WHY TO USE BLENDED FAT ? HOW TO SELECT GOOD QUALITY?

a scientific approach

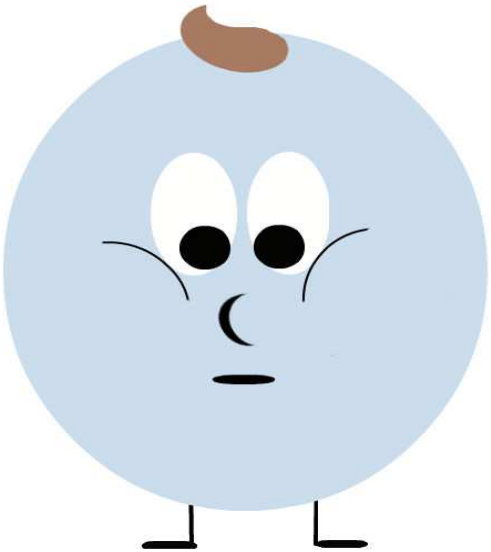
Prepared by: Dr Sanjib Kumar Pratihar- et.al.

Presented By:- Mr Ajaya Sharma

WHY USE BLENDED FAT?

- Human demand of Vegetable oils
- Shortage of Vegetable oil production in India and worldwide
- Economy of feed cost
- Fat is the need of Poultry
- Fat is an essential additive
- No single vegetable oil suitable for Poultry
- Blending of non edible oils is the answer
- SFA:PUFA ratio; FFA
- Selection of right blend
- Elimination of bad blend; Tests involved.

WHAT ARE FATS & OILS



WHAT ARE FATS & OILS

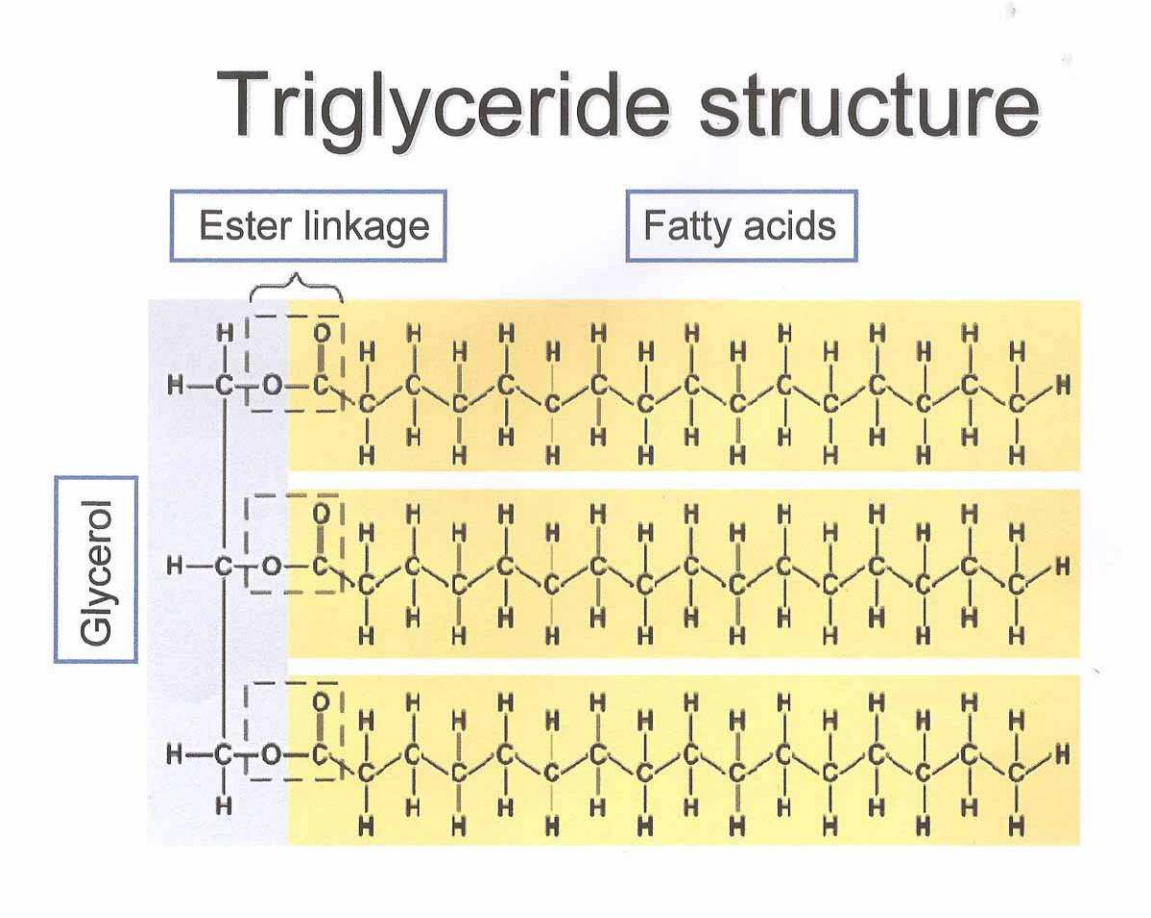
- FAT is another name for Lipids e.g. Triglycerides, Phospholipids, Sterols and fat-soluble vitamins (Brindley,1984)
- **Three types of Lipids-**

