

## POTENTIALS OF MORINGA (*Moringa oleifera*) SEED OIL IN ENHANCING THE NUTRITIONAL QUALITY AND STABILITY OF SOYBEAN OIL

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### ABSTRACT

Partial hydrogenation method has been used to improve the stability of soybean oil, though it results in the production of trans-fatty acid. The objective of this study was to establish the potential of moringa oil to improve the stability and nutritional quality of soybean oil. Oil samples were extracted from sundried soybean and Moringa seeds using Soxhlet extraction techniques. Soybean powder was mixed with Moringa powder at ratio 50:50 and 70:30, and the oil was extracted afterward. The fatty acid profile of the extracted oil from these blends was studied using Gas Chromatography-Mass Spectrophotometry (GC-MS) technique. The results showed that commercial soybean oil and the blended soybean/moringa oil of ratio 50:50 and 70:30 had a polyunsaturated fatty acid of 52.70%, 22.18% and 35.73 % respectively; monounsaturated fatty acid 27.22%, 46.61% and 58.79% respectively; saturated fatty acid 19.01%, 19.02% and 17.86% respectively. Also, trans-fatty acid (0.003-0.395%) was obtained in the commercial soybean oil sample. The blended soybean/moringa oil offers a better option than the use of partially hydrogenation in commercial soybean oil.

**Keywords:** Moringa seed oil, soybean oil, partial hydrogenation, trans-fatty acid, Oil blending.

## INTRODUCTION

Soybean oil is a well-accepted vegetable oil. Its usage is known with reduced risk of cancer of the breast and prostate (Zhang *et al.*, 2011). Nevertheless, it has less oxidative stability when stored at room temperature as well as when they are used in the kitchen for frying and cooking at high temperature (Kozłowska and Gruczynska 2018). Various methods have been developed to improve the oxidative stability of soybean oil. These include partial hydrogenation, fatty acid modification (inter-esterification), genetic engineering and blending with more saturated and monounsaturated oils to lessen the quantity of polyunsaturated fatty acids (Cuesta *et al.*, 1993; Su and White, 2004, Adel *et al.*, 2015, Berry *et al.*, 2019). Partial hydrogenation improves the stability of edible oils but produces trans-fats which have been associated with risks of heart disease in humans (Downs *et al.*, 2013). The inter-esterification process to modify polyunsaturated fatty acids of oils with other stable vegetable oils increases processing costs which is not economically acceptable (Mena *et al.*, 2013). Like any new technology, genetic engineering carries with it some level of uncertainty and requires ways to predict and assess potential unintended effects.

Moringa seed oil is rich in oleic acid (> 70%) and it is one of the major sources of naturally antioxidants (Ojiako and Okeke, 2013). *Moringa oleifera* oil may serve as an additional source of edible oil for domestic and industrial uses (Conrad *et al.*, 2020). It is a potential vegetable oil that can be blended with soybean oil to enhance its oxidative stability as well as its nutritional and deep-frying qualities. There is a pressing need for widely usable and easily available bioactive lipids and natural antioxidants (Gupta and Singh, 2013).

Soybean oil in its natural form has an appreciable level of omega-3- fatty acids which add to the nutritive value of the oil. However, it is known that partial hydrogenation may destroy some of the omega-3-fatty acid and produces trans-fatty acid in the oil. Instead of partial hydrogenation of soybean oil to improve stability, the numerous antioxidants present may be lost. The enhancement of soybean oil by mixing with other vegetable oils such as palm oleic, sunflower, mustard seed has been reported (Abdulkarim and Myat, 2010). Haridas *et al* (2015), blended rice bran oil and safflower oil to produce anti-lipidermic effect on the oil. The use of *temnocalyx obovatus* extracts as an alternative natural antioxidant to improve sunflower and soyabean oil oxidative stability was reported by Dzomba *et al.*, 2012. Adamsu, 2015 reported a positive effect of co-pressing on niger seed oil with black cumin seed oil on yield and oxidative stability and sensory properties of cold pressed oil. Ebrahimzadeh *et al* (2015) mixed soybean oil with

*urtica dioica* to enhance the stability of soybean oil. To overcome the problem of poor stability of soybean oil, blending of vegetable oil that is high in oleic acid can improve the oxidative stability, physicochemical properties of vegetable oils besides enhancement of nutritional quality. The present study was therefore designed to determine the effect of moringa seed oil blend on the oxidative stability and nutritional quality of soybean oil.

## **MATERIALS AND METHODS**

### **Materials**

Soybean and Moringa seeds were obtained locally from an open market at Yoruba Road, Ilorin, Kwara State while the commercial soybean oil was purchased from Shoprite, Kwara State, Nigeria. All the materials were stored at room temperature until further analyses. All the analytical reagents used were of analytical grade.

