UNRAVELLING & UNDERSTANDING OILS

By
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Current literature has well established the benefits of feeding fats and oils to horse's, since it was recognized that grain could be replaced with oils up to a level of approximately 10-15% in the diet. The positive effects of feeding oils to horses include: cool energy; shiny coat, mane and tail; calmer behavior; and a less dusty feed. Oils are also used effectively for prevention of metabolic disorders including tying up. It is important to identify that not all oils are the same, and the metabolic effects of oils vary from very beneficial to extremely harmful depending on the type of oil, how it is processed and how it is fed. This article outlines the various types of oils, along with the good the bad and the ugly sides of oils.

In humans obesity, diabetes and cardiovascular disease are now prevalent health disorders in the Western world. Suggested readings include "Why We Get Fat" by Gary Taubes and "Sweet Poison" by David Gillespie. These are among the growing number of authors confirming that all is not well with what we eat, and that commerce has overtaken nutrition. The combined effects of increased consumption of sugar and industrialized seed oils (canola and soy) are simply causing metabolic chaos. Similarly horses suffer from diabetes (Insulin resistance) in the same way as humans, caused by feeding high NSC (sugar and starch) feeds. Horses are also fed high levels of oils, and it is possible that some of the oils (polyunsaturated industrial seed oils) are also causing metabolic disorders.

What are oils?

This can be a daunting and confusing subject. In general fats are derived from animals and oils are from plants. Animal fat (tallow) is usually solid and plant oils are liquid. However, fish oil (animal) is liquid and coconut oil (plant) can become solid. Animal fats are saturated and not fed to horses because of poor palatability. The term "seed oil" is now used to describe oils produced from crops that have been industrialized, e.g. canola and soy, and are usually genetically modified. Fats and oils consist of chains of carbon atoms joined (bonded) together to form a backbone with a carboxyl group (hydrogen and oxygen atoms) at one end. The

carbon to carbon atoms are held together by either single or double bonds. It is the chain length (number of C atoms) and number of double bonds that determines the chemical structure of oils.

Terms used to describe oils include

Saturated fatty acids (SFAs) have no double bonds and therefore cannot hold additional hydrogen atoms
Monounsaturated fatty acids (MUFA) have only one double bond.
Polyunsaturated fatty acids (PUFA) have more than one double bond and can hold more H atoms.
Essential fatty acids (EFA's). These fatty acids cannot be synthesized by the body and must be provided in the diet. These include the omega 3 and omega 6 fatty acids.

Factors determining the metabolic effects of oils.

- **Chain length**
  - **Short chain fatty acids (2-6 carbon)**
  - **Medium chain fatty acids (6-12 carbon)**
  - **Long chain fatty acids (>14 carbon)**
- **Number of double bonds**
  - **Saturated (no double bond)**
  - **Monounsaturated (single double bond)**
  - **Polyunsaturated (>1 double bond)**
- **Chemical modification**
- **Is the C chain straight (cis) or bent (trans)**
- **Position of double bonds from the omega(last) carbon in the chain**
- **Processing method**
- **Amount fed**
- **Balance**

Omega 3 and Omega 6 fatty acids. The Greek term omega describes the last C in the C chain, and so Omega 3 (Alpha -linoleic acid) refers to the double bond on the third last C in the chain. Omega 6 (linoleic acid) has the double bond on the sixth last C in the chain. It is generally considered that the omega 6to omega 3 ratio should be 4:1.
Chain shape. The C atoms form a chain that is either curved or straight. Liquid oils are curved (cis) and solid saturated oils are straight (trans).
Cis shape. The hydrogen atoms are on the same side of the double bond and so the oils have a curved structure and cant "pack flat", i.e. they always remain a liquid.
Trans shape. Hydrogen atoms are chemically added on opposite sides of the double bond to keep the structure straight, and allows the oil to "pack flat" and become a solid at room temperature e.g. to produce margarine. Trans-fatty acids can only be MUFA or PUFA but never saturated oil (because more H atoms cannot be added). Trans-fatty acids occur to a very limited extent in nature, are never EFA. Trans-fats are chemically modified, and are not natural in nature. Food products must now be labeled because of the negative health effects of trans-fats.
Non esterified fatty acids. any fatty acid that is not esterified (combined) with glycerol to form a triglyceride.

Common Fatty Acids

Chemical Names and Descriptions of some Common Fatty Acids			
Common Name	Carbon Atoms	Double Bonds	Sources
Butyric acid	4	0	butterfat
Caproic Acid	6	0	butterfat
Caprylic Acid	8	0	coconut oil
Capric Acid	10	0	coconut oil
Lauric Acid	12	0	coconut oil
Myristic Acid	14	0	coconut oil
Palmitic Acid	16	0	palm oil
Palmitoleic Acid	16	1	animal fats
Stearic Acid	18	0	animal fats
Oleic Acid	18	1	olive oil
Ricinoleic acid	18	1	castor oil
Vaccenic Acid	18	1	butterfat
Linoleic Acid	18	2	grape seed oil
Alpha-Linolenic Acid (ALA)	18	3	flaxseed (linseed) oil
Gamma-Linolenic Acid (GLA)	18	3	borage oil
Arachidic Acid	20	0	peanut oil, fish oil
Gadoleic Acid	20	1	fish oil
Arachidonic Acid (AA)	20	4	liver fats
EPA	20	5	fish oil
Behenic acid	22	0	rapeseed oil
Erucic acid	22	1	rapeseed oil
DHA	22	6	fish oil
Lignoceric acid	24	0	small amounts in most fats

