The Advantages of oil supplementation of the diet with reference to cold pressed rapeseed oil.

Traditionally a horses' diet is not particularly high in oil, as grass, hay and most cereals and their bi-products have a relatively low total oil content 1.5 – 3.0%. However, over the last 25 years the use of rations with a higher overall oil content has increased significantly. This has been achieved in the main through the addition of 'free' vegetable based oils to feeds including cubes, mixes and chaffs, or by the increased use of ingredients naturally endowed with a high oil content such as full fat soya, linseed, rice bran or naked oats. In the early years of oil supplementation, there was also an increase in the amount of research carried out to establish the effect of oil supplemented diets on health and performance. In this review, I will provide some basic information on feeding oil that may be of help in your marketing material and then will seek to focus on the particular benefits of cold pressed rapeseed oil.

1. Fat or oil supplementation

Oils that are regularly added to horse rations including soya, corn and rapeseed oil (Mazola) have been shown in scientific studies to be both palatable and have a high digestibility. They are usually added to the diet to increase its energy density i.e. to increase the energy content of the diet per kilogram therefore reducing the need to increase the volume of feed fed. Rapeseed oil has a similar energy or 'calorie' content per litre to other vegetable based oils and so offers the same advantages.

a) Increased energy density of the diet

Increasing the energy density of the diet offers clear advantages e.g. for fussy feeders, where poor appetite can prevent adequate energy intake resulting in loss of condition. The addition of oil to feeds is also beneficial when a ration that is low in hydrolysable carbohydrate (starch & sugars) is recommended for veterinary purposes. Diets that are low in starch and sugar, high in fibre and supplemented with oil are recommended for horses at risk from muscular disorders such as chronic intermittent rhabdomyolysis (Harris 1999) and the equine polysaccharide storage myopathy (EPSM) (Firshman et al. 2003) In addition, this type of ration is also advocated for animals with a history of, or who may be at risk of laminitis (Harris and Geor 2007). The recent implication of high starch and sugar containing diets in some forms of developmental orthopaedic disease has initiated further interest in oil as an alternative energy source to starch and sugar (Ralston 1996; Pagan 1998).

b) Palatability

Many types of vegetable oil have been proven to be palatable in horses. (Bowman et al. 1979) compared the palatability of 10 different types of fats and oil using a 'cafeteria' style palatability test. Corn oil was found to be the most palatable when compared to the other sources offered, although rapeseed was not included in this panel test. Rapeseed or canola oil is anecdotally described as being very palatable, although I could not find any formal scientific studies to support this assertion. Long term palatability of oil also appears to be good. (Harris et al. 1999) reported good feed intake during a 16 month oil supplementation trial where horses were fed either a highly unsaturated (soya) or saturated (coconut) oil. Anectdotally, however prolonged use of soya oil has been reported to lead to monotony. Care should be taken when extrapolating palatability data for specific oil sources from country to country as different processing techniques can effect palatability.

c) Digestibility

Both digestible energy (DE) and metabolisable energy (ME) have consistently been reported to increase, as a result of the addition oil to the diet (Hollands and Cuddeford 1992; Kronfeld et al. 2004). However, the form in which the oil is available, i.e. free in the form of vegetable oil or encapsulated within cereal grains or oilseeds, may affect its digestibility.

Oil is digested predominantly in the small intestine, whereas cell wall material (fibre) is fermented in the hindgut. The encapsulation of oil in cereal grains (such oats) or oilseeds (such as soya or linseed) may affect its digestibility, as some fibre has to be digested to free the integral oil (Kronfeld et al. 2001). Free rapeseed oil therefore may be more digestible that the oil present in full fat soya or linseed when added to a horses' ration, although there are no scientific studies to support this possibility.

