Director's Digest
FATS AND PROTEINS RESEARCH FOUNDATION, INC.

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FEEDING FATS

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The animal feed and ingredient industry is a major user of rendered animal fats. Likewise, animal fat in refined forms is used in hundreds of products and applications ranging from jet engine lubricants, rubber production, biodiesel, plastics, paints, varnishes, cosmetics and the traditional use for soap manufacture. Of the approximate 9 billion pounds of edible animal and rendered fat, over 50% (5 billion pounds) is produced by the North American renderers. Feed fat is estimated to be 65% of the total usage of rendered fats placing its total annual usage at 3.3 to 3.5 billion pounds. It is still increasing as technology continues to refine its benefits and application.

There has been a tremendous increase in the use of inedible tallows and greases in the rations of all major species, starting in the 1950s and annual increases ever present. Fats are the most concentrated of all food materials, furnishing about 9 kilocalories of energy per gram. This compares to about 4 each furnished by proteins and carbohydrates. In recent years, energy values for feeding fats have generally been revised upward. Thus, the 2.25 times value as is often used to compare their energy content to corn may be minimal and may be as high as 3.8 times when considering the "extra caloric value" that results when fed under specific conditions. The current National Research Council energy values for several fats and oils is presented in Table 1.

Fats are the highest caloric-dense foodstuff. In addition, fats and certain of their component fatty acids provide essential and indispensable body functions separate and aside from their caloric function. Feeding fats provide a value added utilization for fat sources that result from all livestock production as by-product material not consumed by humans. Fat from animal sources and offal provided by the rendering industry has and continues to be a most valuable economic and ecological contribution to animal agriculture. Few people across this continent and the world are appreciative of this recycling fact. Unfortunately, few livestock producers and animal researchers are aware that the renderer must process more pounds of their product than is sold to the consumer as meat. As long as there is an animal agriculture, the rendering industry and its process offers the only logical, environmentally-acceptable, biosecure procedure for recycling the inedible components of its production into quality, value-added products. Fat is one of those very useful products.

Much like the rendering industry in total, feeding fats are often misunderstood by the end user and, as such, possess mystic properties and characteristics. Fats by chemical structure are rather difficult to describe. However, the predominance of fats are composed of three fatty acids combined with glycerol (triglycerides). The fatty acids are actually the components that give the respective fats their individual characteristics. It is with these characteristics that feeding fats have inherited the myths from the fat specifications that were traditionally developed for the primary use of fats in the making of soap. Thus, the terminology and specifications for many fats are formed on the basis for defining quality and trading specifications as utilized by the soap and chemical industries. For reference, the commodity trading standards for tallow and greases are included in Table 2. These specifications place an emphasis on titre (a measure of hardness), free fatty acid content (FFA) and color of the fat in determining its grade and value. Hard fats (high titre) make hard soaps, while soft fats (lower titre) make softer soaps. Fats with higher FFA contents have greater glycerine loss in the soap making process, and dark colored fats make soaps of lower quality.

These specifications, however, do not have the same impact on value or their utilization and quality when used as feeding fats. As an example, in feeding fats, color actually has no nutritional value. Therefore, terms such as "bleachable" and "choice white" has really lost meaning in fully describing specifications for feeding fats.

The type of fat is designated by species of origin. However, with the advent of recycled restaurant and cooking oils, animal fats are often blended. Cooking oils vary considerably depending upon the plant or animal source. Most contain animal fat as a result of the cooking process, but most of the unused cooking oils are primarily plant origin. The terms edible and inedible have often been used but do not influence the value or specifications when used as feeding fats. Edible fats are the highest quality for food or chemical purposes (though not necessarily for feed purposes) and must be produced in state- or federally-inspected plants operating under the same inspection and processing standards mandated by the U.S. Department of Agriculture for meats and meat products. Conversely, inedible fats is a term that denotes lower-quality products for the aforementioned uses and should be changed by the industry to the more distinctive and descriptive specification according to use. Questions commonly arise concerning the biosecurity of feeding fats. Fats are a very poor media for bacterial replication, being virtually devoid of protein and moisture. The rendering process subjects the products to temperatures that destroy bacterial agents. Their acid properties likewise are not conducive for bacterial growth. Therefore, biosecurity of properly processed and stored feeding fats is not a concern.