ABOUT THE AUTHOR:

Dr Tim Kempton has a degree and PhD in the basic and applied aspects of nutrition and specializes in the relationships between nutrition and performance of animals. He pioneered the concept of .cool feeds. For horses in Australia with the introduction of copra meal in the 1980.s, which is now fed extensively as a cool feed. More recently, he has researched the role of NSC in horse feeds, and is committed to providing equine education and products based on sound science to avoid harming horses with kindness, through overfeeding and underworking.

Fatty acid composition of some common edible fats and oils.
Percent by weight of total fatty acids.

Oil or Fat	Unsat./Sat. ratio	Saturated					Mono unsaturated	Poly unsaturated	
		Capric Acid C10:0	Lauric Acid C12:0	Myristic Acid C14:0	Palmitic Acid C16:0	Stearic Acid C18:0	Oleic Acid C18:1	Linoleic Acid (ω6) C18:2	Alpha Linolenic Acid (ω3) C18:3
Almond Oil	9.7	-	-	-	7	2	69	17	-
Beef Tallow	0.9	-	-	3	24	19	43	3	1
Butterfat (cow)	0.5	3	3	11	27	12	29	2	1
Butterfat (goat)	0.5	7	3	9	25	12	27	3	1
Butterfat (human)	1.0	2	5	8	25	8	35	9	1
Canola Oil	15.7	-	-	-	4	2	62	22	10
Cocoa Butter	0.6	-	-	-	25	38	32	3	-
Cod Liver Oil	2.9	-	-	8	17	-	22	5	-
Coconut Oil	0.1	6	47	18	9	3	6	2	-
Corn Oil (Maize Oil)	6.7	-	-	-	11	2	28	58	1
Cottonseed Oil	2.8	-	-	1	22	3	19	54	1
Flaxseed Oil	9.0	-	-	-	3	7	21	16	53
Grape seed Oil	7.3	-	-	-	8	4	15	73	-
Illipe	0.6	-	-	-	17	45	35	1	-
Lard (Pork fat)	1.2	-	-	2	26	14	44	10	-
Olive Oil	4.6	-	-	-	13	3	71	10	1
Palm Oil	1.0	-	-	1	45	4	40	10	-
Palm Olein	1.3	-	-	1	37	4	46	11	-
Palm Kernel Oil	0.2	4	48	16	8	3	15	2	-
Peanut Oil	4.0	-	-	-	11	2	48	32	-
Safflower Oil*	10.1	-	-	-	7	2	13	78	-
Sesame Oil	6.6	-	-	-	9	4	41	45	-
Shea nut	1.1	-	1	-	4	39	44	5	-
Soybean Oil	5.7	-	-	-	11	4	24	54	7
Sunflower Oil*	7.3	-	-	-	7	5	19	68	1
Walnut Oil	5.3	-	-	-	11	5	28	51	5

* Not high-oleic variety.

Source: http://www.scientificpsychic.com/fitness/fattyacids1.html

Factors affecting the behavior of oils:

1. **Method of Oil extraction.** Oils can be extracted either mechanically using heat and pressure (extrusion) or using chemical solvents (hexane). The resulting oilseed cake co-product, after oil extraction, usually contains 8-10% oil in mechanical and 2% oil from solvent extraction. Most industrial seed oils (canola and soy) are solvent extracted to increase oil recovery from the oilseed cake. Further, oils have a smoke point, i.e. the temperature at which the composition of the oil changes and degrades. Many industrial seed oils are heated and chemically modified and in this process the structure is destroyed. The saturated vegetable oils (coconut oil) have a high smoke point and are stable at high temperatures.
2. **Liquid or solid.** PUFA are liquid and some are modified chemically into trans-fats to make them suitable for uses such as margarine. Trans-fats are harmful and must be labelled in human foods. This is not considered an issue for horses, since most oils are added to feed rations in liquid form. Some oils including coconut oil are saturated, and become solid at temperatures below 22^{o}C, making them difficult to use. This issue can be overcome by feeding powders such as PowerStance.
3. **Modified oils.** Some oils which are highly modified go through more than a dozen processes, including but not limited to: fractionation, esterification, saponification, hydrogenation, dehydrogenation, oxidation, peroxidation, pyrolysis, deodorisation, bleaching, interesterification and neutralization.
4. **Saturated vs. Unsaturated.**
   a. **Storage.** Unsaturated oils will readily become rancid because they will take up additional H atoms, usually from water. Chemicals must be added to prevent rancidity of unsaturated oils. Saturated oils such as coconut oil will not become rancid if they are extracted and stored correctly**.**
   b. **Health.** The mantra has been “saturated oils are bad and PUFA are good”. There is growing evidence that it is the PUFA from industrial seed oils that are causing metabolic chaos in humans. There is no reason to ignore the possibility that the industrial oils (canola and soybean) are causing metabolic disorders in horses. The health benefits of saturated oils (coconut oil) have been recognised for both people and horses.
   c. **Oxidaton**. Saturated oils do not oxidise and create free radicals, while unsaturated oils are readily oxidised forming free radicals.