In ruminants, the addition of free vegetable oils to the diet has been shown to have a negative impact on fibre digestibility. Free vegetable oil may coat the fibre fraction and thus distrupt ruminal fermentation, whereas integral oil does not appear to have the same effect, probably because the oil is released more slowly (Coppock and Wilks 1991). The effect of supplementary oil on fibre digestibility in horses is less clear with conflicting results having been published (Hollands and Cuddeford 1992; Kronfeld et al. 2001; Jansen et al. 2002). Intuitively, however the negative effect should be lower in horses, as oil is primarily digested in the small intestine and fibre is fermeted later in the digestive tract in the hindgut.

d) Glycemic response

Glycemic response (which is equivalent to the rise in glucose following feeding) and insulin release is significantly lower in response to diets that are high in fibre and oil in comparison to traditional cereal based feeds (Williams et al. 2001) and also for cereal based feeds that are topdressed with oil (Pagan and Harris 1999). The reduction in glycemic response to feeding is partly due to the lower starch and sugar content of these former feeds, but may also be influenced by the presence of oil itself in the latter diets. The addition of oil to the diet could affect the rate at which feed moves through the stomach and small intestine and so influences the digestion of starch in the small intestine and the resultant absorption of glucose.

e) Gastric health

Gastric ulceration is a widespread problem amongst race horses and other performance horses. They develop as a consequence of the exposure of the sensitive non-glandular region of the stomach to gastric acid. There is some evidence to suggest that supplementing the horses' ration with vegetable oil may offer some protection against gastric ulceration. This is likely to be due to an improvement in the natural protection against gastric ulcers provided by the gastric mucosa itself. Supplementation with just 45ml of corn oil per day was sufficient to reduce gastric acid secretion and increase the level of the anti-inflammatory substance prostaglandin E2 (PGE2) (Cargile et al. 2004).

f) Behaviour

Oil supplemented diets have been reputed to modify behaviour in excitable horses. (Holland et al. 1996) reported that spontaneous activity and reactivity, evaluated as response to pressure, loud noise and sudden visual stimuli, was reduced in horses fed a diet supplemented with soy lecithin and corn oil. Lecithins are a group of phospholipids that contain two fatty acids, a phosphate group, and a choline molecule. They function as emulsifiers of fat by breaking it down into small droplets or micelles and they effectively form a bridge between the fat and water allowing mixing with water. Lecithins are produced by the liver and are released into the small intestine, where they emulsify dietary fats and oils improving the surface area over which digestive enzymes can act. The reputed effect of soy lecithin and corn oil on behaviour is relevant not only for leisure horses but also for those with a predisposition towards rhabdomyoloysis. Stress and nervousness are two factors that increase the likelihood that a horse susceptible to ERS will develop muscle damage (MacLeay et al. 1999).

g) Metabolic Effects of Fat or Oil Supplementation

i) Effect on muscle glycogen

Addition of oil to performance diets is likely to reduce muscle glycogen concentration when combined with a significant reduction in the starch content of the ration (Pagan et al. 1987; Eaton et al. 1995; Orme et al. 1997). Whilst there have been some conflicting reports of increased muscle glycogen concentration and rate of utilisation during exercise in response to oil supplementation (Meyers et al. 1989; Oldham et al. 1990; Harkins et al. 1992), these are likely to have been due to the experimental diets used, or the study design rather than being a true metabolic effect.

However, it would seem that horses are able to maintain normal muscle glycogen levels in response to moderate oil supplementation (7.5% of total DM, 14% DE), despite a reduction in the starch content of the diet, providing that a period of adaptation is undertaken. The rate of muscle glycogen repletion following moderate intensity exercise can be reduced when oil is first introduced into the diet and this was demonstrated in horses fed a ration supplemented with rape seed oil (7.5% of total DM, 14% DE). However, this effect was abolished once these horses were adapted to an oil supplemented diet (5% of total DM) for a period of 3 weeks (Hyyppa et al. 1999). This may be due to an increased efficiency of fibre fermentation and synthesis of glycogen from propionic acid via glucose.

ii) Metabolic adaptation

Horses that are adapted to an oil supplemented diet have a greater capacity to utilise fat as an energy source during low to moderate intensity excercise e.g. endurance, dressage, eventing. (Orme et al. 1997) reported that the capacity for oxidation of free fatty acids may be increased in response to oil supplementation, as the activity of a key oxidative enzyme within the biochemical energy generating pathway that releases energy from fat was increased. This higher capacity for fat oxidation is confirmed through physiological mesaurements by a lower observed respiratory exchange ratio (RER) in fat-adapted horses exercising at low to moderate intensities (Dunnett et al.,2002). The significance of this finding is that greater use of fat as a fuel source during exercise will potentially 'spare' the limited supply of muscle glycogen supporting performance.