Animal feed fat must contain not less than 90% total fatty acids, not more than 2.5% unsaponifiable matter, and not more than 1% insoluble impurities and a guarantee of maximum moisture and free fatty acids. Thus, the broad categories of feeding fats that are most commonly offered to the feed industry are:

Animal Feed Fat

Beef
Pork
Poultry

Blended Feed Grade Animal Fat

Blended Feed Grade Animal and Vegetable Fat (A/V Blends)

Feed Grade Vegetable Fat or Oil

Titer and Iodine Value

If the product bears a name descriptive of its species kind or origin, its labeling must correspond to the further designations of beef, pork or poultry as applicable.

Thus Beef Feeding Fat (titer 42-45 and IV 43-45), Pork Feeding Fat (titer 36-40 and IV 63-65), and Poultry Feeding Fat (titer 31-35 and IV 77-80) designations are appropriate.

A procedure (Boemer number determination) is available for the detection of the presence of tallows and similar fats in pork fat. The procedure can detect 10% beef fat with certainty and levels of 5% less accurately. Animal Feeding Fat includes rendered fats from beef or pork by-products predominately, thus the feeding fat designations of tallow and grease only designate the titer of the fat. The fat can be identified as tallow if it possesses a titer of 40 or higher or grease if under 40 titer regardless of animal origin. A titer of at least 40 is required for the tallow designation but does not require that the fat be 100% cattle origin.

Titer is a measure of the hardness or softness of fat through a determination of the solidification point of the fatty acids in degrees Centigrade.

Iodine Value (IV) is another measurement of hardness/softness and is defined as the grams of iodine absorbed by 100 gms of fat. Unsaturated fats have higher IV than saturated fats (Table 3).

Unsaturated vs Saturated

As per the previous reference to the chemical structure, fat characteristics are determined primarily by the makeup of the individual fatty acids and the proportions of the component fatty acids. Most fatty acids found in natural fats vary in chain lengths from 8 to 24 carbons. Feeding fats contain their predominance of fatty acids as 16 and 18 carbon lengths. If fatty acids have within their makeup double bonds, they are considered to be unsaturated. Conversely, structures without double bonds are saturated fatty acids. Likewise, if fatty acids contain more than two double bonds, they are referred to as polyunsaturated.

Unsaturated/saturated ratio (U/S) is the calculated ratio of the respective fatty acids that contain one to three double bonds within their structure, (unsaturated) in relationship to the total of fatty acids containing no double bonds (saturated). The hardness or softness of a fat is in direct relationship to the makeup of the fatty acid profile. This is its fingerprint and becomes important in the energy value derived from the fat. An estimate of fat structure and U/S ratio can be derived from the iodine value. Table 4 is included as a reference guide for making this prediction.

Fatty acid profiles

As previously mentioned, fatty acid profiles are the ten-plate or fingerprint of the fat providing the specific structure. These comprehensive profiles can be determined by gas liquid chromatography. From the profile, actual U/S ratios can be calculated. Iodine Values can be estimated from a fatty acid profile for a given fat by using the formula included in Table 5.

Presented in Table 6 are some typical Fatty Acid profiles of fats and oils with iodine values and U/S ratios.

Blended Feed Grade Animal Fat

This designation represents the broadest use of feeding fats. It can include blends of tallow, grease, poultry fats and restaurant grease. Likewise, its origin can be the rendering of raw materials from a mixture of species by-products. Fats so designated must be sold on individual specifications which include the minimum percentage of total fatty acids, maximum percentage of unsaponifiables matter, the maximum percentage of insoluble impurities, the maximum percentage of free fatty acids and moisture.

Suggested quality specifications for Blended Feed Grade Animal Fat are as follows:

Total Fatty Acids - Min % 90

Free Fatty Acids - Max % 15 * (or 20% if includes restaurant grease)

Moisture - Max % 1

Impurities - Max % 0.5

Unsaponifiable - Max % 1 * (or 2.5% if poultry fat)

Total MIU - Max % 2

Blended Animal and Vegetable Fat

The inclusion of vegetable fats in Blended Feed Grade Animal Fat has created the term "A/V blends." The same guarantee for minimums and maximums as per previous category prevails. Quality specifications for Blended Animal-Vegetable Fat are suggested as follows:

Total Fatty Acids - Min % 90

Free Fatty Acids - Max % 30

Moisture - Max % 1

Impurities - Max % 0.5

Unsaponifiable - Max % 3.5

Total MIU - Max % 5

A/V Blends often contain acidulated soap stock which is a by-product of refining crude vegetable oils. Sulfuric acid is blended with the raw soap stock to acidulate. Thus, the darker color, higher FFA and higher allowances for MIU. Non-Feed Use fats and oils should not be a part of the blend.