5. **Omega 3 and Omega 6.** The western diet in humans has resulted in a greater intake of Omega 6 fatty acids, and an imbalance in the Omega3:Omega 6 ratio. The recommendation has been to increase Omega 3 intake. Horses naturally consume Omega 6 from pasture, however with the use of PUFA oils such as canola and soy in horse feeds, and the feeding of high NSC (grain) diets, there is now an oversupply of Omega 6 oils (see paper by Pagan et al).

Parameter	Result	Fat type (C, S, A)	Reference
resting muscle glycogen concentration	increase	A	Oldham *et al* 1990
		A	Hughes *et al* 1995
		A	Meyers et al 1989
		A	Scott *et al* 1992
		A	Jones *et al* 1992
		A	Julen *et al* 1995
		C	Harkin *et al* 1992
	no effect	C	Eaton *et al* 1995
		S	Orme *et al* 1997
	decrease	S	Geelen *et al* 2001
glycogen utilisation during high intensity exercise	increase	A	Oldham *et al* 1990
		A	Hughes *et al* 1995
		A	Scott *et al* 1992
		A	Jones *et al* 1992
		A	Julen *et al* 1995
		A	Meyers *et al* 1987
	no effect	C	Eaton *et al* 1995
		C	Harkin *et al* 1992
A= animal fat, C= corn oil, S= soyabean oil			

Table 1: Muscle glycogen storage and utilization in horses fed different types of fat in various experiments

Omega 6 fatty acids are converted into eicosanoids, which are required for the formation of cell membranes, prostaglandins etc. There are good and bad eicosanoids. Omega 3 is required to support the conversion of omega 6 into good eicosanoids. Insulin causes a shift in the enzyme balance, and promotes the formation of bad eicosanoids. By extrapolation from human nutrition, it is recommended to feed Omega 3 oils (flaxseed, fish oil) to correct the Omega 6: Omega 3 balance, even though the correct balance in horses is not known. Maybe it would be prudent to reduce the intake of Omega 6 from high NSC grains and seed oils containing PUFA.

6. **Digestion /metabolism.** Horse stomachs are designed to secrete bile continuously. PUFA fatty acids are absorbed into the lymphatics, where they are slowly transported to the liver. By comparison, medium chain fatty acids are absorbed directly into the portal transported immediately to the liver where they are metabolised into ready energy**.**
7. **Antibiotic actions.** The Medium chain fatty acids lauric, myristic and caproic acids have selective antimicrobial and antibacterial properties. These MCFA have the potential to improve the immune system and assist in maintaining gut heath and insulin sensitivity.
8. **Metabolism and storage.** While all oils have similar energy content, their ability to be stored as muscle glycogen in the horse appears to vary with oil type. Studies

utilising saturated animal fats have shown increases in both glycogen storage and utilisation, whereas unsaturated corn and soybean oils have generally shown no change or a decrease (Table 1). Thus it appears that saturated oils have a positive influence on muscle glycogen and utilisation. Saturated animal fats present a number of difficulties in that they are solid at room temperature making them difficult to handle; horses generally find them unpalatable; and they may infringe 'restricted animal material' regulations in stockfeed. Thus in order to influence muscle glycogen storage capacity in the horse an alternative saturated fat must be found. Coconut oil, which contains more than 90% saturated oil, presents the horse industry with a safe, clean and palatable alternative that may provide performance benefits over and above those that can be provided by the traditionally utilised vegetable oils.

9. **PUFA.** There is mounting information that the PUFA from the industrial oils (sunflower, maize, and soy in particular) are causing major health issues in humans. PUFA are readily oxidised and form free radicals that are thought to damage the cell DNA. PFA contain high levels of linoleic acid which is thought to be immunosuppressive. Saturated oils by comparison are stable, do not oxidise and cause free radicals. Although PUFA may damage cells in every part of the body, it is thought that PUFA may specifically damage the thyroid causing slow metabolism, low energy and reduced thyroid activity. PUFA have also been identified as being immunosuppressive, i.e. they suppress the immune system. Current advice is to restrict the intake of the PUFA linoleic acid (omega 6) to less than 3% of total fat intake.

Making sense of oils:

- Not all oils are the same.
- Mechanically expelled oils do not use chemicals
- Saturated oils do not go rancid, and cannot be converted into trans fats
- Chemically modified oils are not natural. Trans-fats are foreign to the body.
- Industrial oils (canola, soy, sunflowers, corn) are mainly PUFA and are considered to cause metabolic chaos
- PUFA can cause oversupply of omega 6
- Saturated oils do not contain high levels of omega 6
- The need to omega 3 oils may be reduced by feeding less grain and less PUFA
- Saturated oils increase glycogen storage and utilisation
- MCT have antimicrobial actions.
- MCT are absorbed and digested faster