(a)Simple lipids which are esters of fatty acids with various alcohols are of **two types**

✓**Fats and oils**-which are esters of fatty acids with glycerol

✓**waxes** (present in Rice bran oil) which are esters of fatty acids with high molecular weight monohydric alcohols.

WHAT ARE FATS & OILS



WHAT ARE FATS & OILS

(b) Compound Lipids:

Phospholipids are fats containing phosphoric acid and frequently have nitrogen containing bases and other substituent. They are two types:

- **Glycolipids** are fats containing carbohydrates
- **lipoproteins** are lipids bound to proteins.

(c) Derived Lipids: fatty acids, glycerol, alcohols, fat soluble vitamins, sterols and terpenoids, derived by hydrolysis from simple or compound lipids. Most abundant sterol in animals is **Cholesterol** and from plants is **Phytosterols.**

WHAT ARE FATS & OILS

Oils are liquid (vegetable oils) whereas **fats** are solids (Tallow, Ghee, Butter etc.)
Lipids (Oil and fat) are, insoluble in water. Technically they are **Triglycerides** or **Triacylglycerols** with different fatty acid profiles.

- **Triglycerides** contain three fatty acid molecules esterified to three hydroxyl groups of glycerol.

WHAT ARE FATS & OILS

Triglyceride

- Simple lipid comprising 3 fatty acids esterified (attached by ester bond) to glycerol 'backbone'
- Fatty acid position ('sn') on glycerol relevant to digestion & ME

sn-1	$CH_2 - O - CO - R^1$	(fatty acid 1)
sn-2	$CH_2 - O - CO - R^2$	(fatty acid 2)
sn-3	$CH_2 - O - CO - R^3$	(fatty acid 3)

WHAT ARE FATS & OILS

•**Simple Triglycerides** contain only one type of fatty acid, **Mixed triglycerides** have two or three types. Based on SN1,SN2,SN3 placement.

- Longer the chain, Lesser the double bonds, LESS soluble the fat will be in water.(TALLOW) as their melting point is also higher.

• Composition of fatty acids, degree of saturation and length of the carbonic Chain, determines fat quality.

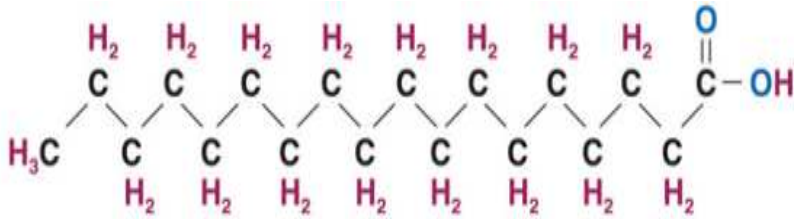
WHAT ARE FATS & OILS

FATTY ACIDS AND THEIR TYPES:

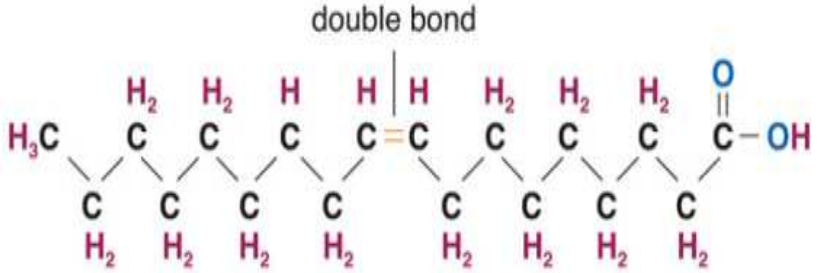
- **Short chain fatty acids (SCFA)**-has aliphatic tails of less than six carbons such as C4:0(Butyric acid);C6:0(Caproic acid)
- **Medium Chain Fatty acids (MCFA)**-has aliphatic tails of six to twelve carbons such as C8:0 (Caprylic acid); C10:0 (Capric acid); C12:0 (Lauric acid); C14:0 (Myristic acid)

