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ORIGINAL ARTICLE

Variations of quality characteristics among oils of different soybean varieties

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Abstract A study was carried out to evaluate the variation of quality attributes among oils from different soybean varieties (Bovender special, Foster and F-8827).Oils were extracted using *n*-hexane as solvent. Results indicated that contents of seed oil among the tested varieties varied from 15.85% to 19.49%, moisture 8.4–10.2%, protein 41.67–45.64%, fiber 6.6–7.6% while ash 5.5–6.9%. The physical and chemical characteristics among the tested oils varied as: color (4.2–5.3R + 40–50Y), iodine value (119–128 g of I/100 g of oil), refractive index (1.4590–1.468), density (0.8698–0.8712 g/cm^3 at 36 °C), free fatty acid content (0.39–0.67% as oleic acid), saponification value (181–187 mg KOH/g) and unsaponifiable matter (0.42–0.74%). The oxidation parameters including peroxide value, conjugated dienes and conjugated triene were recorded as 1.80–2.64 meq/kg, 0.41–0.65 and 1.50–1.91, respectively. The fatty acid composition showed the presence of palmitic acid (11.00–13.50%), stearic acid (3.02–4.90%), oleic acid (22.60–24.00%),

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linoleic acid (49.03–53.00%) and linolenic acid (6.50–8.00%). The amounts of α, γ and δ-tocopherols ranged from 66.5 to 90.7 mg/kg, 907.5–1011.9 mg/kg and 399.8–411.5 mg/kg, respectively. Results indicated a significant variation for most of the physicochemical parameters among three soybean oils which can be mainly linked to the specific genetic makeup of each variety as well as the agro-climatic conditions of the harvest.

1. Introduction

Vegetable oils being an important ingredient of our diet act as a source of essential fatty acids and nutrition and can be extracted from a variety of plant seeds such as soybean, cotton, sesame, sunflower, safflower, palm, corn and canola (Anwar et al., 2005a).

One of the important oil seed crops namely soybean (*Glycine max* L.) is a member of the *Leguminosae* family [sub-family *Papilionoideae*]. The plant is annual, generally grows to a height of 20–180 cm, and has white or lilac flowers and pods. The pods, which usually contain two or three seeds, are formed in the leaf axils. There are several varieties of soybean with yellow, green, brown or black seeds and cultivars. Soybean is essentially a subtropical crop but can also be grown in tropical to temperate regions up to temperatures as high as 50 °C. Soybean like other legumes is useful for crop rotation due to the ability to fix nitrogen from the air (Anonymous, 1994).

Protein and oil are the two important seed constituents that make soy bean (*Glycine max*) an important crop. It contains 40–42% high quality protein and 18–22% oil comprising up of 85% unsaturated fatty acid. Soybean not only contains high quality protein, but the protein content is also much higher than that of other plant foods. This valuable bean also contains about 12% carbohydrate (Yaklich et al., 2002). Soy protein is valued as a healthy protein due to containing a balanced proportion of all of the important and essential amino acids required by the human body (Potter et al., 1998). It is the only vegetable source that contains a complete protein. It contains all the nine essential amino acids that a human body cannot synthesize and which must be obtained from foods. In fact soybeans can provide two fold more proteins as compared to any other vegetable crop or grain (Anonymous, 2015). The soybean flakes obtained after extraction of oil can be further processed into protein meals and protein isolates for animal and human use. Hydrolyzed soybean protein (HSP) can be used in soups, sauces, gravies, spice blends, canned and frozen vegetables, meats and poultry as a flavor enhancer. Moreover, the textured soy flour is widely used as a meat extender (Anonymous, 1994).

The health attributes of soy have been linked to the isoflavones naturally occurring in soy in conjunction with the soy protein (Potter et al., 1998). Soybean contains two primary isoflavones namely genistein and diadzein. A third isoflavone, glycitin is also reported in small amounts. Typically, genistein is found at the highest level in soy foods (Messina and Loprinzi, 2001).

It is assumed that the oil yield and physicochemical properties of oils are not only varied in relation to different species and different agro-climatic regions rather such variations can also be seen within the oils of different varieties/cultivars of the same species. Some recent reports revealed considerable inter-varietal variations the chemical composition of seed oils of okra and wintermelon (Anwar et al., 2011a,b).

World production of soybean (*Glycine max*) in 2014/15 was over 319.36 million metric tons, with 108.01 million metric tons of this production coming from U.S., where soybean plantings on an annual basis are over 33.61 million ha. Soybeans are desired on the marketplace as a valuable source of protein and oil (USDA, 2015). Although soybean as an oil seed crop was introduced in Pakistan along with sunflower a few decades back, yet it could not make its place in the country. Since its average yield per hectare under local agro-climatic set up is also quite low, its production remained small. Soybean, as an oilseed crop, is under research and production trials in several parts of Pakistan. Several attempts have been made over the decades to introduce soybean for commercial planting but no encouraging success was achieved. Presently, it is grown on a very small area, in Punjab, Sindh and Khyber Pakhtunkhwa provinces of Pakistan (FAO, 2013).

Soybean varieties namely, Bovender special, Foster and F8827, investigated in the present study were grown at Ayub Agricultural Research Institute, Faisalabad, Pakistan for adaptive studies. As the oil yield and the physicochemical properties and attributes of the oils can vary among different varieties of oil seeds with respect to their genetic makeup (Clemente and Cahoon, 2009; Hudson, 2012; Ma et al., 2015), so a need exists to investigate such variations with regard to different soybean cultivars. Until now, a full characterization and comparison of the quality attributes of the oils produced from seeds of mentioned locally cultivated soybean varieties has not yet been investigated. The main objective of the present study was to conduct a detailed analysis and to assess the variations in physicochemical characteristics of soybean seed oils of different varieties cultivated in Pakistan. The main theme behind carrying out this study was to convey information to the local growers and industrialists about the physicochemical attributes of the above varieties thus helping them in selection of the appropriate variety for cultivation and industrial processing at regional level.

2. Materials and methods

2.1. Chemicals, standards and reagents

Chloroform, oxalic acid, acetic acid, phenolphthalein, hydrochloric acid, potassium iodide, *n*-hexane, sodium sulfate, potassium hydroxide, sodium thiosulfate, potassium permanganate, boric acid, carbon tetrachloride, iso-octane, iodine, sodium hydroxide, methanol, sulfuric acid, *p*-anisidine and pure standards of fatty acid methyl esters (FAMEs) used in the present study were purchased from E-Merck and/or Sigma–Aldrich Chemical Corporation (St. Louis, MO, USA).