

Evidence review of health benefits of rapeseed oil.

Introduction

Compared to other oils, rapeseed oil is considered to be a 'healthy oil' (Public Health England, 2016; World Health Organisation, 2018) with potential health benefits. This is because rapeseed oil is comparatively low in saturated fatty acids and high in monounsaturated fatty acids and polyunsaturated fatty acids including oleic acid (an omega-9 fatty acid), linoleic acid (an omega-6 fatty acid) and alpha-linolenic acid (an omega-3 fatty acid) (see Table 1). Rapeseed oil also contains plant sterols, carotenoids (pro-vitamin a, cold pressed oil only), vitamin K, and tocopherols (vitamin E) with the main health benefits from reduced cholesterol and increased cardioprotection (Gül and Amar, 2006; Lin et al., 2013). Most references to rapeseed oil are referring to canola (often low erucic acid and glucosinolates) or LEAR (low erucic acid and glucosinolate) types of oilseed rape variety. There are varying levels of evidence that support possible health benefits of rapeseed oil, from animal and in vitro studies through to human studies. These include regulation of circulating lipid profiles, effects on blood lipid profile, biomarkers of hemostasis and inflammation, energy metabolism, insulin sensitivity and cancer and are summarised by the review article by Lin et al. (2013) and represented in **Fig. 1**.

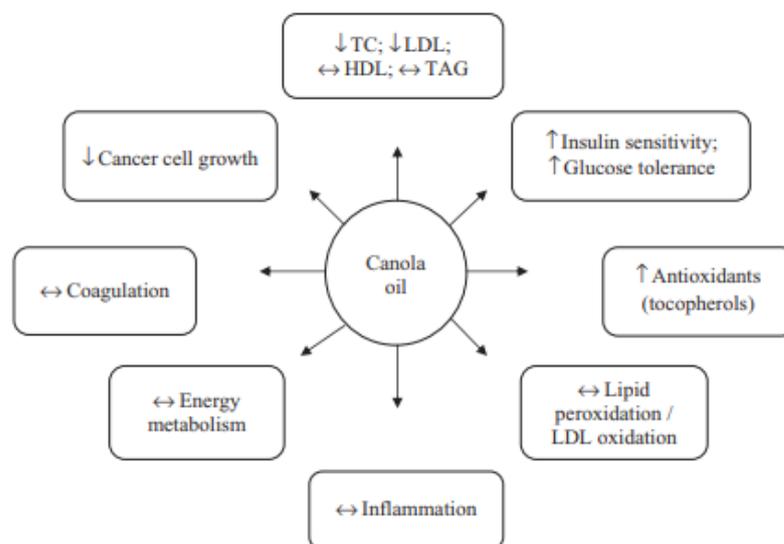


Fig. 1. Evidence of the effect of rapeseed oil on health-related risk factors from Lin et al., 2013. These effects are taken from a range of studies including animal or in vitro through to human studies.

Saturated fatty acids

Fat within foods contains a mixture of different types of fatty acids (saturated, monounsaturated, polyunsaturated). Butter, coconut oil, lard, dripping, ghee and palm oil contain high amounts of saturated fat whereas rapeseed, olive and peanut oils are high in monounsaturated fat. Corn, sesame,

soya, sunflower, linseed (flaxseed) and walnut oils contain high amounts of polyunsaturated fat. High intakes of saturated fat have been shown to raise levels of low-density lipoprotein (LDL, or 'bad') cholesterol in the blood and high LDL cholesterol increases the risk of developing heart disease and stroke (Griffin, 2017). There is also some evidence to suggest a link between saturated fatty acids and cancer, insulin resistance, metabolic syndrome and obesity (Oomah and Mazza, 1999). This is critically important as coronary heart disease is one of the leading causes of human disease and deaths across the world (Finegold et al., 2013)

It is therefore recommended that saturated fat in the diet is reduced and replaced with small amounts of unsaturated fats and oils such as olive and rapeseed oil and spreads made from these (Public Health England, 2016) as this has been found to reduce blood cholesterol levels (Hooper et al., 2015).

