FATS AND PROTEINS RESEARCH FOUNDATION, INC.

Director's Digest

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VALUE ADDED ANIMAL PROTEINS

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A portion of this material was taken from
presentations and papers of Dr. Terry Klopfenstein

INTRODUCTION

Over the past several years animal nutritionists have come to realize the importance of by-pass proteins for ruminants. By-pass proteins is that protein that by-passes (or escapes) digestion by microorganisms in the rumen. Of course, to be of value to the animal this protein must subsequently be digested in the small intestine. Most of the protein digested in the small intestines of ruminants is the microbial protein from the rumen. However, in many production situations this protein is not sufficient to meet the animals' needs and by-pass protein is the only way to supply the additional protein. Growing animals and lactating animals have the highest protein requirements and therefore respond the most to ruminal escape protein.

Most commonly fed protein sources contain some by-pass protein. The protein in soybean meal, for example is 25 to 30% by-passed. On the other hand, there are several protein sources, such as the protein in grain by-products that are 50-60% by-passed. The primary products by renderers are highly by-passed and this may be due both to the inherent nature of the proteins and to the heat applied during the rendering process. Blood meal leads the list of these products...75 to 80% protein by-pass. Flash dried blood meal protein is consistently highly by-passed and is probably the best by-pass protein source available. Because it has two times as much protein as soybean meal and because that protein is by-passed nearly three times the level of that in

soybean meal, blood meal could be worth four to six times the price of soybean meal per ton in certain feed formulations. Table I shows some typical amino acid profiles for flash dried blood meal.

Meat meal and meat and bone meal can be somewhat variable in quality because of the variability in raw materials. By-pass is not as consistent as that in blood meal and may range from 45 to 70%. Because of the calcium and phosphorus contents, meat and bone meal is often a very economical source of by-pass protein when due credit is given to the minerals as well as the by-pass protein. Table II shows some typical amino acid profiles for meat and bone meal.

Feathers are not digested by animals, even rumen microorganisms, in their native state, but with hydrolysis these feathers are readily digested by both ruminants and nonruminants. Even though it is hydrolyzed, the protein in feather meal is highly by-passed...ranging from 65-70%. Because of this, by-pass and the protein content of feather meal, it may be worth up to four times the value of soybean meal per ton in some growing ruminant diets. Table III shows a typical analytical profile for feather meal.

In the past, little attention has been given to amino acid content of protein sources for ruminants because the microorganisms supplied much of the protein. However, if most of the protein in a supplemental source is by-passed, the amino acid content becomes relatively more important. Meat and bone meal has an excellent balance of amino acids with blood meal not as well balanced but is an excellent source of some amino acids such as lysine. Feather meal has a relatively poor balance of amino acids but is a good source of the sulfur containing amino acids and these sulfur amino acids are very important for ruminants because the microorganisms are somewhat low in them.

Animal Proteins in Ruminant Rations

With the continued expansion in the poultry industry for the past ten years and the accompanying increased production of feather meal, it became essential that the rendering industry find new uses for hydrolyzed poultry feathers.

Beeson and Perry et al (1980) published one of the earlier papers on the utilization of hydrolyzed feather meal in beef cattle diets. The digestion

trials at Purdue demonstrated (1) soybean meal was broken down in the rumen nearly twice as rapidly as hydrolyzed feather meal and (2) use of feather meal in the diet resulted in significantly more protein storage and retention than was true for soybean meal.

For the past eight years, Klopfenstein et al (1981) (1985) (1989) has not only investigated single animal protein ingredients as a by-pass protein source in growing beef animals but also combinations of protein ingredients such as blood meal and corn gluton meal; meat and bone meal feather meal and blood meal; blood meal and feather meal. Figure I shows the regression or gain on protein intake for a growth study with steers at Nebraska. The resulting slopes (numbers on graph) are the protein efficiencies from the growth study.

The Nebraska researchers found that a mixture of feather meal with blood meal or meat and bone meal provides an excellent balance of by-pass amino acids. Present research, which is in progress, will try and define the most economical and productive combinations of by-pass protein sources, but at the current time they believe feather meal could provide at least 50% of the supplemental protein with the remainder coming from blood meal or meat and bone meal. The feeding of slowly degraded proteins may create an ammonia deficiency in the rumen that can be alleviated by including urea in the diet.

When a 50:50 mixture of feather meal and blood meal was fed, lysine seemed to be overfed, so it was hypothesized that lower proportions of blood meal would be effective. Current studies are testing 12.5, 25 and 50% blood meal replacing feather meal. Feather meal alone has less than one-half the value blood meal, but when only 12.5% feather meal was replaced by blood meal, a large improvement in protein efficiency was obtained. Feather meal from most poultry processors contains close to ten per cent blood. This is the approximate proportion when all of the blood from poultry slaughter is dried with the feathers.

