

Prioritisation report for nutritional improvement of rapeseed oil

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Industry requirements

The industry need to improve the nutritional value and cooking, processing and storage properties of oil from oilseed rape was evaluated via surveys and interviews conducted by ADAS and Campden BRI, with input from the British Nutrition Foundation (reports appended). Key quality parameters investigated included those relevant to health and/or oil properties, including content of vitamin E, vitamin K, phytosterols and oxidative stability (largely controlled by the levels of saturated, unsaturated and polyunsaturated fatty acids). In addition to a preference expressed for local (UK) production, and as a more sustainable alternative to palm oil, the key conclusions of the analysis are that the main industry drivers are:

1. Fitness for purpose

Rapeseed oil must possess the physical and chemical properties required for the purposes to which it is being put by industry. Rapeseed oil does not contain a sufficiently high proportion of saturated fatty acids for applications such as use in puff pastry, but does have the properties for a wide range of food processing applications. The main limitation is oxidative stability, which limits both shelf life and suitability for high temperature frying.

2. Perceived health benefits

Rapeseed oil is widely perceived as a healthy choice of oil, primarily due to its low content of saturated fatty acids (the lowest of all standard fats and vegetable oils) and high content of unsaturated fats, including long-chain omega-3 polyunsaturated fatty acids. It is also recognised that rapeseed oil contains fat-soluble compounds with health benefits, including phytosterols (which reduce the absorption of unhealthy cholesterol), vitamin K (which builds strong bones and promotes the synthesis of an amino acid involved in blood clotting) and vitamin E (which protect humans from oxidative stress, atherosclerosis, cardiovascular diseases, cataracts and neural tube defects). The main limitations are the amount and variability of these fat-soluble compounds in commercially available rapeseed oil.

Opportunities for genetic improvement of nutritional traits

The OREGIN genetic diversity panel *Brassica napus* accessions (the species to which oilseed rape belongs as a crop type) has already been assessed for most of the traits of relevance and found to contain genetic variation for them all. The primary publication of the resource, comprising 383 accessions, showed tocopherol (vitamin E) varied between 197 and 445 mg/kg dry seed and in food grade (i.e. low erucic acid) material that saturated fatty acids (SAFA) varied between 5.43 and 8.70 % and polyunsaturated fatty acids (PUFAs) varied between 19.6 and 38.6% (Havlickova et al. Plant Journal 93:181-192, 2018). Unpublished results showed phytosterols to vary between 1722 and 3992 mg/kg dry seed, with scope to double this by traditional mutagenesis (Broughton et al, unpublished). Vitamin K has not been analysed on OREGIN material, but a recently published assessment across 7 varieties showed 3-fold variation (Claussen et al. J. Agric. Food Chem. 63: 1076-1081, 2015) indicating that substantial genetic variation is likely to be available.

Breeders have already been working on improving the oxidative stability of rapeseed oil by developing high oleic low linolenic (HOLL) types. However, these do not satisfy the industry's requirements, so there is scope for further improvement. Work towards an alternative oil specification, high oleic low

polyunsaturate (HOLP), is yielding promising results with higher unsaturated fatty acid content, lower saturated fatty acid content (Wells et al. *Molecular Breeding* 33:349-362, 2014) and substantially better thermal stability (Kaur et al unpublished).

The analyses reveal there to be extensive scope for improving the nutritional quality of rapeseed oil. Priority traits identified are phytosterol, vitamin E and vitamin K content, all of which have been shown (or are expected to show) variation in germplasm available to OREGIN. Part of the variability observed for these compounds in rapeseed oil is considered to be due to processing (especially deodorization), so processing options such as removal and reincorporation may also need to be evaluated in order to preserve customer's expectation of oil appearance whilst enhancing content.

Prioritisation for rapeseed nutritional improvement

Combining nutritional and stability traits would be most compelling commercially. Pre-breeding assessment by combining nutritional improvements in the HOLP background would benefit from freedom to operate and facilitate subsequent transfer by breeders to proprietary backgrounds tailored for the UK market.

Prioritisation of activities:

1. Maximise phytosterol content in a HOLP winter oilseed rape background. This represents the greatest potential health-based gain, as we project it may be possible to reach the 0.8g per day necessary to make a health claim for a daily intake of 20 ml of oil, with that oil also being very high in unsaturates (up to 90%).
2. Maximise vitamin E content in a HOLP winter oilseed rape background. This represents the greatest potential product stability-based gain, as vitamin E is an antioxidant that will contribute to oil stability as well as having nutritional value.
3. Assess vitamin K content across the OREGIN *B. napus* genetic diversity panel and evaluate opportunities for future improvement. This is a prerequisite for focused investment in improvement.

We anticipate that further activities will involve processors to enable us to make oil samples available for the food industry for testing, a UK specialist supply chain management company to assemble a supply chain based on pre-breeding products and UK rapeseed breeders to initiate development of new elite varieties for cultivation in the UK.

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