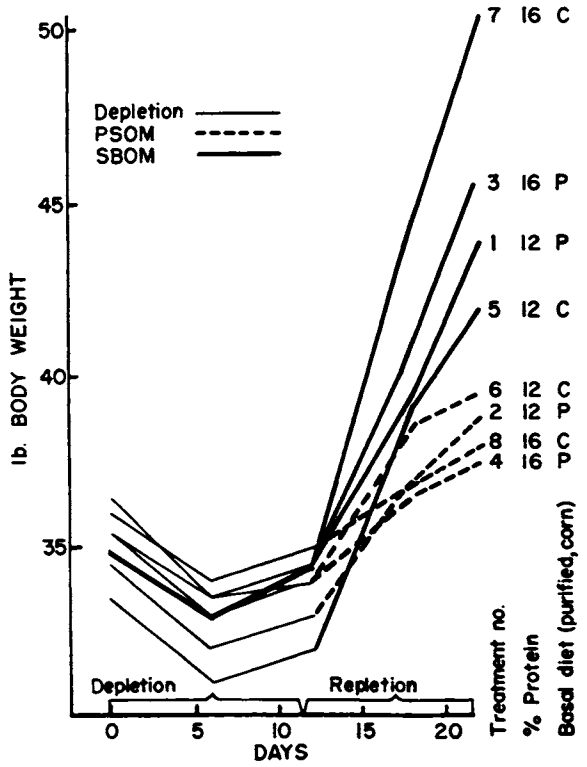

Fig. 2 Body weight changes in swine during depletion and during repletion on two levels of soybean oil meal and pumpkin seed meal protein.

a satisfactory protein source for ruminants and that digestibility of the protein was above 80% even for unhulled meal containing 30% of crude fiber.

An important difference seems to exist in the depletion behavior of rats as compared to swine. Rats of 93 gm body weight responded to the protein-free ration with an immedi-

ate drop in body weight, amounting to about 20% in 8 days. The pigs (35 lbs. body weight) almost maintained their weight over a period of 12 days, and most of them even gained slightly after an initial loss. The different physiological age between the two species and possible differences in the nutritional adequacy of the protein-free rations would not appear to be entirely responsible, since such a consistent weight loss on protein-free rations is known to occur generally in rats regardless of age. Data obtained recently at this station show that even much younger pigs (2 weeks of age and 7 to 10 lbs. body weight) withstand a protein-free diet over a 7-day period of time with little weight loss (Peo et al., '57).

Since a simultaneous comparison with a conventional growth experiment was not conducted, no statement can be made concerning the accuracy of the depletion-repletion technique as a tool for protein evaluation in growing swine. An obvious realimentation, expressed by high growth rate and thereby increased sensitivity to differences in protein quality, should be expected to be the main advantage of such a method. The high daily gain on the 16% protein corn-SBOM ration gives support to the verification of this principle.

SUMMARY

A depletion-repletion technique was employed with growing rats and swine to evalute the protein quality of an expeller-processed pumpkin seed oil meal. Soybean oil meal (expeller-processed) was used as a standard protein source and the two were fed in N-equivalent amounts. Rats and swine responded similarly to each protein source, showing markedly lower performance when fed pumpkin seed meal than when fed soybean meal. Increasing the level of pumpkin seed meal protein in the repletion diet of rats improved gains slightly, but the improved rates of gains were below those observed for the low level of soybean oil meal protein. Increasing the level of pumpkin seed protein in the diet of pigs appeared to depress gains slightly and increase feed required per pound of gain.

A marked difference was observed between the rat and the pig in their response to a protein-free diet, which was otherwise nutritionally well balanced. The growing pigs (35 lbs. body weight) showed little or no weight loss over a depletion period of 12 days, whereas rats (93 gm body weight) lost approximately 20% of their body weight in an 8-day period.

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