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Enhancement of the oxidative stability of some vegetable oils by blending with *Moringa oleifera* oil

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Abstract

Blends (20%, 40%, 60%, 80% w/w) of *Moringa oleifera* oil (MOO) with sunflower oil (SFO) and soybean oil (SBO) were prepared to evaluate the changes in fatty acid (FA) composition, oxidative and thermal stability of SFO and SBO. The blending of MOO with SFO and SBO in proportions of 0–80% resulted in the reduction of linoleic acid ($C_{18:2}$) content of SFO and SBO from 67.0% to 17.2% and 56.2% to 14.6% and increase in the contents of oleic acid ($C_{18:1}$) from 26.2% to 68.3% and 21.4% to 65.9%, factors of 0.72, 0.72 and 1.27, 1.33, respectively. A storage ability test (180 days; ambient conditions) showed an appreciable improvement in the oxidative stability of substrate oils with increase of MOO concentration, as depicted by the least oxidative alterations in PV, IV and highest increase in induction period, IP, of the MOO:SBO (80: 20 w/w) blend. Each 20% addition of MOO resulted in decreases of PV and IV by factors of 0.84, 0.85 and 0.89, 0.88, respectively, and increases in IP by factors of 1.45 and 1.37 of SFO and SBO, respectively.

The heating performance test (180 °C for 42 h; 6 h heating cycle per day), as followed by the measurement of polymer contents and total polar contents (TPC), also revealed the MOO:SBO (80:20 w/w) blend to be the most stable. Every 20% addition of MOO in SFO and SBO resulted in reduction of the polymer contents and TPC of SFO and SBO by factors of 0.91, 0.92 and 0.94, 0.94, respectively. On the basis of the present findings, it appears that proper blending of high linoleic oils with MOO can result in oil blends which could meet nutritional needs with improved stability for domestic cooking and deep-frying.

Keywords: Blending; Storage stability; Heating performance; *Moringa oleifera* oil; Fatty acid composition; Total polar components; Induction period

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1. Introduction

During storage and heat treatment, vegetable oils undergo hydrolysis, oxidation and polymerization, resulting in quality deterioration with respect to their sensory and nutritive value. Although the mechanisms of such processes are essentially the same in different fats, the kinetics of deteriorative reactions may vary (Che Man, Liu, Jamilah, & Rahman, 1999). The deep fried flavours are due to degradation products of linoleic acid (Pokorny, 1989) and their intensity can be lowered if the food is fried in oil of low linoleic acid content. Nutritional advantages have been recognized for oils rich in oleic and other mono-unsaturated fatty acids with reduced linoleic acid contents and low contents of saturates (Nestel, Clifton, & Noakes, 1994).

Recent studies have demonstrated that diets with high contents of oleic acid are associated with low levels of low-density lipoprotein cholesterol in blood plasma and they may reduce the incidence of coronary heart diseases (Noakes, Nestel, & Clifton, 1996).

Oleic acid ($C_{18:1}$) is the most abundant mono-unsaturated fatty acid in many common edible oils, e.g. canola oil. Compared with polyunsaturated fatty acids, oleic acid is more resistant toward oxidation, both at ambient storage

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and at high temperatures (Warner & Knowlton, 1997) that prevail during the cooking and frying of food. Conventionally, soybean, rapeseed, sunflower or peanut oils, with high contents of polyenoic FA, are the main edible oils used for domestic cooking purposes (Erickson, 1996). Pan-frying, however, is not suitable for deep fat frying due to the higher magnitude of thermoxidation at elevated temperatures. Some low-linoleic, high-oleic vegetable oils could be used for deep-frying, e.g. canola, olive, or almond oils, as they are quite stable at high frying temperatures. However, their high cost restricts their usage on a major scale.

Therefore, the use of more stable frying oils of comparatively low price would be desirable. To overcome the problem of poor stability of traditional soybean, sunflower and rapeseed oils, ways of reducing the unstable polyunsaturated fatty acid content were sought. One way to improve the stability of these oils is by blending with oils of high-oleic acid contents. Blending of vegetable oils and fats has emerged as an economical way of modifying the physicochemical characteristics of vegetable oils and fats besides enhancement in oxidative stability (Chu & Kung, 1997, 1998; Premavalla, Madhura, & Arya, 1998).