Feed Grade Vegetable Oils

This category includes a variety of vegetable oils, acidulated soap stocks, and other refinery by-products.

Specific Quality Characteristics

There are several quality characteristics that become important when establishing specifications for feeding fats, the most important being:

Total Fatty Acids

Free Fatty Acids

Moisture

Insoluble Impurities

Unsaponifiables

Iodine Value (IV)

Adulterants

Peroxide Value

Fatty Acid Profile (Structure)

As listed in Table 7, various specifications are provided for the various feeding fats. Likewise, within the Glossary of Terms section on pages 11 - 14, the above characteristics are described.

Traditional Terms

Even though the above referenced terms are becoming commonplace in feeding fat terminology, there still exists the traditional designations for commonly "traded fats." These include tallow, choice white grease, yellow grease and restaurant (kitchen or used cooking oil). As a method of comparison, table 8 contains the quality specifications and average fatty acid profiles for these respective commonly traded fats. Likewise, some detail is also included in the Glossary of Terms.

Uses and Selection of Feeding Fats for Livestock Diets

The traditional recommendation of feeding species-derived fats as the feeding fat of choice for the respective species has persisted. Thus, the recommendation of feeding choice white grease (lard) to swine, poultry fat to poultry and tallow to ruminants remain commonplace. However, there has been considerable research relating to all species which has continually refined and altered those recommendations. The Fats and Proteins Research Foundation has been instrumental in sponsoring research to address new knowledge relative to the levels and types of fat for optimum performance. These studies and application into formulating livestock and poultry rations continue. It is important to understand fundamental aspects of lipid digestion in the respective species so that these unique aspects of digestive physiology can direct the feeding strategies within that species. Improper use of feeding fats in the diets of livestock can result in less than optimum utilization, depressed feed intake, interference in digestion of other dietary components and lowered performance. Feeding fats have been a very integral part of the tremendous increase in animal efficiencies that have been experienced during a relatively short period of time. In very general terms, the usage of fat in the respective species can be described as follows:

Poultry - Fat has been a common dietary ingredient of poultry rations for a longer period than other livestock species. Much of the pioneering research work concentrating on the effects of fat composition on digestibility in the small intestine was derived from poultry research. Likewise, the success of poultry in leading the commercialization process can be partly attributed to its utilization of feeding fats as an economical energy source. The current (1994) Poultry NRC lists a range of energy values for the respective feeding fats. Energy value is dependent upon ration level, fatty acid makeup of basal diet and the physiological state of the animal. The Extra Caloric Value (ECV) based on the synergistic effect that supplemental fat has on the other dietary components has best been illustrated in poultry. The use of animal fats in broiler and turkey diets is extensive. Research has demonstrated positive performance results attributed to improved feed efficiency. Greater improvements in body weight gain and feed efficiency due to fat supplementation in warmer environments has been noted relative to cool environments.

Use of fat in layer diets is much less extensive than meat birds but responses in egg weight and production in young layer diets is an observed effect. Fat supplementation may be advantageous in diets fed to mature birds during periods of heat stress when feed intake is depressed and thus energy intake becomes limiting to egg production.

Swine - Baby pig diets should contain from 5 to 8% total fat with animal fat being a primary supplemental source. A substantial data base exists to predict a 2% improvement in feed efficiency for each 1% supplemental fat incorporated into Grow-Finish diets. The most common formulation level is 2 - 5%. As with other species, it is important to make ration adjustments so that energy protein (lysine) ratios remain optimum when utilizing fat supplementation. The use of fat in late gestation and lactation diets based on past research is a very common feeding strategy. Feeding fat to sows prior to and during lactation increases both milk fat percentage and total milk yield, increasing the survival potential of the litter. Enhanced energy intake during lactation provides reproductive benefits that include shorter returns to estrus and increased sow longevity. As with poultry, the beneficial effects may be more pronounced in elevated environmental temperature.