### **Methods**

#### **Extraction of Oils**

About 1,500g of soybean seeds were sorted, dried and milled into powder. About 800g of Moringa seed was sorted, dried and milled into powder. Oil was extracted as designed by Evwierhoma and Ekop (2016), using Soxhlet extraction technique with n-hexane as solvent. Three different blends of 100:0; 70:30; 50:50, respectively, for soybean and moringa oil were prepared.

#### **Determination of Fatty Acid Composition**

The preparation of fatty acid methyl esters (FAMES) was done as described by Li et al (2012) and the FAME was removed and dried with anhydrous Na<sub>2</sub>SO<sub>4</sub>, then diluted to a concentration of 5-10% for injection into the gas chromatography, the FAMES was removed and dried with anhydrous Na<sub>2</sub>SO<sub>4</sub>, it was then diluted to a concentration of 5-10% for injection into the Gas chromatography-mass spectrometry, (GC/MS) analysis was carried out with an Agilent 6890-5973 (Agilent Technologies, CA, USA) instrument. Separating procedure was achieved on an Agilent HP-88 capillary column (100×0.25 mm i.d., film thickness 0.2 µm). The conditions of operation were as follows: carrier gas pressure, 100 kPa; carrier gas, helium; split ratio was 1:30; injection temperature, 250°C; scanning scope: 50-550 amu; ionization voltage: 70 eV. Oven temperature was programmed as follows: it was held at 80°C for 5 min, and then rising to 150°C at 10°C/min, and held for 2 min at 150°C; then continuously rising to 230°C at 5°C/min and held for 10 min. The specific fatty acids were

identified and quantified by comparing their retention times with external standards. Fatty acid composition of the oil was reported as total percentage of total fatty acids.

## RESULTS AND DISCUSSION

The composition of the fatty acid of oil samples is as shown in Table 1. Trans-fatty acid was present in the commercial soybean oil while the freshly extracted and the blended oils did not indicate the presence of trans-fatty acids. This result is in line with previous researches which reported that though partial hydrogenation improves stability of edible oil, it results in the production of trans-fats (Da Silva *et al.*, 2010, Downs *et al.*, 2013). This implies that commercial soybean oils that are relatively stable on the shelf might have undergone partial hydrogenation. The fatty acids composition of the extracted soybean oil is as shown in Table 1. It has 54.59% Linoleic acid and 7.30% Linolenic acid while 48.43% and 4.40% were obtained for the commercial soybean oil for Linoleic acid and Linolenic acid respectively. The reduction of linoleic and linolenic acid of commercial soybean oil, could be due to the loss of unsaturation as a result of partial hydrogenation. The result obtained is within the range reported for fatty acid composition of soybean oil in several works (Reena and Lokesh 2007). The blending of moringa oil with soybean oil had positive effects on the composition of the fatty acids. The relative percentage composition of the level of saturation of the oil samples are as shown in Table 2. Commercial soybean oil and soybean/moringa oil blend (50:50) had slightly higher percentage of saturated fatty acids, 19.01% and 19.02% respectively, compared to extracted soybean oil and soybean/moringa oil blend (70:30) which had 16.43% and 17.86% respectively.

The soybean/moringa oil blends (50:50 and 70:30) had higher monounsaturated fatty acid (58.79% and 46.41%) and lowest amount of polyunsaturated fatty acid (22.18% and 35.73%), respectively. This is possibly due to the effect of moringa oil composition that has high content of oleic acid. The extracted soybean oil had the highest percentage of polyunsaturated fatty acid (61.8%) and the lowest percentage of monounsaturated fatty acid (21.67%). Blending of soybean oil with *Moringa oleifera* oil did not significantly modify the saturation level of the oil samples but there was a significant modification on the fatty acids composition. Soybean oil in its natural form has an appreciable amount of polyunsaturated acid and low percentage of monounsaturated fatty acids; however, it has less oxidative stability. Blending of soybean oil with other oils has been reported to enhance its oxidative stability and modify the fatty acid profile (Abdulkarim and

Myat, 2010 and Naghshineh *et al.*, 2010). Thus, the result obtained from this study shows that soybean/moringa oil blends has the lowest percentage of polyunsaturated fatty acids and the highest amount of monounsaturated fatty acids. This confirms the reports from previous research that blending soybean oils with other oils may yield positive effects on the stability and fatty acid profile of the oil (Yang Li *et al.*, 2014). This may probably be a nutritional advantage for the blended oil as oleic acid has been shown to have beneficial health effects. Oleic acid has been associated with decreased low-density lipoprotein (LDL) cholesterol, and possibly increased high-density lipoprotein cholesterol (Nadeem and Imran 2016). Dinicolantonio and O'Keefe (2018) also reported that oleic acid may be responsible for the hypotensive (blood pressure reducing) effects of olive oil.