Proper mixing of high-oleic and high-linoleic oils may result in oil blends with improved stability characteristics. Mariod, Matthaus, Eichner, and Hussain (2005) investigated improvement in the oxidative stability of sunflower kernel oil by blending with non-conventional Sudanese oils. Studies of Padmavathy, Siddhu, and Sundararaj (2001) have shown that the FA profile of the oils can be improved by blending; hence, the need to hydrogenate unsaturated oils is appreciably decreased, thereby eliminating the chances of formation of harmful *trans*-FA. Gupta, Sinddhu, and Sundararaj (2001) studied the oxidative stability of edible grade crude palm oil (CPO) blends with sunflower oil or ground nut oil (GNO) as the deep-frying medium and reported that CPO:SFO had better oxidative stability than had CPO:GNO.

Moringa oleifera Lam. is the most widely known and utilized species, belonging to the family Moringaceae. A native of the sub-Himalayan regions of northwest India, *M. oleifera* is also indigenous to many countries in Africa, Arabia, Southeast Asia, the Pacific, Caribbean islands and South America (Siddhuraju & Becker, 2003). As a traditionally important food commodity, *M. oleifera* has received attention as “natural nutrition of the tropics”. The leaves, flowers, fruits and roots of this multipurpose tree are locally esteemed as a vegetable (Anwar & Bhanger, 2003). In addition to its myriad uses and superior nutritional benefits, *M. oleifera* also has surprising medicinal attributes and is used in the treatment of ascites, rheumatism, venomous bites, and as a cardiac and circulatory stimulant (Anwar, Ashraf, & Bhanger, 2005). The plant has been well positioned in Ayurvedic, Unani, and even allopathic systems of medicine (Mughal, Ali, Srivastava, & Iqbal, 1999). *M. oleifera* seeds and the extracted oil, known commercially as “ben oil” or “behen oil”, have been extensively used in the enfleurage process. Oliveira and Silveira (1999) described the composition and nutritional attributes of *M. oleifera* seeds and suggested that these antipyretic, acrid, and bitter seeds could be utilized for wastewater treatment (Ndasbigengeser & Narasiah, 1998). Numbers of studies have been conducted on the characterization of *M. oleifera* oil (MOO) (Anwar et al., 2005; Abdulkarim, Long, Lai, Muhammad, & Ghazali, 2005; Tsaknis & Lalas, 2002). The MOO is reported to have a high level of oleic acid and different tocopherol isomers (Anwar et al., 2005). Tsaknis and Lalas (2002) reported that MOO has excellent oxidative stability during frying. So, great potential exists for blending of MOO with other high-linoleic oils.

As food habits of most of the Pakistani population are based on deep fried/baked foods, oxidative-resistant oils are needed. Conventionally available cooking oils can not fulfil this requirement; rather, they may cause serious health disorders due to the generation of hazardous oxidation products. This requirement can be conveniently met through the blending process. In the present study, efforts have been made to investigate the effects of blending of MOO on the oxidative stability of high-linoleic oils. No such previous studies have yet been conducted on the blending of MOO. This report might serve as a milestone toward development of newer blended oils with improved stability characteristics.

2. Materials and methods

2.1. Samples and standards

The seeds of *M. oleifera* were collected from the periphery of the University of Sindh, Jamshoro, Pakistan, whereas, the seeds of sunflower and soybean were obtained from the Agricultural Research Institute, Tandojam, Pakistan. All reagents used were from E. Merck or Sigma Aldrich unless stated otherwise. Pure standards of fatty acid methyl esters were obtained from Sigma Chemical Co. (St. Louis, MO).

2.2. Extraction of vegetable oils

The seeds were dehulled, crushed and ground to pass through a 0.5 mm sieve by a grinding mill (Petra electric, Burgau, Germany). The crushed seeds (200 g) were then fed into a Soxhlet extractor fitted with a 1 l round-bottom flask and a condenser. The extraction was executed on a water bath for 4–5 h with 0.5 l of *n*-hexane. The solvent was distilled off under vacuum in a rotary evaporator (EYELA, Rotary Vacuum Evaporator, N.N. Series, equipped with an Aspirator and a Digital Water Bath SB-651, Japan).

2.3. Degumming of oils

The oils to be degummed were heated at 70 °C on a water bath. Hot water was added to a final volume of 18%, and