



Original Research Article

Minor components and oxidative stability of cold-pressed oil from rapeseed cultivars in China

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ABSTRACT

The contents of the minor components and induction period (IP) of cold-pressed oils from 203 rapeseed varieties from the Yangtze River Valley in China were determined. The average contents of total phenolics, phytosterols, tocopherols, β -carotene, lutein and chlorophyll of the samples were 36 mg/100 g, 826 mg/100 g, 378 mg/kg, 2.4 mg/kg, 104 mg/kg and 8.2 mg/kg, respectively. There were significant differences ($p < 0.0001$) among the varieties in the content of these minor components. Correlation analysis revealed there was a positive correlation between the IP and content of total polyphenols ($r = 0.303$, $p < 0.0001$), lutein ($r = 0.250$, $p < 0.0001$) and total tocopherols ($r = 0.225$, $p = 0.001$). Additionally, the IP negatively correlated with total phytosterols and chlorophyll content. Principal component analysis differentiated the rapeseed oils based on their IP and total phenolic, tocopherol, β -carotene, lutein and chlorophyll content.

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1. Introduction

Rapeseed (*Brassica napus* L.) is the second most important oilseed crop in the world after soybean. Every year, about 31 million hectares of rapeseed are cultivated and 60 million tons of oilseed rape are produced. Rapeseed is the most important oilseed crop and a major source of edible vegetable oil in China. The planting area of the rapeseed is about 6.7 million hectares, and the total yield is about 12 million tons, accounting for 20% of the world's supply. During the past 20 years, the quality of rapeseed varieties has been continuously improving in China. Currently, the planting area of double-low (low erucic acid and low glucosinolates) oilseed rape accounts for about 70% of all rapeseed planting area, and low-erucic acid rapeseed oil has entered the Chinese market.

Low erucic acid rapeseed oil is classified as one of the healthiest vegetable oils because of its fatty acid composition. Rapeseed oil contains low levels of saturated fatty acids (5–10%), high amounts of monounsaturated fatty acids (44–75%), some linoleic acid (18–22%) and alpha-linolenic acid (9–13%). Therefore, the optimal ratio of omega-6 (linoleic acid) to omega-3 (linolenic acid) fatty acids (2:1) for human health occurs natively in rapeseed oil (Matthäus and Brühl, 2003; Ratnayake and Daun, 2004). Moreover, rapeseed oil is a rich source of bioactive compounds, such as polyphenols,

phytosterols, tocopherols, β -carotene and lutein, which may help prevent coronary heart diseases, cancers, diabetes, hypertension, neurodegenerative diseases (Alzheimer's and Parkinson's) and autoimmune diseases (Bradford and Awad, 2007; Naczek et al., 1998; Szydlowska-Czerniak et al., 2010; Trautwein et al., 2003). Most of these beneficial effects are due to antioxidative activity (Koski et al., 2002; Subagio and Morita, 2001).

Among commercial oilseeds, rapeseed contains the highest amount of phenolics: defatted rapeseed meal may contain up to 2% of phenolic acids. When pressing the oil from rapeseed, some of the phenolic compounds are transferred to the oil. Koski et al. (2002) reported that cold-pressed rapeseed oil contained only minor amounts (0.3–0.4 mg/100 g) of polar phenolics. However, Koski et al. (2003) detected higher total amounts of phenolic compounds (16 mg/kg caffeic acid equivalents, CAEs) in refined rapeseed oil. Harbaum-Piayda et al. (2010) reported that cold-pressed rapeseed oil contained 0.9–19.4 mg/kg (steam-treated: 19.4 and 9.8 mg/kg, native: 0.9–5.6 mg/kg) of sinapic acid (50% methanolic extracts) by HPLC. Many phenolic compounds have antioxidative properties.

Phytosterols are present in all plants and in food products of plant origin. In general, the main sources of phytosterols in the diet are vegetable oils, cereals and nuts. Corn oil is richest in these compounds, followed by rapeseed oil, which has a slightly lower content. The main phytosterols in rapeseed oil include β -sitosterol, campesterol, brassicasterol, stigmasterol and Δ^5 -avenasterol, and these levels are 358–395, 164–300, 51–92, 0–16 and 14–56 mg/100 g, respectively (Phillips et al., 2002; Soupas, 2006). The content

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of phytosterols in oils depends on many factors: the variety/cultivar, growing conditions and post-harvest storage, method of oil production (pressing, refining) and storage conditions of the product (Phillips et al., 2002).

Tocopherols are important natural antioxidants that inhibit fatty acid peroxidation in vegetable oils and act as free radical quenchers. Rapeseed oil contains mostly α - and γ -tocopherol, with γ -tocopherol usually present in higher amounts. The total tocopherols content in rapeseed oil is higher than in many other common vegetable oils, such as sunflower, safflower, palm and coconut oils, but lower than in soybean and corn oils (Ratnayake and Daun, 2004).