The extracted soybean oil had the highest amount of omega-3 fatty acid (7.3%). This was probably because the oil did not go through partial hydrogenation. Thus, the omega-3 fatty-acid were preserved. However, the commercial soybean oil had a low content of omega-3 fatty acid (4.4%). This was probably because it was partially hydrogenated. Omega-3 fatty acid has been reported to have possible impact in prevention of coronary heart disease, cardiovascular diseases and related disease (Torpy *et al.*, 2006, Bowen *et al.*, 2016). Nutritionally, omega-3 fatty acid determines the quality of the oil indicating that the higher the percentage of omega-3 fatty acid in the oil samples the better the nutritional quality. The oil blended with 70:30, soybean and moringa oil had 4.61% of omega-3 fatty acid while the oil blends (50:50) had the lowest amount of omega-3 fatty acid (2.8%). Higher contents of omega-3 fatty acid were obtained with 70:30 oil blends than the commercial oil samples that had gone through partial hydrogenation.

Extracted soybean oil had the highest amount of omega-6 fatty acid (54.59%). Omega-6 fatty acid has been reported to help in the maintenance of healthy bone, regulating metabolism, and in stimulating skin and hair growth (Al-khudairy *et al.*, 2015), which indicates a better nutritional quality. The oil blends (50:50) and (70:30) had the highest percentage of omega-9 fatty acid (57.76%) and (45.54%). It has also been reported that omega-9 fatty acids regulate pro-and anti-inflammatory processes via its ability to stimulate enzymes and produce cytokines and other acute phase molecules (Maskrey *et al.*, 2011). This is an indication that the blending increased the omega-9 content in the oil and hence a better quality.

**Table 1: Fatty acid composition (%) of vegetable oil samples**

Fatty acid	Extracted Moringa Oil	Extracted soybean oil	Commercial soybean oil	Soybean/moringa oil blend (50:50)	Soybean/moringa oil blend (70:30)
C12:0	ND	ND	2.49	ND	ND
C14:0	ND	ND	0.93	ND	0.15
C16:0	7.72	ND	12.32	8.79	11.2
C16:1	0.93	ND	ND	ND	ND
C16:1t	ND	ND	0.003	ND	ND
C18:0	3.52	4.13	4.2	4.31	4.2
C18:1	76.52	ND	ND	ND	ND
C18:1n9t	ND	ND	0.395	ND	ND
C18:1n9c	ND	21.67	27.22	57.76	45.54
C18:2n6c	ND	54.59	48.43	19.38	31.12
C18:3n3	ND	7.3	4.4	2.8	4.61
C20:0	2.49	ND	ND	1.79	0.50
C21:0	ND	ND	ND	2.88	ND
C22:0	0.5	ND	ND	1.25	ND
C22:1	2.48	ND	ND	ND	ND
C23:0	2.62	ND	ND	ND	ND

ND (Not Detected)

**Table 2: Classes of fatty acid in their relative percentage**

Samples	SFA	MUFA	PUFA	n-3	n-6	n-6/n-3	t-fats
ESO	16.43	21.67	61.89	7.30	54.59	7.48	ND
CSO	19.01	27.22	52.70	4.40	48.30	10.97	0.4
SMO (50:50)	19.02	58.79	22.18	2.80	19.38	6.92	ND
SMO (70:30)	17.86	46.41	35.73	4.61	31.12	6.75	ND

ND (Not Detected)

SFA- Saturated fatty acid

MUFA- Monounsaturated fatty acid

PUFA- Polyunsaturated fatty acid

n-3- omega-3 fatty Acid

n-6- omega-6 fatty Acid

t-Fats-Trans-fatty Acid

ESO- Extracted soybean oil

CSO- Commercial Soybean oil

SMO (50:50) - Soybean/Moringa oil blend (50:50)

SMO (70:30) - Soybean/Moringa oil blend (70:30)

## CONCLUSION

Commercial soybean oil contains trans-fatty acid due to the use of partial hydrogenation to improve its stability. In this research, extracted soybean oil was mixed with moringa oil at different ratios (50:50 and 70:30). The result showed that the mixed soybean/moringa oil did not contain trans-fatty acid. The polyunsaturated fatty acid of the mixed soybean/moringa oil was reduced as compared to the commercially used soybean oil. Also, the Omega-3 value of Soybean/moringa oil of ratio 70:30 (4.61%) was higher than 50:50 (2.8%) and commercial soybean oil (4.4%). It can be concluded that the blended soybean/moringa oil offers a better option than the use of partially hydrogenated commercial soybean oil. Also, the blending of Moringa oil with soybean can be recommended since they contain high percentage of mono-unsaturated fatty acid.

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