WHAT ARE FATS & OILS

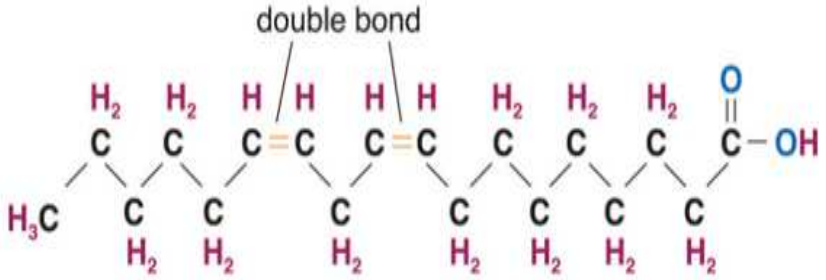
Stearic acid
$C_{18}H_{36}O_2$
A saturated fat



Oleic acid
$C_{18}H_{34}O_2$
A monounsaturated fat



Linoleic acid
$C_{18}H_{32}O_2$
A polyunsaturated fat



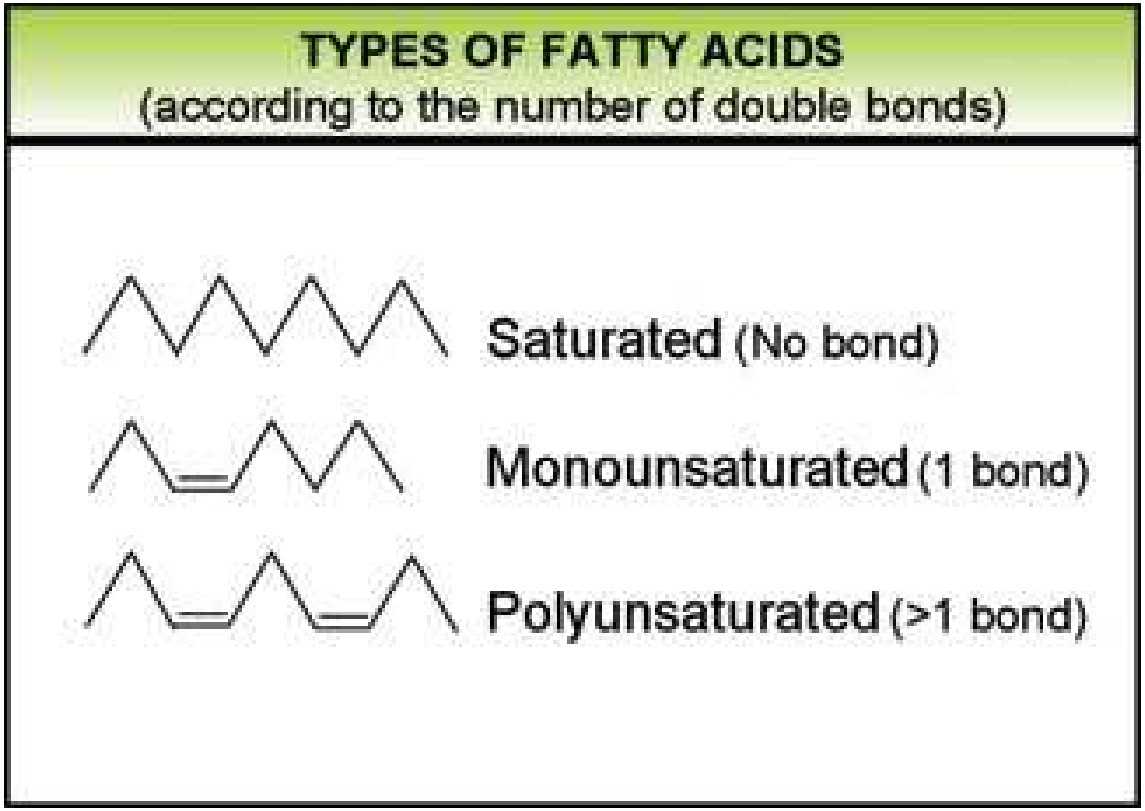
WHAT ARE FATS & OILS

- **Long** Chain **Fatty acids (LCFA)**-has aliphatic tails between 14 to 20 carbons such as C16:0 (Palmitic acid); C18:0 (Stearic acid); C18:1 (Oleic acid); C18:2 (linoleic acid);
- **Very Long Chain Fatty acids (VLCFA)-** has aliphatic tails of more than 22 cardons such as C24:0 (tetracosanoic acid) Source:*Pond et.al.(2005)*

WHAT ARE FATS & OILS

- **Free fatty acids (FFA)** are free floating acids not attached to any other organic component, like glycerol.
The term **"saturated"** indicates the absence of double bonds and this term is used with respect to hydrogen atoms, whereas **"unsaturated"** is the Presence of a double bond decreases the melting point (OILS)

WHAT ARE FATS & OILS



WHY DIETARY FAT FOR POULTRY

ADVANTAGES

Essential Fatty Acids

- linoleic (18:2, n-6) and linolenic (18:3, n-3) fatty acids are easily absorbed from the feed (Dvorin, et al., 1998).