Crude rapeseed and canola oils may contain as much as 95 mg/kg of total carotenoids. These are predominantly xanthophylls (about 85–90%), including lutein (50%), 13-*cis*-lutein (15%) and 9-*cis*-lutein (20%). Approximately 7–10% of the carotenoids are present as carotene (Ratnayake and Daun, 2004). β -Carotene has been shown to protect lipids from free radical auto-oxidation by reacting with peroxy radicals, thereby inhibiting propagation and promoting termination of the oxidation chain reaction (Britton, 1995; Goulson and Warthesen, 1999). β -Carotene is also an effective quencher of singlet oxygen during the inhibition of photooxidation (Goulson and Warthesen, 1999). Lutein has also been reported to have pro-oxidant activity in TAG in both dark and light (Haila and Heinonen, 1994).

The presence of chlorophyll in rapeseed seeds imparts an undesirable green color to the oil, but the pigment is important for photosynthesis. In addition, chlorophyll promotes photooxidation and inhibits the catalysts needed for hydrogenation (Usuki et al., 1984). Chlorophyll has a pro-oxidant effect in the presence of light, but it has been shown to work as an antioxidant in the dark (Endo et al., 1985).

Rapeseed yields a considerable amount of oil rich in bioactive compounds. The quality of oilseed rape breeding has largely been driven by the nutritional concerns of consumers. By combining modern biotechnology, such as genetic engineering, with classical plant breeding types of varieties, the functional rapeseed oil will be produced (Szydlowska-Czerniak et al., 2010). China is divided into

two oilseed rape production regions, winter region and spring region. The winter rape makes up above 90% of the total rapeseed planting area, while spring rape accounts below 10%. The winter rape region is located in the Yangtze River Valley, and many rapeseed cultivars are planted. It is necessary to study the contents of the minor components of these cultivars. Moreover, to the best of our knowledge, no data about the correlation between oxidative stability and the chemical component of rapeseed oil have been published. Therefore, this study investigated the contents of polyphenols, phytosterols, tocopherols, β -carotene, lutein and chlorophyll of cold-pressed oils from 203 rapeseed varieties currently grown throughout the Yangtze River Valley in China for commercial oil production. Moreover, this work established the statistical relationships between oxidative stability (induction period, IP) and these minor components. The IP, total amounts of phenolics, tocopherols and β -carotene as well as lutein and chlorophyll contents of 38 representative cultivars were used as descriptors for the principal component analysis (PCA) to differentiate the analyzed rapeseed varieties.

2. Materials and methods

2.1. Materials

Two hundred and three commercial winter rapeseed cultivars were collected from different areas in the Yangtze River Valley of China. Among these varieties, 84 cultivars come from the upper Yangtze River, including Sichuan (43 cultivars), Chongqing (10 cultivars), Guizhou (12 cultivars), Shanxi (2 cultivars), Yunnan (11 cultivars) and Guangxi (6 cultivars); 78 cultivars come from the middle Yangtze River, including Hubei (35 cultivars), Hunan (18 cultivars), Jiangxi (9 cultivars) and Henan (16 cultivars); 41 cultivars come from the lower Yangtze River, including Anhui (30 cultivars), Jiangsu (4 cultivars) and Shanghai (7 cultivars). The zone distributing and planting location of these rapeseed cultivars were shown on the map in Fig. 1. The selected oilseed rape cultivars were cleaned and stored at 20 °C.

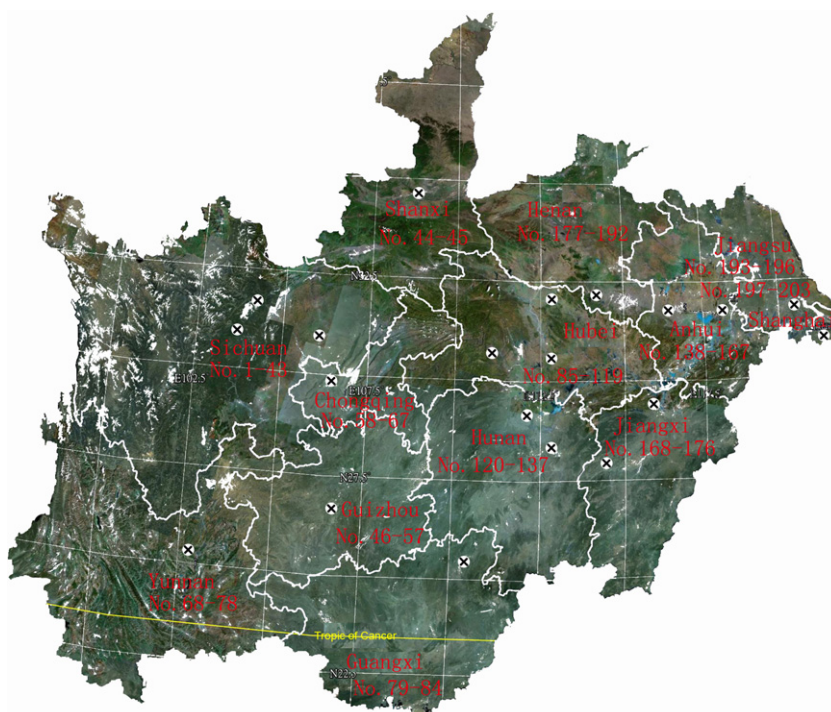


Fig. 1. Map illustrating the rapeseed cultivars grounds.

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