To prevent the destruction of lysine and other heat sensitive amino acids, the blood should be added to the feathers for drying after the feathers have been hydrolyzed. Table IV shows the effect of hydrolyzing blood with feathers on protein by-pass and digestibility.

As you will read in Dr. Stern's paper, feeding animal by-product proteins which are resistant to microbial degradation in the rumen will only be successful in affecting animal performance if (1) proteins are not denatured to the extent that intestinal absorption of amino acids is diminished so that the net effect

on amino acid supply is reduced and (2) the animals have the metabolic capacity to respond to an increase of amino acids supply; that is, requirements for amino acids have not been met.

Stern et al (1988) studied the effect of ruminal protein degradation of blood meal and feather meal on the intestinal amino acid supply to dairy cattle. Total tract N digestibility was lower for diets containing feather meal (63.4%) and a 50:50 combination of blood meal and feather meal (66.3%) than the soybean meal diet (78.5%). Total amino acid flow to the duodenum was 19.3 and 15.6% higher for cows fed the blood meal and feather meal diets respectively compared with the soybean meal diet. Total amino acid absorption from the small intestine was higher for the blood meal and feather meal diet compared with the soybean meal diet. Absorption of individual amino acids, expressed as a percentage entering the duodenum, was lowest for the feather meal diet.

All of the recent work in the utilization of animal proteins in ruminant rations has had a positive effect on their per unit of protein value versus soybean meal. Tables V and VI show the improvement in blood meal and feather meal per unit protein prices versus soybean meal protein.

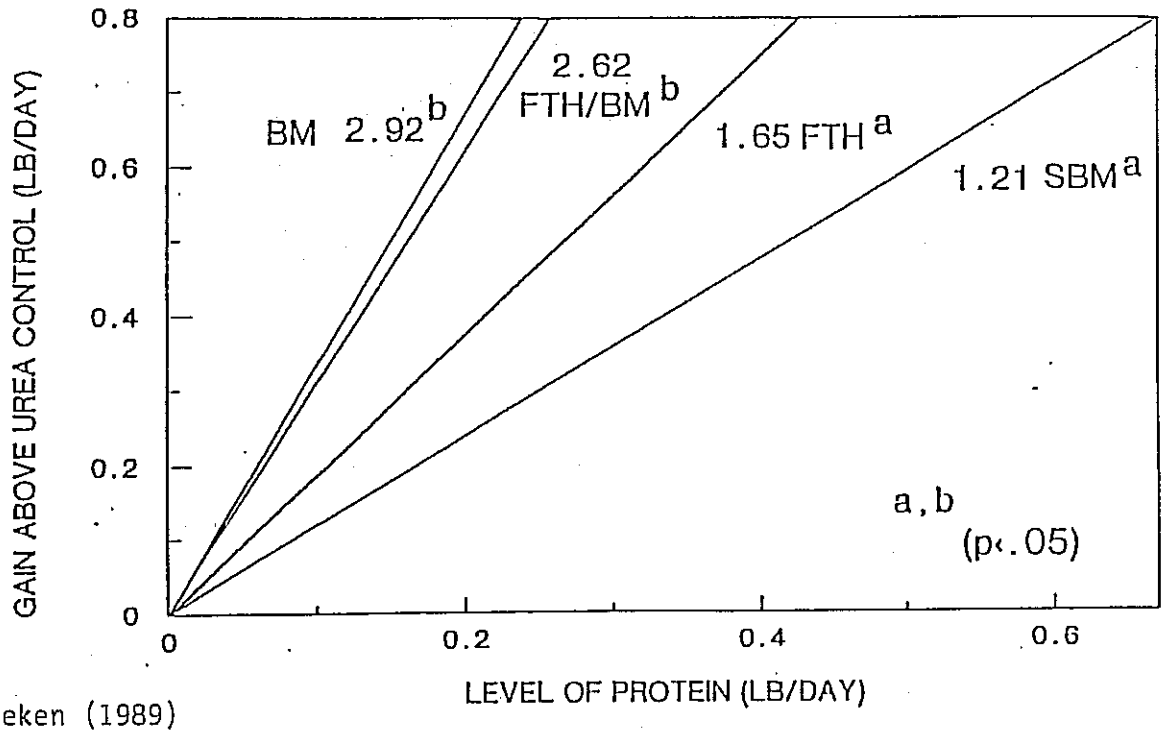
Poultry By-Product Meal In Pet Food Rations

One other area where there has been improvement in the value of an animal protein by-product is the production of low ash poultry by-product meal (9-11% ash) from regular poultry by-product meal (14-19% ash).

There are approximately 582,000 tons of poultry by-product meal produced in the U. S. each year with over one-half of this tonnage being utilized in low residue pet food rations. Eight to ten percent of this production is further processed into the low ash meal, with almost all of it being formulated in cat diets. Table VII shows the analytical comparison of the two poultry by-product meals.