Micronutrients

- Vitamins (A, D, E and K) are absorbed easily by Fat as "carriers" (Iqbal and Hussain, 2009).

Inability to absorb fat-soluble vitamins is an indication of deficiency of fat (Jacob, et al., 2011).

- **Improved Carcass Quality** (Crespo and Esteve-Garcia 2001, Azman et.al 2004, Nayebpor et al.2007,Febel et al. 2008) Bad ratio
- **Deterimental on greasiness & storage quality; as fatty acids are incorporated directly into adipose tissues.**

WHY DIETARY FAT FOR POULTRY

Milling Benefits

- Acts as a binder, improving pellet quality and providing optimal durability.
- Reduces dusting and wastage of feed during the milling process.

Diet-Induced Thermo genesis

- Conversion of carbohydrates and protein to fatty acids is a heat-producing process,

The presence of an adequate level of dietary fat prevents this process. Aids in faster Anabolism.

Modulators of Immune response-marked improvement and medium chain fatty acids effective in controlling campylobacter counts in caeca **(Thomas et.al.2006)**

WHY DIETARY FAT FOR POULTRY

- **AIDS IN DIGESTION OF AMINO ACIDS-(**gives Xtra caloric gain Dr Coweison A.J.Scotland,Knowledge day Hyd)
- **INCORPORATED/NATURALLY AVAILABLE LECITHIN- 3% or less-**improves tenderness, acts as emulsifier, > yolk %, improves albumen and yolk color
- **IMPROVED PALATABILITY- smell and taste**
- **MISCIBILITY- Well blended and mixed gives free flow**

RESEARCHER'S VIEWS
ON FAT INCLUSION

Scott et al. have concluded that CHICKS:

- USE 60% of the ME of proteins,
- USE 75% of the ME of carbohydrates
- USE 90% of the ME of fats FOR BEST UTILIZATION.
- BROILER CHICKS have good digestibility of FAT when included in the STARTER diet from the first week to 21 days, compared to the chicks received rations without OIL/FAT

(Baião and Lara, 2005).

RESEARCHER'S VIEW

ON FAT INCLUSION

-:CONCLUSION:-

- CHICKS utilized ME more efficiently for growth if part of the **carbohydrate portion** of the diet was **replaced with vegetable oil**.
- For growing chicks, the net availability of ME from vegetable oil was about 10% higher than that of carbohydrate-rich feed ingredients;
- Also, chicks fed diets devoid of supplemental fat had higher levels of lipogenesis (metabolic fat deposition) and increased adipose fat deposition (Dvorin, et al., 1998).

RESEARCHER'S VIEWS
ON FAT INCLUSION

- Fat digestibility-not a limiting factor in the growth of young broilers .
- Broiler chicks could absorb VEG oil from 84% during the first week of age-as against 75% of carbo. to 95% during the second,
- SFA absorption increased from 40 to 79%
- The ME of a diet was maximized.
- Day-old broiler chicks had increased fat digestibility.

RESEARCHER'S VIEWS

ON FAT INCLUSION

LAYERS

- **In Laying Hens-** dietary Fatty acids increase egg weight (Whitehead et.al.1963,Whitehead 1995)
- **Egg weight Gain** mainly due to increase in Albumen (Whitehead et.al.1991)
- **The effect was best** from 24 to 38 weeks of age (Grobas et. al.1999)

Conclusion: The Supplemental Fat exerts Favorable effects on egg weight and egg production

EFFICIENT FAT UTILIZATION

- Fat absorption dependent on bile salts and appropriate ratio of SFA to USFA
- Polar USFA and Monoglyceride readily form an association with bile salts.
- **DIGESTIBILITY** is dependent on the length of carbon chain and the degree of saturation of the fatty acids.
- **Interactions** between the degree of saturation, relative to fat absorption have been suggested by several authors (Young and Garrett, 1963; Leeson and Summers, 1976)

EFFICIENT FAT UTILIZATION

- The **poultry Fat and Palm oi**l samples consistently had the lowest,**MEV**
- While **blends** with balanced SFA and USFA ratio .had best digestibility.
- Renner and Hill (1961)--**Fats used for deep frying** such as restaurant OIL/FAT have substantially lower and more variable **MEV** . This decrease depends to a great extent on the duration of heating, temperature used, and fatty acid profile.

