

FEEDING FATS

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In man's search for methods to improve the efficiency of animal production and at the same time reduce the cost per unit of food produced, he has turned to the use of a great variety of dry feed ingredients, fats and oils, nutrient extenders and unidentified growth factors (UGF) to accomplish his objectives. The advent of the computer has made it possible to evaluate these nutrients, crude as the ingredient evaluation system may be, and combine them in such a combination that we can formulate feeds with several objectives such as: (1) the least cost feed formula, (2) the least cost of food production formula, (3) greatest profit feeding program or (4) a formula to eliminate a specific flavor such as the elimination of the fish flavor. Our early use of the computer was to develop a least cost feed formula, but with the integration of the food producing industries our attention had to be redirected to a combination of the system. The world needs food, and above all we must be cognizant of the needs of man.

As our industries roll along it is not uncommon for a specific industry to get caught in a rut. Our current automobile industry is a good example -- in 1975 approximately 20% of the market was captured by the small import car. I doubt if any industry has escaped this experience. Certainly the poultry industry has seen its share of changes.

The rendering industry has had changes too. Years ago our grandmothers made lye soap from animal fat. With the development of the fat industry large soap producing plants were developed. But Father Time has made changes, and it all happened about the end of the second World War. The introduction of detergents for washing compounds created a gigantic shift in the use pattern for fats and oils. Now faced with a vast surplus of fats and oils, the fat processors turned to the poultry producers for relief. Here there was a new market and the poultry growers had a cheap source of energy that not only made their broilers grow faster, but also made them more tasteful.

The mechanization of the farm and industry produced another change. No longer did man need those heavy meat, potato and gravy meals. Instead, man turned to eating many delightful foods such as salads and other foods produced by deep fat frying -- Kentucky Fried Chicken, French fried potatoes, potato chips, fish and chips, Dunkin Donuts and many other deep fat fried goodies. Food companies used specific fats and blends of animal fats and vegetable oils to create their unique flavor. They developed a new market and to maintain this market they soon learned that fats used for deep fat frying foods had to be kept fresh. This necessitated that the fats and oils used for deep fat frying had to be rotated to keep their food products fresh. The new result of all of these changes is that the renderer obtained a new source of raw material -- spent edible fats and oils or yellow grease.

Today spent edible fats and oils contribute to the total supply of feeding fats. Even if feeding fats are purchased from the fat blender their fats generally contain large quantities of what is called yellow grease for they, as a group, are one of the renderers most important customers.

Years ago the term "grease" indicated that the fat was of pork origin. Going back to the 19th century, and perhaps earlier, some European countries used the term "grease" to identify what we call lard. Today the term "yellow grease" does not indicate that the product is of pork origin, but merely means that it has a lower titre or melting point than tallow. Therefore, we now find that yellow grease may be a product of pork origin, or a mixture of animal fat and vegetable oil, or largely vegetable oil. Yellow greases have been known to contain in excess of 25% linoleic acid. The net result is that our current feeding fats are largely a by-product of the food and meat industries. Very little of the fat sold as feeding fat is pure tallow. For those feed companies who still request tallow, an adequate supply of high grade tallow is available, but high quality tallow finds many other uses -- all the way from fancy lipstick to high temperature lubricants for jet engines.

Because of the changing pattern in the usage of fats and oils, the National Renderers Association (NRA) recently conducted an in-depth survey, national in scope, to learn more about the composition of what the renderer sold as feeding fats. The American Meat Industry Service Laboratory and WARF were employed to conduct the basic analysis. The results of the survey are most interesting. Although the input material for production came from varied sources, the consistency of source usage by the individual rendering plants was very high. Only 2.5% of the group surveyed indicated that they varied the input material. With this as a starting point, the survey produced some most interesting data. Table I lists the composition of feeding fats.

A fat with a low MIU is one of the major factors to consider in determining fat quality. As indicated in the survey feeding fats sold by the renderer contained an average MIU content of 1.33 (+ 1.10%). This is less than 40% of the standard established by the American Feed Control Officials (AAFCO). In most cases those few fat samples which exceeded the AAFCO standards probably could have been improved with further fat processing techniques. The average Free Fatty Acid Content is only 6.5%, again an indication of a high quality fat.

A review of the feeding fat composition in Table I show that the fatty acid profile is more like PORK FAT than TALLOW. Furthermore, this information shows that there is room for selection of FEEDING FAT with a higher or lower linoleic acid content should there be a need for such a product.

In some areas of the country, poultry men are ordering a 50:50 blend of FEEDING FATS and TALLOW. This has become a rather common practice in some of the heavy turkey producing areas of our country. Regardless of what type of fat is used by the poultry producer, the bulk of the feeding fat originated at the rendering plant.