The metabolic response to oil supplementation occurs rapidly being apparent after just 3 weeks of supplementation (Hughes et al. 1995; Orme et al. 1997). These supplementation effects are, however, transient and dependent on continued use of the oil in question, with the response being abolished within 5 weeks of withdrawal of the oil supplemented diet (Orme et al. 1997). The response to oil supplementation may also vary between individual horses, being related to their inherent ability to utilise fat as a fuel source during exercise (Dunnett et al.,2002).

h) Thermal Load

A further advantage to fat or oil supplementation is a reduction in thermal load. Physiological processes including eating, digestion, fermentation and the metabolic process of energy generation are not completely efficient and heat is produced as a consequence, giving rise to what is termed a thermal load. A horse's thermal load which is increased by exercise must be dissipated in order to maintain normal body temperature. Exercise in the heat presents a greater challenge to the horse's thermoregulatory system and measures that are effective in reducing the thermal load could offer a performance advantage.

Diets supplemented with oil are suggested to reduce thermal load by reducing the amount of heat that is produced during eating, digestion and production of energy and this may be reduced still further when combined with a low fibre diet, which reduces the heat produced through fermentation (Kronfeld 1996).

i) Omega 3 and Omega 6 fatty acids

Oils including rapeseed contain a number of polyunsaturated fatty acids that make up their constituent triglycerides. The fatty acid components of oils such as rapeseed contain many carbon atoms joined by either single or double bonds. The position of the first C-C double bond within an unsaturated fatty acid effects its metabolism by the body and this feature is used to further classify unsaturated fatty acids. **Omega 3 fatty acids** are those that have their first C-C double bond between the 3rd and 4th carbon atom. In contrast, **Omega 6 fatty acids** are those that have their first C-C double bond between the 6th and 7th carbon atom counting from the omega end and so forth for Omega 9 fatty acids.

In oils and other high oil ingredients such as soya and linseed, α-linolenic acid is the major omega 3 fatty acid; whilst linoleic acid is the major omega 6 fatty acid and oleic acid is the major omega 9 fatty acid. Horses are unable to synthesise fatty acids, which have their first C-C double bond before the 9th carbon atom. In other words, the omega 3 and omega 6 fatty acids must be provided by the diet and are termed essential fatty acids (EFA). Fatty acids from the omega 3 and 6 series perform numerous important functions within the body:

- Form parts of vital body structures
- Components of phospholipids
- Role in immune function
- Role in vision
- Integrated into cell membranes

Additionally both linoleic and α-linolenic acids are metabolised further by cells and used in the synthesis of hormone like substances called eicosanoids. Omega 6 fatty acids are converted primarily to arachadonic acid, whilst omega 3 fatty acids are converted to eicosapentanoic acid (EPA) and docosahexanoic acid (DHA). Further biochemical modification results in the production of the eicosanoids including substances called prostoglandins, prostacycline, thromboxane and leukotriens. Unlike regular hormones such as insulin or the thyroid hormones these 'local hormones' are used where they are produced and are not transported to their site of action in the blood.

The omega 3 and omega 6 fatty acids follow different biochemical pathways to produce distinct types of prostoglandins and thromboxanes, each of which have very different effects within the body. The eicosanoids are important regulators of vital body functions such as blood pressure, blood clotting, immune response and inflammatory response. In general terms, the eicosanoids produced from omega 6 fatty acids tend to increase inflammatory processes and blood clotting, whilst those produced from omega 3 fatty acids tend to decrease blood clotting and inflammatory response, although this is a gross simplification as the mechanisms involved are very complex.

The physical and functional properties of cell membranes are affected by the relative fatty acid composition within their structure, which can be altered by changing the fatty acid delivery from the diet. The different biochemical pathways involved in eicosanoid production utilize and therefore compete for the same enzymes and so the degree of inflammation, for example, is influenced by the relative proportions of omega-6 and omega-3 fatty acids present in cell membranes (Baur 1994).