EFFICIENT FAT UTILIZATION

- **Constant heating increases the loss** of PUFA, as they are much more sensitive to oxidative degradation than SFA, and it changes the fatty acid profile (Renner and Hill, 1961a).

- **ME values may also be reduced** by the **presence of damaged fats** including, for example, dimeric or polymerized fatty acids.

- **Tallow and poultry fat**, have very low (PUFA)levels with high (SFA) content. These fats have wide variation not only in MEV, but also in chemical characteristics.

EFFICIENT FAT UTILIZATION

- **Oleic acid (C18:1)-MUFA (MONO UNSATURATED FATTY ACID)** plays a more direct role in the absorption process, either in the lumen or in the mucosa cells, to **facilitates the increased absorption** of SFA (Young and Garrett, 1963).

- These Vegetable Fats have high PUFA content with high degrees of ME, which are well absorbed and utilized as a source of energy by the bird (Young and Artman, 1961).

EFFICIENT FAT UTILIZATION

- A **synergistic effect** occurs when these Vegetable fats are having at least 20-25% of saturated fatty acids, providing a higher ME level to the blend.

- By increasing the level of unsaturation, digestibility and ME of fats from different sources were improved up to an optimum value when the U/S ratio was 2.5 (Ketels and De Groote, 1989).

- Increase in dietary PUFA improves ME **by lowering the amount of heat produced** during metabolism (Dvorin, et al., 1998).

EFFICIENT FAT UTILIZATION

- **Sophisticated fat suppliers** often blend various sources of fats and oils to attain a specific U/S ratio and thus produce a product with superior ME, (Sibbald, et al., 1960; Sibbald, et al., 1962; Young, et al., 1963; Lewis and Payne, 1966; Leeson and Summers, 1976).

- Surprisingly, the ME **of the blends is higher than expected from the arithmetic mean of the ME of constituent parts** (Lewis and Payne, 1966; Leeson and Summers, 1976).

PUFA:SFA –HOW MUCH?

- **Broiler chicken Diets** enriched with PUFA compared to Diets enriched with SFA stored more fat .(Becker et.al,1979; Yeh and Leveille, 1973; Saadoun and Leclercq,1983, Leyton et.al.1987, Shimoura et.al.1990;Donaldson 1985)
- **Broiler chickens** fed diets enriched with PUFA compared to diets high in SFA had low abdominal fat (Sanz, 1999) or total body fat (Sanz, et al., 2000).
- In **laying hens**, the catabolism of adipose fat is essential for ovulation and yolk formation in minimum concentration (Bornstein, et al., 1984).

PUFA:SFA –HOW MUCH?

- Fatty acids with high polarity have higher solubility.
- USFA readily form micelles along with monoglycerides, when linked to the bile salts, increasing their absorption (Baião and Lara, 2005).
- Thus SFA Impede absorption .
- Most of the dietary USFA were absorbed by the birds as opposed to SFA .
- The digestibility of fat is optimized when there is at least 75% USFA

PUFA:SFA –HOW MUCH?

- USFA Act synergistically in the absorption of SFA when mixed with them.
- Fat digestibility increases when the U/S ratio is higher.
- The ME content is around 7,100 kcal/kg for SFA such as tallow, compared to 9,000 kcal/kg for vegetable oils, which are high in USFA.
- **Diets deficient in unsaturated fatty acids will cause**

PUFA:SFA –HOW MUCH?

- **Laying Hens** easy catabolism leads to ovulation and yolk formation **(Bornstein et.al.1984)**

1. **metabolic disorders (Wiseman, 1984).**
2. **Abnormalities** in the structure of membranes, capillaries and skin,
3. **A general depression of immunity (Wiseman, 1984).**

CONCLUSION: Thus, U/S ratio is a vital regulating factor in the efficient utilization of dietary fat (Bensadoun and Rothfeld, 1972

FREE FATTY ACIDS & DIGESTIBILITY

- Free fatty acids (FFA) were not responsible for the inefficiency.
- Feeding FFA, properly stabilized, showed no negative effect on chick performance, regardless of the free fatty acids content (Siedler, et al., 1955; De Groóte, 1968).
- **laying hens,** high amounts of dietary FFA had no adverse effects on egg production (Treat, et al., 1960).

FREE FATTY ACIDS & DIGESTIBILITY

- **WITH HIGH %** of USFA in the dietary fat, the FFA concentration does not negatively affect the energy value of the dietary fat, mineral retention, eggshell quality, or egg production in mature birds.

- Negative effects of FFA on energy utilization ,directly related to the degree of saturation of the FFA (Wiseman and Salvador, 1991).

