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Field trials of the oilseed crop camelina *sativa* and properties of the obtained oil

Key external stakeholders:

Camelina breeders, Teagasc Food Research Centre, vegetable oil plants, food manufacturers and Camelina growers.

Practical implications for stakeholders:

- Camelina oil can be stabilised with synthetic and natural antioxidants to the level of commercial oils. It should be possible therefore to exploit the health benefits of camelina oil by using the stabilised oil in spreads, functional foods and other vegetable oil based products.

- The relation between chemical structure and antioxidant activity in camelina oil, and the effect of ascorbyl palmitate on carbonyl rates shown in the present work, could be very useful information in the formulation of new antioxidants for the stabilisation of camelina and other oils with high omega-3 fatty acid content.

Main results:

- Unrefined camelina oil met CODEXSTAN specifications for cold pressed virgin oil, but it had lower oxidative stability in terms induction times and carbonyl rates than rapeseed or sunflower oil.
- Camelina oil could be stabilised with both synthetic and natural antioxidants.
- Induction times of the evaluated antioxidants in camelina oil depends on the position of hydroxyl groups on the phenyl ring and, within the same type of phenols, (i.e. ortho hydroxyphenols) on the molar concentration phenylhydroxyl groups per weight of antioxidant.
- Camelina oil obtained from camelina seeds grown under Irish conditions was found to be somewhat more stable in terms of induction times, and had about the same oxidative stability in terms of peroxide and carbonyl rates as the commercial oil.

Opportunity / Benefit:

Potential for camelina oil to be used as a commercial oil.

Collaborating Institutions:

University of Limerick

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1. Project background:

Camelina *sativa*, a member of the Brassicae family, is an annual oilseed plant. Also known as false flax or golden pleasure, it has been grown widely in Central Europe until the 1940's when it was replaced by rapeseed. Interest in the crop was revived in the 1990's, on account of its relatively low production costs in Northern Europe including Ireland and the high linolenic acid content of its oil.

Linolenic acid is an omega-3 fatty acid occurring in substantial amounts only in flax and fish oils and its anticholestemic effect should provide similar health benefits. Furthermore camelina oil is considerably cheaper than fish oil and it has none of the objectionable taste and odour of the latter. In spite of its obvious advantages camelina has not been commercially successful, and only a small amount of commercial camelina oil is produced in Europe at present, mainly for the health food industry.

High linolenic acid content of camelina oil might be a nutritional advantage, but it could also be an indicator of low stability. Hence if camelina oil is to be commercially successful its oxidative stability needs to be investigated, and if necessary, the oil will need to be stabilised to the level of commercial edible oils. Considering that sunflower methyl ester, which was shown to have the same primary oxidation rate as camelina oil, could be stabilised with synthetic and natural antioxidants, it should be also possible to stabilise camelina oil.

2. Questions addressed by the project:

- What is the oxidative stability of camelina oil relative to commercial edible oils such as rapeseed and sunflower oils?
- How can the oxidative stability of camelina oil with food grade antioxidants be improved?
- What is the oxidative stability of camelina oil obtained from seeds grown under Irish conditions relative to commercial camelina oil?

3. The experimental studies:

Commercial unrefined camelina oil obtained from a small seed oil producer and commercial rapeseed and sunflower oils obtained from local supermarkets were characterised in terms of composition, impurities including fatty acids, water, oxidation products formed during storage and oxidative stability. Oxidative stabilities of the three oils were evaluated by oil stability index induction time which determines the time elapsed to the formation of volatile organic acids as determined by the Rancimat® instrument, referred to as induction time, and by oven storage test, with daily monitoring of peroxides and of carbonyl compounds as p-anisidine values. Oven storage test data was expressed as rates of increase of peroxides and carbonyl compounds, referred to as peroxide and carbonyl rates.

Stabilisation of camelina oil was evaluated with twenty one food grade synthetic and natural antioxidants and antioxidant formulations obtained from several commercial sources. Antioxidant effects were determined at four concentrations. Maximum concentration of synthetic antioxidants (200mg/kg) was set as per current EU food additive directive, but there are no regulatory limits at present on the maximum concentration of natural antioxidants permitted in foodstuffs. Therefore, threshold concentration or the effect of added plant extract on the odour and flavour of camelina oil was the criteria for the upper limit (2000 mg/kg) of the added natural antioxidant.

Oxidative stabilities of the camelina oils with added antioxidant were determined as per oils without antioxidants, except conjugated dienes and tocopherols were also monitored in the oven storage test to indicate structural changes and loss of stability. Induction times and carbonyl and peroxide rates of camelina oil with antioxidants were used as stability parameters, and they were compared to those of pure camelina, sunflower and rapeseed oils.

Irish camelina oil was obtained from six varieties of camelina, Slovenian Landrace, Calinta, Sonny, Ligena, Calena and Lindo, grown at Oakpark, Carlow in 2009 in small plots. Harvested seeds were cleaned and

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dried and oil was extracted by cold pressing using a bench scale screw press. Oxidative stabilities were evaluated as per commercial camelina oil and stabilising effect of selected antioxidants were determined by induction times.

4. Main results:

Unrefined camelina oil met CODEXSTAN specifications for cold pressed virgin oil, but it had lower oxidative stability in terms induction times and carbonyl rates than rapeseed or sunflower oil. The order of induction times and carbonyl rates were: rapeseed(8.5h) > sunflower(4.5h) > camelina(2.4h) and sunflower(0.7) < rapeseed(2.4) < camelina(5.9), respectively.

Camelina oil could be stabilised with both synthetic and natural antioxidants. Two formulated antioxidants namely a TBHQ citric acid formulation (V101, donated by Vitablend Ltd.) and rosemary extract ascorbyl palmitate formulation (RPT40 donated by Kemin Food Technologies) increased oxidative stability of camelina oil in terms of induction times and carbonyl rates to the level of rapeseed and sunflower oils, respectively.

Induction times of the evaluated antioxidants in camelina oil depended on the position of hydroxyl groups on the phenyl ring, and within the same type of phenols (i.e. ortho hydroxyphenols) on the molar concentration phenylhydroxyl groups per weight of antioxidant. Carbonyl rates could be reduced very effectively with the synergyst ascorbyl palmitate.

Camelina oil obtained from camelina seeds grown under Irish conditions was found to be somewhat more stable in terms of induction times, and had about the same oxidative stability in terms of peroxide and carbonyl rates as the commercial oil. Evaluated antioxidants had a stronger stabilising effect on the Oak Park camelina oils, and average induction times of TBHQ/citric acid and rosemary extract/ascorbyl palmitate were 19 and 50% longer than of the commercial camelina oil used in the present work. However the longer induction times could be caused by the shorter storage period of the Oak Park camelina oils.

5. Opportunity/Benefit:

Potential for camelina oil to be used as a commercial oil.

6. Dissemination:

Main publications:

Fröhlich, A., O'Dea, G., O'Beirne, D. (2011). Stabilisation of camelina oil with synthetic and natural antioxidants. Journal of the American Oil Chemists' Society, under review
http://www.agresearchforum.com/publicationsarf/2011/Page%in press.pdf

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