Rapeseed oil has relatively low levels of saturated fatty acids (7% or less), the lowest of all main edible oil sources (**Table 1**) (Finglas et al., 2015) making it a healthier option. However, in order to use the nutrition claim 'low in saturated fat', products must contain less than 0.75 g/100 ml (for liquids) (European Commission, 2019), which rapeseed oil currently exceeds. Similarly, the UK traffic light front of pack labelling system currently classes food with > 5g of saturated fatty acids per 100 g, or 6 g per portion as high in saturates (Department of Health and Food standards Agency, 2016). Therefore whilst rapeseed oil has the lowest saturated fat level of all the oils, it still carries a red traffic light label for saturates (this means it is high in saturated fats, and should be eaten less often) (Department of Health and Food standards Agency, 2016). Furthermore, the low content of saturated fatty acids also makes oil from some varieties of oilseed rape unstable at high temperatures and therefore less suitable for deep-frying (Möllers, 2002) unless an additional processing step called 'hydrogenation' is performed. The hydrogenation step generates trans fatty acids known to increase plasma concentrations of LDL cholesterol, decrease plasma concentrations of high density lipoprotein (HDL) cholesterol and therefore risk of coronary heart disease (Ascherio and Willett, 1997). High-oleic low-linolenic (HOLL) oilseed rape varieties have been developed through conventional breeding that have less polyunsaturated fatty acids and increased oleic acid. Therefore the oil from HOLL varieties is more stable at high temperatures and suitable for frying (Baux et al., 2013, 2008).

Unsaturated fatty acids

Monounsaturated fat

The nutrition claims 'high in unsaturated fat' and 'high in monounsaturated fat' and the health claim 'replacing saturated fats with unsaturated fats in the diet contributes to the maintenance of normal blood cholesterol levels (MUFA and PUFA are unsaturated fats; oleic acid is an unsaturated fat)' can be used in relation to rapeseed oil (EFSA Panel on Dietetic Products Nutrition and Allergies, 2011; European Commission, 2019).

The predominant fatty acid present within rapeseed oil is the monounsaturated fatty acid most notably oleic acid (61% of total fatty acids) (Table 1) which can lower plasma cholesterol levels in humans (Mensink, 2016; Lopez-Huertas, 2010). The same effect is found when polyunsaturated fatty acids are consumed in place of saturated fatty acids. Experimental and clinical data have suggested that monounsaturated fatty acids have cardioprotective components that regulate plasma lipids and

lipoproteins, inhibit LDL oxidation, and insulin sensitivity (Gillingham et al., 2011; Hunter et al., 2010). Current levels of both monounsaturated and polyunsaturated fats are high in rapeseed oil, with only olive oil having higher levels of monounsaturated fats (Table 1).

Polyunsaturated fat

Rapeseed oil provides both of the essential fatty acids, alpha-linolenic acid (ALA) and linoleic acid (see Table 1) and, due to the quantity of ALA present, the nutrition claim 'high in omega-3' can be used in relation to rapeseed oil, and the health claim 'ALA contributes to the maintenance of normal blood cholesterol levels' may also be used (EFSA Panel on Dietetic Products Nutrition and Allergies, 2011; European Commission, 2019). Rapeseed oil is a good source of long-chain omega-3 polyunsaturated fatty acids (Yang et al., 2013), for example alpha-linolenic acid (Gerster, 1998; Rajaram, 2014). Omega-3 fatty acids have been reported to have numerous health benefits with significant roles in the brain but have also been reported to have positive effects on cardiovascular disease, inflammatory disease, brain function and mental health (including helping with depression and bipolar, behavioural disorders including ADHD, dyslexia, dyspraxia and autism) and also have an immunomodulatory (regulatory adjustment) effect suppressing inflammatory bowel disease, rheumatoid arthritis, asthma, cystic fibrosis (for review see Calder, 2017, 2014, 2010). Increasing Omega-3 polyunsaturated fatty acid intake during pregnancy can also benefit the developing foetus (Swanson et al., 2012). There is also limited evidence to show that omega-3 fatty acids are toxic to tumor cells (Laviano et al., 2013). In addition, α -linolenic acid is reported to ameliorate the process of wound healing and promote cell proliferation, and improves liver enzymes, and basal inflammation, but this is based on in vitro work and a single human study (Kruse et al., 2015; Lewinska et al., 2015). In contrast, it is currently not possible to make a nutrition claim for levels of omega-6 (European Commission, 2019). Rapeseed oil has the highest % content of omega-3 as a proportion of the total fatty acid content compared to the other oils listed in Table 1.