- Vila and Esteve-Garcia In **three** week old broilers dietary **saturated fatty acids** (i.e. Palmitic acid [C16:0] and stearic acid [C18:0]) decreased the digestibility and ME of added dietary fat,

FREE FATTY ACIDS & DIGESTIBILITY

- USFA (Oleic acid) and Linoleic acid Improved Digestibility and ME (Villa & Esteve Garcia)

- Limited effect of FFA even in two week old Broiler (Villa & Esteve Garcia,1966a)

- Feed Manual of leading breeds does not object to using higher FFA in fat.

- **Economic advantage:**
- Fat ingredients with higher FFA are cheaper.
- When stabilized they have long shelf life- e.g. **BROFAT** claims 6 months shelf life.

ME VALUE OF FAT-A CALCULATION

- **ME Calculation by Garrett et.al. (unpublished) is appropriate**

- U/S ration & FFA content not suitable as XTRA CALORIC Values should be considered.

- Prediction equation(Wiseman,1997) commonly used by nutritionists to estimate dietary energy of fat considers higher FFA as depressant of AME values.

- **Garrett et.al.** discount that method. Even Wiseman (1997) in his research on swine says that at Farm level it hasn't made any impact.

ME VALUE OF FAT-A CALCULATION

FACTORS IMPROVING ME VALUES:

1. Total fatty acid content-USFA & MUFA content
2. Fatty acid position on Glycerol back bone-SN1,SN2 ,SN3
3. Triglycerides hydrolyzed by lipase at SN1 and SN3 releases FFA in the form of mono glycerol.
4. If SN1 & SN3 has USFA molecules it's easily digested.
5. Whereas stearic 73% & 81% Palmitic located at SN1 & SN3 in Beef tallow- reduces digestibility (Meng et.al. & Sibbald & Kramer1977)
6. Thus in USFA:SFA ratio higher USFA ensure higher AME
7. AME improves with bird age.

ME VALUE OF FAT-A CALCULATION

FACTORS IMPROVING ME VALUE

7. Blended Fat ensures EXTRA CALORIES than estimated.

What is extra caloric factor or X factor?

- Increase in AME than actually calculated.

Reasons for X FACTOR

- Decreased rate of passage, Improved digestion & Intestinal absorption (Mateos et.al.)
- Synergistic enhancement of SFA absorption(Renner & Hill; Sibbald et.al.)
- Lowered heat increment improves ME (Shannon & Brown; Lipstein & Bornstein)
- Improved palatability and characteristics of the diet. (Dale & Fuller; Cherry)

ME VALUE OF FAT- A CALCULATION

- Increased absorption of the Amino acids.

CAUTION

- Rations are formulated using a **single** MEV, usually less than their Gross energy values (Scott, et al., 1982).
- Rations Economically inefficient and undervalued.