Dairy - Fat supplementation of dairy diets was not commonplace until the 1980s. Its use in dairy continues to increase. In research summaries, the average fat-corrected milk (FCM) yield response to feed 1 to 2 lbs. of fat has been 4.3 to 8.2 lbs./day. A recent summary of studies (Hoffman et al., 1991; Chan et al., 1992; Grant et al., 1993; Cant et al., 1991; Klusmeyer et al., 1991) utilizing factorial arrangement of treatments to examine potential interactions when feeding fat and additional undegradable intake protein (UIP) illustrate the positive responses for the fat treatments compared to controls.

Treatment		DMI kg/day	Milk kg/day	FCM[b] kg/day	Fat %	Protein %	Protein g/day
Control	**ave.**	**22.2**	**31.9**	**29.4**	**3.42**	**3.07**	**973**
	range	17-25	24-40	22-34	3.0-3.7	2.9-3.2	735-1180
	SD	3.4	5.8	4.6	.28	.11	169
Control + UIP	**ave.**	21.2	32.2	29.4	3.35	3.06	981
	range	17-23	24-42	22-36	3.1-3.6	3.0-3.2	765-1260
	SD	2.9	6.3	4.9	.24	.09	178
Fat	**ave.**	22.2	33.9	31.8	3.55	2.99	1007
	range	17-25	27-40	26-35	3.3-3.7	2.9-3.1	805-1140
	SD	3.5	4.6	3.6	.19	.09	126
Fat + UIP	**ave.**	21.3	33.2	31.2	3.61	2.95	976
	range	17-25	27-41	25-36	3.3-3.8	2.8-3.1	805-1140
	SD	2.6	4.8	3.6	.23	.13	131

The feeding of total mixed rations makes an ideal method by which fat can be added from on-farm storage. Other potential benefits from feeding fat to lactating cows can be improvement in body condition, reproductive performance and metabolic status. With the introduction and expanding use of bovine somatotropin (BST) these benefits may be enhanced. Fat is most commonly fed to cattle during months when feed intake is depressed and additional energy intake is necessary. The high producing dairy cow, however, has energy intake challenges during most of her early- and mid-lactation periods.

Beef - It may appear that research available on fat supplementation to beef animals is limited relative to other livestock species. Fat supplementation of diets fed to finishing beef in commercial feedlots is becoming increasingly popular and commonplace in the Southwest and Southeast. To a large extent, the use of fat is determined by its comparative value to cereal grains. It is typically recommended that fat be added to high-concentrate finishing diets at the 2-6% level of ration dry matter. Research has demonstrated increased daily gains and feed utilization improvements as well as improved carcass characteristics. This is illustrated by the data presented by Brandt & Anderson (1990) when supplementing 4% fat to flaked milo diets.

Effects of 4% Supplemental Fat on Performance and Carcass Traits of Finishing Yearling Steers

	Control	Supplemental fat source		
		Soybean oil	Tallow	Yellow grease
Initial weight (lb)	811	799	799	815
Final weight (lb)	1191	1207	1199	1235
Daily gain (lb)	3.13^{f}	$3.39^{d,e}$	3.30^{e}	3.50^{d}
Daily Feed (lb)	$19.6^{d,e}$	$19.6^{d,e}$	19.1^{d}	20.1^{e}
Gain/feed	0.160^{c}	0.173^{b}	0.174^{b}	0.175^{b}
Carcass traits				
Warm weight (lb)	756^{e}	$777^{c,e}$	$771^{d,e}$	792^{d}
Dressing percentage	63.42^{e}	64.57^{d}	64.15^{d}	64.13^{d}
Backfat (cm)	0.81	0.94	0.84	0.86
Marbling[a]	5.07	5.12	5.00	5.15
Percent choice	62	79	62	79

From Brandt & Anderson (1990)

[a] Marbling:slight^{50} = 4.50, small^{0}, = 5.0, small^{50} = 5.5.

[b,c] Means in a row with different superscripts differ ($P < 0.01$).

[d,e,f] Means in a row with different superscripts differ ($P < 0.05$).

Companion Animal Foods - Fats and oils from rendered animal offal and the production of by-products are highly desirable nutritionally as an energy source to provide required fatty acids and for their palatability influence when used in pet foods. Animal fats likewise have a positive influence on texture and appearance. The color of the respective fats, though not influencing the nutritional values, is important to the appearance of some companion animal foods, and thus color may need specification. The utilization of the various melting points of the respective fats as a means to influence physical types and appearance of pet foods is highly recognized. As with fat usage for all species, the effective use of antioxidants is important. It is most important in fats supplied to the pet food manufacturer that antioxidants that meet the specific manufacturers requirements for effective fat stabilization be used.