The members of NRA are deeply interested in research. NRA and the meat industry support work at state and federal governmental, and independent, research establishments. Currently, Dr. Jerry Sells (1974) at South Dakota State University is conducting work with laying hens in which he is feeding different levels of animal feeding fat with different cereal grains where the fat and one kind of grain constitute the major source of energy. From his work it would appear that the type of plant tissue, or perhaps the type of carbohydrate, may have an effect on feeding fat utilization. He reports, "This extra caloric effect of fat was particularly evident in rations based on relatively fibrous grains. When feed grade animal fat was included at 0, 2, 4 or 6% in rations based on oats, ration M.E. determined experimentally was increased 100 k cal./k with each 1% increase in dietary fat. This increase was fairly constant irrespective of the test level of fat. On a calculated basis, the expected increase was 53 k cal./k for each 1% of added fat." Therefore, the calculated extra caloric effect in this laying hen experiment was 47 k cal./k for each 1% added dietary fat, or nearly equal to the original fat energy value used. A review of the raw data would suggest that this extra caloric effect was somewhat higher for the lower levels of fat; furthermore, the extra caloric effect was intermediate for barley and somewhat less pronounced for the high density grains -- corn, milo and wheat.

Dr. Jerry Sells (1972) earlier reported on some preliminary research work which led to his indepth study currently in progress. In this earlier work he reported that the addition of 5% animal feeding fat improved egg production 12.7 and 9.5% for the oat and barley ration (See Tables 2 and 3). The hens fed the oat and barley ration with the 5% added animal fat required 24 and 20% less feed per dozen eggs produced. These findings are currently being used commercially in oat and barley producing areas.

The extra caloric effect of fat has been shown in many energy evaluation experiments where fat has been added at practical feeding levels. A number of types of fats and oils including tallow have produced these effects. In addition, experiments showing specific ME values which illustrate the extra caloric effect in poultry have been reported by Wilder (1959), Cullen (1962), Jensen (1973 and 1974), Gomex (1974) and others including Ewing (1963) and Vahra (1972). In addition, Bushong (1973) reported that when fat was fed to broilers at a level of 18% it contained 8057 k cal ME per k but when it was fed at 12% the fat contained 9387 k cal ME per k.

Reports of this extra caloric effect of feeding fats can also be found in swine feeding trials as reported by Bosticco (1974) and Moser (1975).

Although we may attempt to explain this extra caloric effect of feeding fat based on some Bacterial, Biochemical, Physiological or Physical function, there is not sufficient documented experimental evidence to explain this SYNERGISM which is so frequently reported when practical ration levels of feeding fats are added to the diet.

Energy values determined during the second and third week of a chicks life represent the value of the specific fat or oil at that specific age. It is questionable if these values represent an accurate evaluation of the energy value during the life cycle of the animal.

Recently Displininghoff (1975) reported on four different fats of known unsaturated to saturated ratios (See Table 4). This experiment measured the ME values of these fats fed to broiler chicks during the second and third week of life. In this experiment which used 3 replications of broiler chicks per treatment with unsaturated FA to saturated FA ratios of 1.24:1, 1.5:1, 1.72:1 and 2.05:1 there was no significant differences in the feed/gain between any of the 4 fats although there was a small 0.06 lb. F/G advantage for the fat with the 1.72:1 ratio (See Table 5). The ME values were determined by the method of Hill (1960), Almquist (1971), and Jensen (1970). Using the average values of these three procedures these fats had an ME value of 3707 k cal/lb. or 8155 k cal/k (See Tables 6 and 7). It would have been most interesting to have evaluated these same fats during the 6th or 7th week of their life, and also in laying rations, using a practical type ration. All indications would suggest that the energy value may have been 10 to 20 percent greater.

The time has arrived when it is necessary to evaluate our resources with greater precision. It is often said that our present system of determining the energy value of feed ingredients overestimates the ME value of proteins by 10-20% and underestimates the ME value of fat by 10-20%. The cost of energy is too high to allow this imperfection to continue. A new approach for determining the energy value of fats and oils for the different stages of the life cycle of the animal must be developed.

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Table 1. ANALYSIS OF FEEDING FAT BASED ON A NATIONAL SURVEY

<u>Component</u>	<u>Average</u>	<u>Std. Dev.</u>
1. Moisture and Volatiles	0.44%	(0.57)
2. Insolubles	0.21%	(0.50)
3. Unsaponifiables	0.68%	(0.52)
4. Total MIU (1, 2, 3)	1.33%	(1.10)
5. Free Fatty Acid	6.50%	(7.34)
6. Capillary Melting Point	39.8C	(3.45)
7. FAC Color	25	(9.00)
8. Unsaturated Fatty Acids 50.50%		
Myristoleic (C14:1)	0.23%	(0.25)
Palmitoleic (C16:1)	2.74	(0.89)
Oleic (C18:1)	38.20%	(3.32)
Linoleic (C18:2)	8.69%	(5.40)
Linolenic (C18:3)	0.94%	(0.54)
9. Saturated Fatty Acids 49.50%		
Palmitic (C16)	18.56	(2.31)
Stearic (C18)	12.17	(2.77)
Misc. F.A. (C12), (C14), (C15) and (C17)		
Ratio of Palmitic to Stearic 1.5:1		