MEV OF FAT- A CALCULATION

FACTORS DECREASING METABOLIZABLE ENERGY

1. Non Starch Polysaccharides (NSP)-Wheat, barley and rye have high % of SFA

2. Poor Digestion-Low Bile salts NSP Diets.

3. MIU (Moisture, Insolubles & Unsaponifiables)

4. SFA-Palmitic , Stearic etc.

ME VALUE OF FAT-A CALCULATION

5. Phospholipids (Ethanol, Inositol, Choline)
6. Oxidation Status

7. Polymers

8. Fiber, Excess Ca>1% + Hi Palmitic & Stearic acid, Mycotoxin, Coccidiosis.

9. Rate of Passage

ME VALUE OF FAT-A CALCULATION

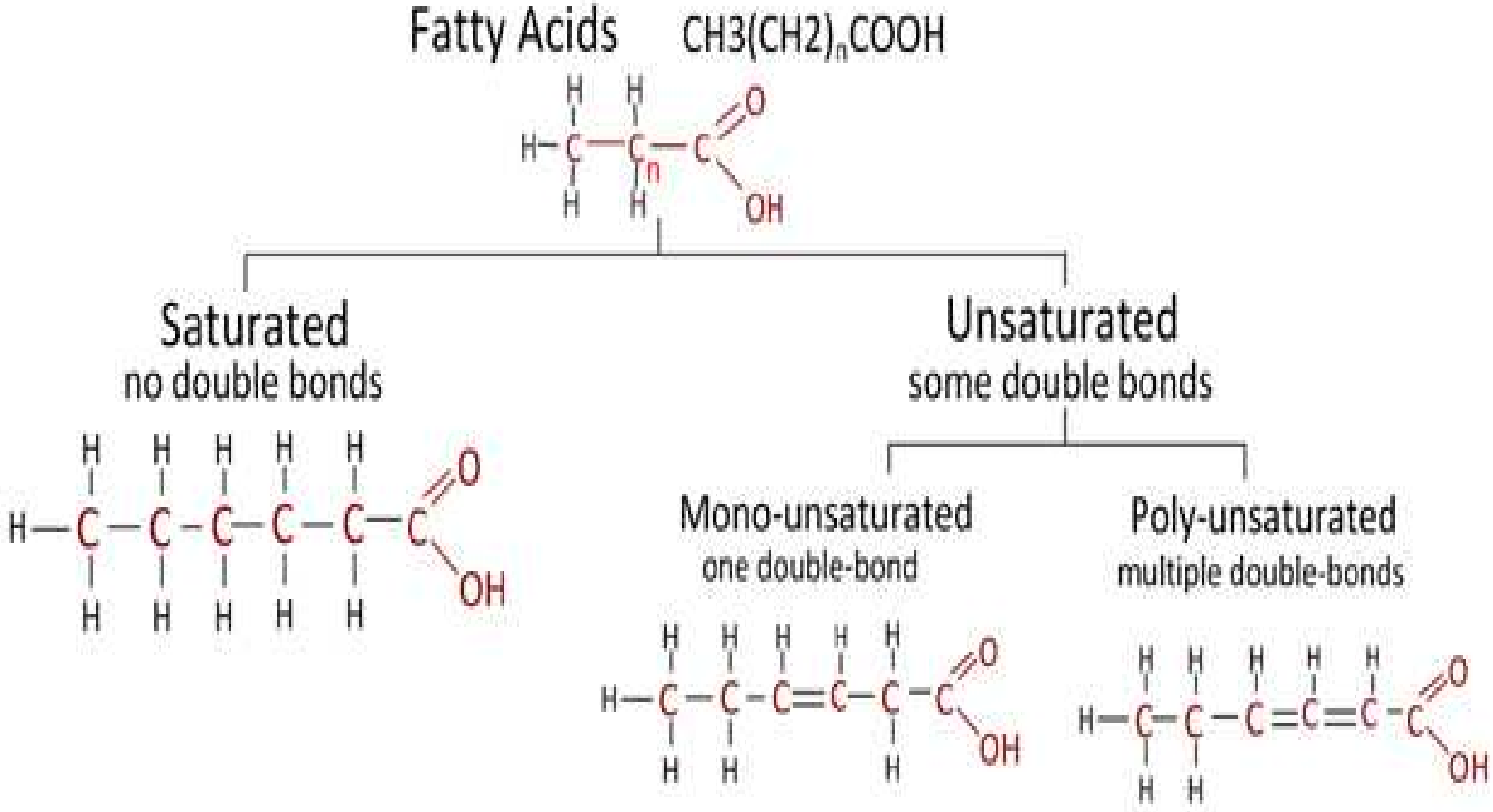
10. **Damaged Fats,** Dimeric or Polymerized Fatty acids.

11. TALLOW-Wide variation Chemically, Low PUFA High SFA

12. Positional Distribution of Fatty acids, Hydrolysis by Lipase at Sn1 and Sn3-typically animal fat.

WHAT IS AN IDEAL BLEND

IDEAL FAT FOR POULTRY



WHAT IS AN IDEAL BLEND?

- Ideal SFA, MUFA & PUFA Content
- **SFA 20-25%+MUFA35-40%+PUFA35-40%**
- SFA not more than 25%
- MUFA like Oleic Acid should be available in FFA form-preferably
- PUFA must have Linoleic and linoleneic acids
- Ensure nil% of Odd numbered fatty acids-C=17 or C=19
- Ensure min% of waxes

WHAT IS AN IDEAL BLEND?

WHAT IS AN IDEAL BLEND?

HOW TO QUALIFY BAD BLEND FROM A GOOD ONE?

- Stated MEV may not be appropriate.
- Blenders do not analyse input fat properly.
- **MOISTURE +NON FAT IMPURITIES+UNSAPONIFIABLE 3%**
- **MOISTURE** interferes directly with the energy content of fat and can accelerate rancidity, the maximum accepted moisture values are between 1.0 and 1.5%.
- **NON FAT IMPURITIES** should be lower than 1% since they displace caloric content.
- **UNSAPONIFIABLES**, which comprise steroids, pigments and hydrocarbons, are indigestible- higher their percentage, lower the energetic value of the Fat.