Storage Responsibility

The quality of feed grade fat is sensitive to proper handling and storage in every aspect of its use. The producer as well as the customer must handle and store the product under the proper conditions:

1. No yellow metals must be allowed to come into contact with the fat (valves and valve seats, piping, pipe connections, heating coils, atomizers, etc.) Yellow metals (brass, copper, etc.) will cause fat to oxidize and become rancid at a very increased rate.

2. Fat must be stored at cool temperatures except at the add tank. High temperatures cause fat breakdown and rancidity.

3. Fat storage tanks must be cleaned on a regular basis. Sludge buildup in the bottom of the tank will cause increased rancidity.

4. Fat should be moved and stored with as little contact as possible with both air and moisture. The more contact, the more likely fat will be to speed up the oxidation process.

Added benefits to Feeding Fat to Feed and Ingredient Industry

- Dust control

- Feed mill cleanliness

- Worker comfort

- Improved palatability of the feed

- Enhanced pelleting efficiencies

- Increased stability of fat soluble vitamins

- Enhanced life of feed mixing and handling equipment

- Ecologically and environmentally friendly. "You are recycling an ingredient that is the end result of your feeding efforts."

The benefits of fat supplementation and utilization are many. It is hoped that with this "brief" discussion that you have become more familiar with the terms associated with feeding fats. There is really little need for fats to be considered as mystery ingredients. The credible and quality suppliers making up the rendering industry stand ready to assist in directing the most optimum fat sources for the intended use. The Fats and Proteins Research Foundation, as the organization coordinating research for the rendering industry, continues to support projects to improve and enhance the utilization of feeding fats. It is only through the transfer of the findings of the results from this research to the end user for its application that benefits will be derived. The supporters and members of FPRF are anxious to share these results with you.

Glossary of Terms

Animal Fat - is obtained from the tissues of mammals and/or poultry in the commercial processes of rendering or extracting.

Vegetable Oil - is the product of vegetable origin obtained by extracting the oil from plant seeds or fruits.

"Feed Grade" - requires that the specific type of product be adequately tested to prove its safety for feeding purposes.

Adulterated - the bearing or containing of any poisonous or deleterious substance which may be injurious to health. As with any other feed ingredient, the potential for feeding fats to become contaminated with pesticides or other toxic chemicals is real. Every shipment should be certified by the supplier to be pesticide-free.

Current FDA Action Levels for Pesticide Residues (1995)

Pesticide	Maximum Level (ppm)	Pesticide	Maximum Level (ppm)
Aldrin	.15	Heptachlor	
Benzene Hexachloride	.30	& Metabolities	.3
Chlordane	.30	Lindane	.3
Dieldrin	.15	Methoxychlor	.3
DDT & Metabolites	.50	Toxaphene	5.0
Endrin	.30	PCB's	2.0
		HCB's	.5

Total Fatty Acids (TFA) - comprises both free fatty acids and those combined with glycerol (intact glycerides). Fat is composed of approximately 90% fatty acids and 10% glycerol. Glycerol contains about 4.32 calories per gram compared with 9.40 calories per gram for fatty acids. Since fatty acids contain over twice the energy of glycerol and are the primary energy source in feeding fats, the TFA content acts as one indicator of energy. Fatty acid levels less than 90% reflect dilutions with other ingredients and the value should be discounted on total fatty acid content.

Free Fatty Acids (FFA) - are those fatty acids which are not linked to glycerol by an ester linkage but are in free form. Oxidation of fat produces FFA as a by-product; therefore, the presence of high levels of FFA in feeding fats, particularly "whole" animal fats, causes concern about oxidative rancidity. Antioxidants should be added to all feeding fats to prevent rancidity from occurring, particularly in the presence of high levels of FFA. A common source of vegetable fats used in Blended Animal and Vegetable Feeding Fats or Vegetable Fats are acidulated soap stocks which are free fatty acids removed from the crude oil during refining.

Moisture - Some condensation moisture is unavoidable with any feeding fat. Moisture contributes no energy or any other beneficial contribution to the feeding fat and should be kept at a minimum. Moisture is particularly detrimental in accelerating rancidity due to corrosion of fat handling equipment. Moisture accumulates in the lower strata of fat storage units which makes sampling difficult. Moisture in the presence of high FFA and high temperature will also promote hydrolysis of the glycerides.