While there are few studies on dietary omega 3 fatty acids in horses, (Henry et al. 1991), reported that dietary intervention with rations rich in α-linolenic acid, in the form of linseed oil, were potentially useful in preventing some of the deleterious effects of endotoxemia in horses. Recently, a double blind, cross over trial in Icelandic ponies predisposed to recurrent seasonal puritis (sweat itch) revealed that supplementation with linseed (flax), a rich source of α-linolenic acid, reduced the sensitivity to Culicodes the biting midge implicated in the condition (Pearson-O'Neill et al. 2002).

Studies support a protective role for omega-3 fatty acids in human asthma, a related condition to recurrent airway obstruction or RAO (heaves, formerly COPD) in horses (McKeever and Britton 2004). Supplementation of RAO affected horses with long chain omega-3 fatty acids from seal blubber, however, did not significantly alter clinical indicators of lung function despite some changes to the omega-3:omega-6 ratio in plasma and white blood cell plasma membranes (Khol-Parisini et al. 2007).

A minimum requirement for α-linolenic acid of 0.1% has been recommended for horses (Vitec 1987), whereas the requirement for linoleic acid is considered to be close to 1-4% of the total dry matter intake (see Roche Vitec 1987). Although there are no published guidelines in horses regarding the optimum ratio of C6 to C3 fatty acids in the diet, the consensus in other animals seem to be a ratio of about 10:1 (see Roche Vitec 1987).

An EFA deficiency in other species is characterised by a dry lustreless hair coat, scaly skin and predisposition to skin infections. However, a true EFA deficiency with similar symptoms has not been documented in horses, despite diets with a very low total fat and linoleic acid content being fed (0.05, .03% respectively) (Sallmann et al. 1991). The only finding linked to this low intake of fat was a reduction in the plasma and tissue levels of vitamin E, which may reflect reduced absorption from the diet.

2. Rapeseed oil for horses

Rapeseed oil has a similar energy value per litre as many of the other vegetable oils commonly fed to horses such corn or soya oil. It is used extensively in America, Australia and Canada as 'canola oil' and appears to be palatable to horses with no adverse reports on palatability having been published. Similarly to other vegetable oils, rapeseed oil offers all of the advanages discussed above with reference to horse feed supplementation.

a) Cold pressed oils

Cold pressed oils may be of greater nutritional benefit to horses as they have been extracted from their parent plant, in this case rapeseed, using a low heat technique and without the use of solvents such as hexane. Much of the 'supermarket' oils will have undergone a more intensive solvent extraction at higher temperatures as this serves to increase the yield from the oil seed. Furthermore, a process of hydrogenation to 'saturate' the mono and polyunsaturated fatty acids can be used with many 'supermarket' oils to improve their physical characteristics and stability but this obviously detracts from the benefits of their unsaturated fatty acid content. The unsaturated fatty acids found in rapeseed and other vegetable oils are also sensitive to oxidation at high temperature, making cold pressing an attractive technique for extraction despite the lower yields.

b) Palatability Cold pressing which is a much less intensive and more traditional process is anecdotally thought to improve palatability, as flavour can be modified when traditional extraction techniques are used.

c) Natural – Cold pressed oil offers a much more natural product, with no residual solvents present, as no solvents are involved in the pressing process. The low temperatures employed in the extraction process also retain the stability of the long chain polyunsaturated fatty acids such as α–linolenic acid.

d) Vitamin E

All oils have a natural antioxidant content, usually in the form of tocopherols or vitamin E. This vitamin E is present to help maintain the stability of the fatty acids contained within the triglyceride content of the oil. High temperature solvent extraction or high pressure expeller extraction techniques can destroy much of the vitamin E present and these oils therefore may contain synthetic antioxidants such as BHA / BHT in order to maintain the shelf life of the oil. The vitamin E content of rapeseed oil is about 30iu/kg, which means that it can make a small contribution to a horses daily requirement for vitamin E. More importantly this vitamin E is available to help maintain the stability of the oil itself without the need for synthetic antioxidants. Vitamin E is an important fat soluble antioxidant within the body and forms part of a team of antioxidants that function to reduce the formation or minimise the deleterious effects of reactive oxygen species or free radicals formed in the body. These are produced as a natural consequence of metabolism and their production can increase with disease and exercise, especially where there is a high aerobic component. Adequate vitamin E in the diet is therefore important for all horses including leisure animals and performance horses alike.