Phytosterols

Phytosterols accumulate in rapeseed oil, with higher levels than in palm oil and olive oil (Gül and Amar, 2006; Oomah and Mazza, 1999; Table 1). Phytosterols are cell membrane structural components and have a similar structure and function to cholesterol (Kritchevsky and Chen, 2005), and can lower blood cholesterol through competing for micellar space in the small bowel, thus reducing the absorption of unhealthy cholesterol or stimulating its excretion from the body (De Smet et al., 2012; Kritchevsky and Chen, 2005). This effect has been demonstrated in humans leading to an authorised European health claim (EFSA Panel on Dietetic Products Nutrition and Allergies, 2012). There is some evidence to suggest that phytosterols may protect against various chronic ailments such as cardiovascular diseases (Marangoni and Poli, 2010), diabetes and cancer (20% reduction in cancer risk) (Kritchevsky and Chen, 2005; Shahzad et al., 2017; Tran, 2011). Sterols are 50% higher in rapeseed oil than in soybean oil but two of the major sterols (campesterol and sitosterol) are affected by processing (Gunstone, 2011). Significant portions (up to 40%) of sterols are removed from the oil during deodorisation (Verleyen et al., 2002) and refining (Gunstone, 2004). Furthermore, currently for a health claim relating to phytosterol content, 0.8 g of phytosterol should

be provided per day. Assuming a 20 g portion of rapeseed oil per day with a content of 250 mg per 100 g, this would only provide 50 mg of phytosterol (EFSA Panel on Dietetic Products Nutrition and Allergies, 2010). Thus at present rapeseed oil contains insufficient quantities of sterols for the health claim to be applied. In contrast, other oils (e.g corn oil and soybean oil) have higher values of 845 mg/ 100g and 330 mg/ 100 g respectively. Nonetheless, these values still fall short of the health claim threshold. Rapeseed oil does however outperform olive oil and palm oil in this category. Regardless of oilseed rape variety, the oil was found to reduce total cholesterol by av. 12.2% (ranging between 6.7% to 20.1%) compared to oil typical of a western diet in 5 human studies (Lin et al., 2013).

Tocopherols (vitamin E compounds)

Rapeseed oil contains relatively high levels of tocopherols compared to other oils (**Table 1**) (Gunstone, 2011). Tocopherols are antioxidant compounds (also referred to as vitamin E) which protect cells from oxidative stress (EFSA Panel on Dietetic Products Nutrition and Allergies, 2010). There is also evidence that Tocopherols aid in protection against atherosclerosis, cardiovascular diseases, cataracts, and neural tube defects (Gliszczyńska-świgło et al., 2007; Stocker and Azzi, 2000). The level of tocopherols obtained from rapeseed oil depends on the extraction method (Mirzaee et al., 2014). Oil extraction by cold pressing can result in lower tocopherol levels (Fine et al., 2015). The refining process further decreases the tocopherol content of rapeseed oil, and deodorisation causes the removal of the largest portion of these compounds. Currently, a 20g serving of rapeseed oil can be considered as being 'high in vitamin E', whereas a 10 g serving would qualify as a 'source-of' vitamin E. Whilst high in vitamin E, both sunflower oil and palm oil have higher vitamin E contents than rapeseed oil.

Vitamin K and other components

Rapeseed oil contains vitamin K (Finglas et al. 2015) and has moderate levels compared to other oils (Table 1). Vitamin K contributes to bone development (EFSA Panel on Dietetic Products Nutrition and Allergies, 2009) and promotes the synthesis of an amino acid involved in blood clotting (Foster et al., 2009; Ryan-Harshman and Aldoori, 2004). Currently, a 20g serving of rapeseed oil can be considered as being 'high in vitamin K', whereas a 10 g serving would qualify as a 'source-of' vitamin K (EFSA Panel on Dietetic Products Nutrition and Allergies, 2009). Rapeseed oil is second only to sunflower oil for vitamin K content in Table 1.