Insoluble Impurities - usually consist of small particles of fiber, hair, hide, bone, soil, minerals or polyethylene and are filterable materials. These components do not represent hazardous contaminants but create physical problems as they settle out and create tank sludge and ultimately clog valves, lines and nozzles. The filterable material is not soluble in petroleum ether.

Unsaponifiables - refers to that material which is soluble in petroleum ether but does not react with sodium or potassium hydroxide to form soap. This includes a wide variety of compounds, such as sterols, pigments, fat soluble vitamins, fatty alcohols and esters, waxes, mineral oils. Certain problem compounds are contained in portions of the unsaponifiable, such as edema factor. Unsaponifiables apparently contribute very little energy value to the feeding fat. A high unsaponifiable value is not any more indicative of an animal health safety hazard than is a low value indicative of wholesomeness.

MIU - The composite content of moisture, insoluble impurities and unsaponifiable.

Iodine Value - Each double bond in a fatty acid will take up to two atoms of iodine. The iodine number is defined as grams of iodine absorbed by 100 gms of fat. Unsaturated fats have higher IVs than saturated fats. Iodine value can be used to estimate the complete fat structure.

Titer / Titre - is determined and a measure of the solidification points of the fatty acids of the respective fats. It is determined by melting the fatty acid, and while slowing cooling, the congealing temperature in degrees Centigrade is the titer/titre.

Tallow - is primarily derived from rendered beef tissue but could contain other animal fat. Most chemical and soap manufacturers require a minimum of 40.5 to 41.0. A titer of at least 40 is required for a tallow designation but does not require that it be 100% cattle fat.

Choice White Grease - CWG is traded with a standard specification of 36 titer, 4 FFA, 11 B color. This standard was again developed by the soap industry. In feeding fats, color has no nutritional value. Thus, considerable savings can often be acquired by developing feeding fat specifications that concentrate on the nutritional value of the respective fat.

Yellow Grease - has been a term used for a number of years and often confused with off-color CWG. Yellow grease is primarily restaurant grease but can contain dead stock fat, and/or high FFA and high MIU fat from any type of rendering operation. High FFA and dark tallow is often sold as yellow grease with a titer of over 40 and when compared to YG containing near the minimum 36 titer may be lower in energy value when fed to poultry or swine.

Restaurant Grease - Recycled cooking fat and oils made up of partially hydrogenated (hardened) vegetable oils and/or animal fats.

Fat Stability Measurements

<u>Peroxide Value</u> - sometimes called Initial Peroxide Value because it is determined on a sample as submitted. The test measures the milliequivalents of peroxide per kg and indicates the current state of oxidative rancidity. A low PV or IPV (less than 5.0 me. peroxide/kg indicates a non-rancid sample. Upper limits of 20 me. of peroxide as IPV are generally established. It should be noted that rancidity of fats can change rapidly and thus stabilization with antioxidants as early in the distribution chain as possible is indicated.

<u>AOM Test</u> - (20-hour stability) - AOM is for measurement of time (hours) by bubbling oxygen into fat or oil at a given temperature and reading the peroxide value periodically as an indication of the lapse time required for a PV of 20 meg. This test is designed to determine the ability of the fat to resist oxidative rancidity in storage. The validity of this test as it applies to feeding fats has been questioned in recent years and misunderstood by the feed industry.

Oxidative Stability Index (OSI) - is another fat stability test currently being approved by AOCS. The cost to perform this procedure is approximately two times that of the AOM.

Hydrogenation - is a saturation process via a combination of the fat with hydrogen as a reduction process.

Hydrolysis - is the fat splitting process used as the starting point for most fatty acid manufacture that results in glycerine and three fatty acids.

Feeding Fat Guidelines

- Establish a purchasing specification for the intended use of the fat. This specification should include the minimum of:

    - Total Fatty Acids (minimum)

    - Free Fatty Acids (maximum)

    - Moisture \
    - Impurities > Total MIU
    - Unsaponifiables /

    - Certified that PCB and pesticide residues are within FDA allowable limits.