WHAT IS AN IDEAL BLEND

- **Poor quality** blend tends to separate or coagulate on storage
- **Clear, Light color Blended Fat is no Guarantee of Ideal Fatty acid profile.**
- **Tendency of blenders to use refined restaurant oils.**
- **Restaurant oils or heated oils have variable MEV.**
- **Constantly heated Oils have lower PUFA.**

WHAT IS AN IDEAL BLEND

- **Saponification Value rises if shorter** triglyceride chains .
- **POV ideally upto 10 POV is accepted.**
- **Oxidative Stability Index and Active Oxygen Method TESTS**
- **DAMAGED FATS DECREASE MEV**

FAT TESTING PARAMETERS

Acid value/FFA CONTENT is a measure of the free fatty acids in oil. Normally, fatty acids are found in the triglyceride form. THE ACCEPTABLE VALUES ARE DIRECTLY CORELATED WITH UNSATURATED FATTY ACID CONTENTS AS SUGGESTED ABOVE BY GARRET
AOCS Official Method Cd 3a-63

FAT TESTING PARAMETERS

Peroxide Value is tested as an indicator of oil freshness and quality. High peroxide values are an indicator of oxidation and the greater the peroxide value, the more oxidized the oil has become. Acceptable levels for plant oils are below 10 meq/kg (measured in mili equivalents per kilogram).
AOCS Official Method Cd 8-53

FAT TESTING PARAMETERS

AOM (Active Oxygen Method). This method predicts the stability of a fat by bubbling air through a solution of the fat using specific conditions of flow rate, temperature, and concentration. The AOM value is defined as the number of hours required for the peroxide concentration to reach 100 meq/kg of fat. The more stable the fat, the longer it will take to reach that level. **The method is very time-consuming since a stable fat may require 48 hours or more before reaching the required peroxide concentration.** AOM method is being supplanted by faster automated techniques. The method is included in compendia published by AOAC, AACC, and AOCS.

FAT TESTING PARAMETERS

Oil Stability Index (OSI) is an American Oil Chemists Society (AOCS) approved method that determines the relative resistance of fat and oil samples to oxidation. **It replaces the outdated AOM (Active Oxygen Method),**
The rapidity of oxidation depends on the degree of unsaturation, the presence of antioxidants, and prior storage conditions.

FAT TESTING PARAMETERS

•Unlike POV and FFA analyses which give an idea of how good or bad an oil is at a particular time, the OSI analysis has predictive value. OSI can be used to compare various oils to predict their respective shelf lives. The OSI analysis can also be used to evaluate the effectiveness of antioxidants or determine how much longer a oil can be used before it goes bad.
AOCS, Cd 12b-92, "Oil Stability Index"

Iodine Value is an index of the number of double bonds in a Fat. A high iodine value indicates high unsaturation. Iodine value is reported in terms of the grams of iodine that will react with 90-100 g of fat or oil under specified conditions.
AOCS Official Method Tg 1a-64

FAT TESTING PARAMETERS

p-Anisidine value is an indicator of secondary oxidation products, including ketones and aldehydes that negatively affect oil quality. High anisidine levels usually indicate harsh or excessive processing. For plant-based oils, industry guidelines / recommendations for anisidine levels do not exist; however, some suppliers will test for anisidine as a "double check" for oxidation even though peroxide may have already been tested. Acceptable levels are generally zero to TEN.

AOCS Official Method Cd 18-90

FAT TESTING PARAMETERS

Moisture Value: Analysis. (i) AOCS vacuum oven method. The calibration samples were analyzed in duplicate for determination of moisture content and volatile matter using **AOCS method Ca2d-25 (2) in Eyela Vacuum Oven VOS 450SD**

Heavy metals are naturally occurring elements. In excess, these heavy metals can have potentially harmful health effects. Acceptable levels for metals such as lead, mercury, cadmium and arsenic in plant oils should be below 10 ppm (measured in parts per million).

ICP Method (inductively coupled plasma)

FAT TESTING PARAMETERS

Saponification value is a measure of the free acid and saponifiable ester groups. It is expressed as the number of milligrams of potassium hydroxide required to neutralize the free acids and saponify the esters contained in one gram of the material. Ester value is a measure of the saponifiable esters in the material. It is calculated as the difference between the saponification value and the acid value. **AOCS-cd-3D**

FAT TESTING PARAMETERS

FATTY ACID COMPOSITION: Before selection of Fat it's important that Fatty acid composition of the offered product is tested. The test results in identifying the saturated and unsaturated fatty acids available in the sample. It's gas Chromatography test, which can be conducted periodically to ensure consistency of supplies.

Method: IUPAC: 2.301

THANK YOU VERY MUCH

FOR MORE DETAILS VISIT OUR STALL NO.B8 INSIDE HALL A OR WRITE TO
rnkagro1@gmail.com

BROFAT-RHT-II