Polyphenols and carotenoids are present in higher quantities in cold pressed rapeseed oil than refined rapeseed oil, but currently no health or nutrition claims can be made around them. Studies and quantification of these in relation to human health may lead to a health claim in the future. In contrast, there is an approved health claim for the specific polyphenols present in olive oil, which can be used provided that a particular oil contains the minimum amount per serving, as specified in the conditions of use (EFSA Panel on Dietetic Products Nutrition and Allergies, 2011) .

Conclusions

This review has identified that improvement of some specific characteristics of rapeseed oil could make it more effective than other vegetable oil sources at either enhancing, or causing less detriment, to human health. Priority characteristics for improvement include; unsaturated fatty acids, omega-3 and 6, tocopherols, saturated fatty acids, sterols and vitamin k.

Unsaturated fatty acids. These are beneficial to human health if used to replace saturated fats. Rapeseed oil already has high levels, but some other vegetable sources have greater levels. If levels of unsaturated fats can be increased in rapeseed then it could become the best vegetable source for this characteristic.

Omega fatty acids. Omega-3 and 6 beneficial for human health. Rapeseed oil already has high levels of Omega-3 and is greater than other vegetable sources of oil. Is it possible to further enhance Omega-3 levels? Is it possible to enhance omega-6 to levels that allow a health claim?

Tocopherols (vitamin E compounds). Essential for human health. Rapeseed oil already quite high for these compounds. Can tocopherol content be further improved to give greater content than palm and sunflower oil?

Vitamin K. Beneficial for human health. Rapeseed oil already quite high for these compounds. Can vitamin K content be further improved to give greater content than soyabean oil?

Phytosterols. These may be beneficial to human health with high consumption. Rapeseed oil already has one of the highest levels of phytosterols (behind soyabean and corn oil). Modest increase in content would enable it to overtake soyabean oil for this property, but unlikely to achieve great enough increase to make a health claim.

Saturated fatty acid. This may be detrimental to human health with high consumption. The content is already low in rapeseed oil and breeding of HOLL varieties to improve cooking quality with low saturated fatty acids has already occurred. If the saturated fatty acid content could be reduced to less than 5 g per 100 g, rapeseed oil would no longer have to display a red 'traffic light' for saturates under the UK traffic light front of pack labelling system.

Drafted by ADAS with input from the British Nutrition Foundation.

Table 1. Contents of different vegetable oils

	Rapeseed oil	Palm oil	Soybean oil	Olive oil	Sunflower oil	Corn oil	Reference
SFAs (g/100 g food)	6.6	47.80	15.6	14.3	12	14.4	Finglas et al., 2015
MUF (g/100 g food)	59.3	37.10	21.3	73.0	20.5	29.9	Finglas et al., 2015
PUFA (g/100 g food)	29.3	10.4	58.8	8.2	63.3	51.3	Finglas et al., 2015
Linoleic acid (g/100 g food) (omega-6)	20	10.1	52	8	63	50	Finglas et al., 2015
α -linolenic (g/100 g food) (omega-3)	9.6	0.3	7.3	0.7	0.1	0.9	Finglas et al., 2015
Oleic acid (g/ 100 g food) (omega-9)	57.6	37.1	20.8	71.9	20.2	29.4	Finglas et al., 2015
Phytosterols* (mg)	250.7	38.8	330.0	113.8	290.0	845.0	Finglas et al., 2015
Vitamin K (Phylloquinone μ g)	112.5	7.90	131.0	57.5	6.3	3.0	Finglas et al., 2015
Vitamin E (mg)	22.21	33.12	16.06	5.10	49.22	17.24	Finglas et al., 2015

Saturated fatty acids (SFAs), monounsaturated fatty acids (MUF), polyunsaturated fatty acids (PUFA).

*Phytosterols include beta-sitosterol, brassicasterol, campesterol, delta-5-avenasterol, delta-7-avenasterol, delta-7-stigmastenol and stigmasterol.

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