    - Minimum and maximum Iodine Value

    - Stabilized with an acceptable feed grade antioxidant, added and mixed at recommended levels to satisfy an oxidative requirement (i.e., AOM at 20 hrs with less than 20 me peroxide)

    - Certificate of Analysis

    - Species specific requirements that accompany the intended use (i.e., Poultry ration fats should be certified as negative for chick edema factor as measured by Modified - Libermann - Burchard test. Due to the gossypol potential, no cottonseed soap stock or other cottonseed by-products should be included in fats intended for poultry).

    - Establish a procedure for the proper handling and storage.

TABLE 1

CURRENT NRC ENERGY LEVELS FOR FATS AND OILS

	Poultry ME-Cal/lb 1994	Swine ME-Cal/lb 1988	Beef NEm 1984	Beef NEg 1984	Dairy NEm 1989	Dairy NEg 1989	Dairy NEL 1989
Corn	1522	1555	916	780	855	585	800
Soybean oil	4000	3309	2160	1595	2650	2650	2650
Tallow	3545	3588	2160	1595	2650	2650	2650
Choice white grease	3935	3541	2160	1595	2650	2650	2650
Yellow grease	3840	3800	2160	1595	2650	2650	2650
Poultry fat	3727		2160	1595	2650	2650	2650

TABLE 2

COMMODITY TRADING STANDARDS FOR TALLOW AND GREASE

	TITER Min.	FFA Max.	M. I. U. Basis	M. I. U. Max.	FAC Color Max.
TALLOW					
Extra Fancy	42.0	2	1		5
Fancy	40.5	4	1		
Bleachable Fancy	40.5	4	1	2	none
Prime	40.5	6	1	2	13-11B
Edible	42.5		1	1	5
DARK TALLOW					
Special	40.5	10	1	3	19-11C
#1	40.0	15	2	4	33
#3	40.5	20	2	4	39
#2	40.0	35	2	4	none
GREASE					
Choice White (All Hog)	36	4	1	2	13-11B
Yellow (Feed Fat)	36	15	2	4	37

TABLE 3

TITRE AND IODINE VALUES (IV) FOR FAT FROM VARIOUS LIVESTOCK SPECIES

Species	Titre, °C (°F)	IV
Sheep	44 - 48 (111 - 118)	42 - 43
Beef	42 - 45 (108 - 113)	43 - 45
Hogs	36 - 40 (97 - 104)	63 - 65
Horses	35 - 38 (95 - 100)	80 - 85
Poultry	31 - 35 (89 - 95)	77 - 80

TABLE 4

GUIDE TO ESTIMATED FAT STRUCTURE. U/S RATIO FROM IODINE VALUE

Iodine Value	45	55	60	65	70	75	80	85	90	100	110	125	130
Key Fatty Acids													
C 12 Lauric	0.5	0.5	1.0	2.0	2.0	1.5	0.5	0.2	1.0	0.5			
C 14 Myristic	2.0	2.0	2.0	2.0	2.0	2.0	1.5	1.5	1.0	0.5			
C 16 Palmitic	26.0	25.0	23.0	20.0	19.0	18.0	18.0	17.0	15.0	14.0	13.0	11.0	10.0
C 16-1 Palmitoleic	1.5	1.5	2.0	2.0	3.0	3.0	3.0	3.0	2.0	1.0	1.0	1.0	1.0
C 18 Stearic	19.0	18.0	15.0	12.0	11.0	10.0	9.0	8.0	8.0	4.0	4.0	4.0	4.0
C 18-1 Oleic	47.0	45.0	45.0	44.0	43.0	44.0	45.0	44.0	44.0	38.0	35.0	23.0	22.0
C 18-2 Linoleic	4.0	6.0	10.0	12.0	15.0	16.0	18.0	22.0	27.0	36.0	42.0	53.0	55.0
C 18-3 Linolenic	1.0	1.0	1.5	1.5	1.5	1.5	1.5	2.0	2.5	3.5	4.0	7.0	7.0
Unsat/Sat Ratio	1.11	1.20	1.44	1.50	1.94	2.17	2.45	2.75	3.00	4.26	4.88	5.67	6.14

This table should be used only with tallow, grease, poultry fat and/or vegetable fats, soapstocks or blends of these fats.
Blended fats containing over 50% Restaurant Grease should be evaluated by Gas Liquid Chromatography.

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TABLE 5

If a fatty acid profile is known, an estimation of Iodine Value can be obtained by using the following calculations.