Table 2. PRELIMINARY WORK -- THE INFLUENCE OF ADDING FEEDING FAT* TO DIFFERENT GRAINS FOR LAYING HENS

<u>Ration Treatment</u>	<u>Rate of Egg Prod. (%)</u>	<u>kg Feed Per kg Eggs</u>	<u>Av. Egg Weight (g)</u>
No Added Fat			
Corn	75.6	2.50	60.0
Oats	58.9	3.42	60.4
Wheat	74.5	2.61	58.5
Barley	66.5	3.12	58.8
Millet	73.8	2.72	59.8
<u>Difference</u>			
Added Fat		+	-
Corn + 2% Fat*	80.1	4.5	2.26 0.24 61.5
Wheat + 3% Fat	76.7	2.2	2.33 0.28 62.5
Oats + 5% Fat	71.7	12.7	2.60 0.82 60.3
Barley + 5% Fat	76.0	9.5	2.52 0.60 61.4
Millet + 5% Fat	78.6	4.8	2.36 0.36 60.8

* Feeding Fat referred to as Animal Fat was fed for 252 days.

Sells, J. L. and R. L. Johnson, North Dakota State University, unpublished data. 1972

Table 3. PRELIMINARY WORK -- INFLUENCE OF ADDING FEEDING FAT* TO DIFFERENT GRAINS FOR LAYING HENS OBSERVED INCREASE IN M.E. DUE TO ADDED FAT

Grain Base	Added Fat* %	Expected Increase In M.E. Due to Added Fat (k cal/kg)	Observed Increase In M.E. Due to Added Fat	Differences
Corn	(2)	145	497	352
Wheat	(3)	249	563	314
Oats	(5)	475	820	345
Barley	(5)	453	873	420
Millet	(5)	440	867	427

* Fat referred to as Animal Fat was fed for 252 days.

Sells, J. L. and R. J. Johnson, North Dakota State University, unpublished data, 1972

Table 4. UNSATURATED FATTY ACID PROFILE OF FAT SAMPLES*

Sample No.	Unsaturated Fatty Acids				Total %
	16:1 %	18:1 %	18:2 %	18:3 %	
1	2.81	41.11	10.02	1.10	55.04 (1.24:1)**
2	2.47	37.71	16.61	2.06	58.85 (1.51:1)**
3	2.14	34.04	22.75	2.97	61.90 (1.72:1)**
4	1.68	30.50	29.92	4.08	66.18 (2.05:1)**

* National By-Products, Inc., 1975

** Ratio UsSFA:SFA

Fat Composition was determined by gas chromatography.

Table 5. WEIGHT GAINS AND FEED CONVERSIONS*

Sample	Ratio Unsat. to Sat. F.A.	Chicks 2nd & 3rd wk. of life		Means of 3 groups
		Gain*** g	F/G Unadjusted	F/G*** Corrected
Control	---	271a	1.71	1.71
1 **	1.24:1	297b	1.48	1.73
2 **	1.51:1	299b	1.46	1.71
3 **	1.72:1	311b	1.42	1.66
4 **	2.05:1	303b	1.44	1.70

* National By-Products, Inc., 1975

** Assumed M.E. value of 8.16 k cal./g of fat

*** Values which are not followed by the same litter differ significantly at the 1% level of probability. There was no significant difference in the corrected feed conversion.

Table 6. DETERMINED M.E. VALUES OF FAT SAMPLES*

Sample No.	Total Collection Method (1)	Chicks 2nd & 3rd wk. of life		Means
		Fiber Analysis Method (2)	(Almquist Method + 4%) ²	
		k cal./g Dry Basis		
1	7.82	7.68	(7.37) (7.99)	7.75**
2	8.11	7.93	(7.61) (8.25)	8.02**
3	8.45	8.37	(8.04) (8.71)	8.41**
4	8.27	8.24	(7.91) (8.57)	<u>8.25**</u>
Average of the 8 determinations				8.11

* National By-Products, Inc., 1975

** These determined M.E. values should be combined to one average value because there was no statistically significant differences between the feed conversion of the 4 samples of fat.

¹Hill, 1960

²Almquist, 1971

Table 7. DETERMINED AND CALCULATED M.E. VALUES OF FAT
FOR THE CHICK DURING ITS 2ND AND 3RD WEEK OF LIFE*

<u>Fat</u>	<u>Hill</u>	<u>Almquist</u>		<u>Jensen</u>	<u>Means</u>
<u>UnS:Sat Fatty Acid Ratio</u>	<u>Total Collection Method</u>	<u>Fiber Analysis Method</u>	<u>Error Range ± 4%</u>	<u>"Adjusted Energy" Method</u>	<u>Means</u>
	k cal./lb.				
1.24:1**	3530	3460	3322 3598	3580	3523
1.51:1**	3660	3580	3437 4004	3750	3663
1.72:1**	3810	3780	3629 3921	4100	3896
2.05:1**	3730	3720	3571 3869	3790	<u>3746</u>
					3707
					(8205)***

* Adapted from the National By-Products, Inc., report, 1975

** Since there was no statistically significant difference in the F/G all values were combined.

*** Metric System