Nutritionists of companies utilizing low ash poultry by-product meal are reluctant to disclose their reasons for paying a twenty to forty per cent premium for the low ash meal, but the higher protein content plus improved digestibility and palatability and the past association of high ash diets with urinary calculi in cats, could be some of the major reasons.

Figure 1.
Protein Efficiency of Calves Fed Soybean Meal (SBM)
Feather meal (FTH) and Blood Meal (BM).



Goedeken (1989)

TABLE I

AMINO ACID PROFILE OF BLOOD MEALS

	(1) Per Cent	(2) Per Cent	N.R.C. Per Cent
Protein	90.0	90.0	86.0
Arginine	4.37	4.00	3.59
Histidine	5.25	6.00	5.18
Isoleucine	1.18	1.26	0.91
Lysine	8.57	7.69	7.44
Methionine	1.33	.71	1.05
Threonine	4.71	3.49	3.63
Tryptophan	1.24	1.54	1.05
Valine	7.28	6.88	7.52

TABLE II

AMINO ACID PROFILES OF MEAT AND BONE MEALS

	(1) Per Cent	(2) Per Cent	N.R.C. Per Cent
Protein	50.5	51.1	50.9
Arginine	2.87	3.83	3.65
Histidine	1.01	0.88	0.96
Isoleucine	1.51	1.50	1.47
Lysine	2.87	2.68	2.89
Methionine	0.83	0.73	0.68
Threonine	1.74	1.80	1.60
Tryptophan	0.31	0.29	0.28
Valine	2.34	2.32	2.14

TABLE III

AMINO ACID PROFILE OF FEATHER MEALS

	Holly Farms Per Cent	N.R.C. Per Cent
Protein	85.0	84.9
Arginine	8.51	5.33
Cystine	3.85	3.21
Histidine	0.97	0.47
Isoleucine	4.08	3.51
Lysine	2.41	1.67
Methionine	0.54	0.54
Threonine	4.52	3.63
Tryptophan	0.50	0.52
Valine	6.02	5.85

TABLE IV

EFFECT OF HYDROLYZING BLOOD WITH FEATHERS
ON PROTEIN BY-PASS AND DIGESTIBILITY

Protein Source	Bypass[a]	Digestibility[b]	Net Bypass[c]
Soybean meal	26[d]	100[e]	26
Blood + raw feathers hydrolyzed, ring dried	76[e]	87[d]	63
Blood + hydrolyzed feathers then ring dried	82[f]	96[e]	78
Blood meal	90[g]	100[e]	90
Feather meal	73[e]	96[e]	69

a Bypass determined as percentage of protein remaining after 12 hours of ruminal incubation in dacron bags.
b Total tract digestibility determined in lambs.
c Net bypass - Bypass - indigestibility.
d,e,f,g Means within columns with unlike superscripts differ (P .07).

Goedeken (1989)

TABLE V

	BLOOD MEAL PRICE (a.)		44% SOYBEAN MEAL PRICE (b.)	
	Per Ton	Per Unit of Protein	Per Ton	Per Unit of Protein
1982	$326.70	$3.84 (95%)	$178.67	$4.06
1984	$331.49	$3.90 (102%)	$166.63	$3.79
1986	$376.08	$4.41 (123%)	$156.93	$3.57
1987	$435.15	$5.12 (129%)	$174.93	$3.98
1988	$558.64	$6.57 (125%)	$231.13	$5.25

a. Yearly Average - Iowa-Minn. production (3 plants)
b. Yearly Average - Decatur, IL.

TABLE VI

	FEATHER MEAL PRICE (a)		44% SOYBEAN MEAL PRICE (b)	
	Per Ton	Per Unit of Protein	Per Ton	Per Unit of Protein
Jan.1985	$ 95.25	$1.12 (44%)	$109.63	$2.49
Dec.1985	$145.20	$1.71 (52%)	$145.63	$3.31
Dec.1986	$164.94	$1.94 (58%)	$147.69	$3.36
Dec.1987	$255.56	$3.01 (63%)	$210.63	$4.78
Dec.1988	$259.70	$3.06 (56%)	$241.97	$5.50

(a) Jacobsen Feed Bulletin Monthly Average S.E. Mkt.
(b) Jacobsen Feed Bulletin S.B. Meal Monthly Average Decatur, IL.

TABLE VII

	HOLLY FARMS REGULAR POULTRY BY-PRODUCT MEAL Per Cent	HOLLY FARMS LOW ASH POULTRY BY-PRODUCT MEAL Per Cent
Protein	65	70
Ash	17	9-11
Pepsin Digestibility	89	92
Arginine	4.35	4.77
Cystine	0.65	0.84
Histidine	1.25	1.53
Isoleucine	2.02	2.46
Lysine	3.68	4.52
Methionine	1.18	1.45
Threonine	2.34	2.75
Tryptophan	0.47	0.62
Valine	2.51	2.91

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