f) Omega 3 and Omega 6 fatty acids

All vegetable oils contain a number of different fatty acids within their constituent triglycerides, which give them certain characteristics. Vegetable oils vary in terms of the proportion of saturated versus unsaturated and polyunsaturated fatty acids present. Different vetable oils also provide a varying amount of the essential fatty acids linoleic acid (omega 6) and α–linolenic acid (omega 3) see table below.

The free fatty acid profile of rapeseed oil is particularly beneficial as it is characterised by a low saturated to unsaturated fatty acid ratio, particularly when compared to the other oils commonly used in horse nutrition. A high intake of saturated fat can lead to an increase in non healthy LDL cholesterol in humans, whereas the mono and polyunsaturated fats tend to promote the more healthy HDL cholesterol. Whilst high cholesterol and associated atheroscleros is not a known major problem in horses they may be other undefined health benefits.

Rapeseed oil also provides a relatively rich source of the omega 3 fatty acid α-linolenic acid in comparison to the oils commonly used in horse feed including soya oil and corn oil and even the sunflower oil from the supermarket. It is only linseed or flax oil that has a higher α-linolenic acid content and this is often also a higher price per litre. The only recommendation for α-linolenic acid in horses is that of 0.1% of the total dietary dry matter, which for a typical 500kg horse would be near to 10g per day. Therefore feeding just 120mls of rapeseed oil per day can potentially offer upto 10g of α-linolenic acid per day thus satisfying the total daily requirement.

		Saturated fatty acids (S)			Mono unsaturated fatty acids (US)	Polyunsaturated fatty acids (US)	
	S/US ratio	Myristic Acid	Palmitic Acid	Stearic Acid	Oleic Acid	Linoleic Acid (? 6)	a-Linolenic Acid (?3)
		C14:0	C16:0	C18:0	C18:1	C18:2	C18:3
Canola / rapeseed Oil	15.7	-	4	2	62	22	10
Cod Liver Oil	2.9	8	17	-	22	5	-
Corn Oil (Maize Oil)	6.7	-	11	2	28	58	1
Flaxseed Oil	9	-	3	7	21	16	53
Olive Oil	4.6	-	13	3	71	10	1
Soybean Oil	5.7	-	11	4	24	54	7
Sunflower Oil	7.3	-	7	5	19	68	1

g) Rapeseed double zero varieties

Plant breeding carried out over the last 50 years has resulted in what are termed double zero varieties of rapeseed. These rapeseed crops do not contain any appreciable amounts of two undesirable substances erucic acid and glucosinolates, which had previously limited the use of rapeseed in both the human and animal feed sector. Erucic acid has a tendency to reduce palatability, as it gives a bitter taste to the oil and glucosinolates are substances produced by the rapeseed plant itself that are toxic when fed at a high level. In Canada, these double zero varieties were renamed as Canola, which is a name commonly known by horseowners.

Conclusions

The whole area of essential fatty acid nutrition in the horse is of great interest due to its clinical relevance and the lack of research in this area offers great scope for future investigatations. However, the relationship between the eicosanoids and their essential fatty acid precursors is complex and requires thorough investigation before dietary recommendations can realistically be made in horses. Supplementation of the equine diet with rapeseed oil offers many potential advantages ranging from effects on behaviour to those on performance and health. Rapeseed oil appears to be readily accepted by horses, however care should be taken in introducing it into the diet and the level of supplementation should be increased gradually in order to avoid digestive problems. For performance effects, the adaptive response to oil supplementation is long-term and measured in weeks rather than days. Care should also be taken to provide an overall balance of protein, as well as minerals and trace elements when integrating oil into the diet, as oil will not contribute to the provision of these latter nutrients.

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