C - 14 : 1	Myrestoleic	x	1.1
C - 16 : 1	Palmitoleic	x	1.0
C - 18 : 1	Oleic	x	1.8
C - 18 : 2	Linoleic	x	1.8
C - 18 : 3	Linolenic	x	2.7

The total of the values gives an estimate of Iodine Value

TABLE 6

FATTY ACID COMPOSITION OF VARIOUS FATS AND OILS
AS EXPRESSED IN PERCENTAGES

FATTY ACID COMPOSITION		Tallow	Hog Grease	Lard	Restaurant Grease	Poultry	Corn	Soy-bean	Saf-flower	Peanut	Palm	Canola	Cotton seed	Coco-nut
C 8	Caprylic													6.5
C10	Capric		.2	.1										6.0
C12	Lauric		.2	.2		.1								49.5
C14	Myristic	3.0	1.9	1.3	1.9	1.1					1.5		1.0	19.5
C16	Palmitic	25.0	21.5	25.8	16.2	20.8	12.5	11.5	8.0	11.5	42.0	4.0	26.0	8.5
C16-1	Palmitoleic	2.5	5.7	2.7	2.5	5.9							1.0	
C17	Margaric	0.5	.7		1.0									
C18	Stearic	19.5	14.9	13.5	10.5	8.5	2.5	4.0	3.0	3.0	4.0	2.0	3.0	2.0
C18-1	Oleic	45.0	41.1	42.2	47.5	48.8	29.0	24.5	13.5	53.0	43.0	60.0	17.5	6.0
C18-2	Linoleic	3.0	11.6	10.2	17.5	19.1	55.0	53.0	75.0	26.0	9.5	20.0	51.5	1.5
C18-3	Linolenic		.4	1.0	1.9	.8	.5	7.0	.5			10.0		
C20	Arachidic		.4		.3	.3				1.5				
C20-1	Eicosenoic		.9	1.0	.1	.6				1.5		2.0		
C22	Behenic		.4		.2	.4				2.5				
C22-1	Erucic		.1		.4	.1						2.0		
C24	Lignoceric									1.0				
IODINE VALUE		50	60	65	75	80	125	130	140	92	50	118	105	10
U/S Ratio		.96	1.49	1.45	2.33	2.22	5.67	5.45	8.09	5.90	1.10	15.70	2.33	.10
Total % Unsaturated		49.0	59.8	59.1	70.0	67.6	85.0	84.5	89.0	85.5	52.5	94.0	70.0	7.5
Total % Saturated		51.0	42.0	40.0	30.0	30.4	15.0	15.5	11.0	14.5	47.5	6.0	30.0	92.5

* Values do not always total 100% but represent means as obtained from various fat analyses obtained via GLC. FPRF Source - 1995

TABLE 7

FEED FAT CATEGORIES

		Animal	Poultry	Blended Feed Grade Animal	Blended Animal and Vegetable
Total Fatty Acids	Min %	90	90	90	90
Free Fatty Acids	Max %	15	15	15	30
Moisture	Max %	1	1	1	1
Impurities	Max %	0.5	0.5	0.5	0.5
Unsaponifiables	Max %	1	1	1	3.5
Total MIU	Max %	2	2	2	5
Iodine Value		56-57	79-83	73-83	80-95
Adulterants		As per state and federal regulatory standards			
Peroxide Value		AOM with less than 20 mg peroxide at 20 hrs.			

TABLE 8

	Tallow	C. White Grease	Yellow Grease	Hydrolyzed A/V Soap Stock Blend
Total fatty acids, %	90	90	90	90
Free fatty acids, %	4-6	4	15	40-50
FAC color	19	11A	37-39	45
Moisture, %	0.5	0.5	1.0	1.5
Impurities, %	0.5	0.5	0.5	0.5
Unsaponifiables, %	0.5	0.5	1.0	2.5
Total MIU, %	1.5	1.5	2.5	4.5
Iodine value	48-58	58-68	58-79	85
AOM, hours	20	20	20	20
Fatty acids				
Lauric / myristic (12 - 14)	3.5	1.0	1-3	2.5
Palmitic (16)	26	26	26	18-24
Steric (18)	19.5	11.5	12-18	7-16
Oleic (18 - 1)	41	58	45-55	35-50
Linoleic (18 - 2)	2.5	8-10	15-20	22-28
Linolenic (18 - 3)				2

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