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BLENDING AFRICAN OIL BEAN SEED OIL WITH SESAME SEED OIL: PHYSICOCHEMICAL PROPERTIES AND PHYTOCHEMICAL CONTENTS

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ABSTRACT

The effect of blending on the physicochemical properties and phytochemical contents of African oil bean seed oil and sesame seed oil was investigated. Vegetal oils were extracted from African oil bean seeds (AB) and sesame seeds (SS) through Soxhlet extraction and blended in the following proportions: AB100:SS0, AB0:SS100, AB90:SS10, AB80:SS20, AB70:SS30, AB60:SS40 and AB50:SS50 respectively. The physicochemical properties and phytochemical contents were evaluated and emanated data was statistically analyzed at 95% confidence level. Physicochemical results showed that moisture decreased from 1.87 to 1.76%, specific gravity increased from 0.92 to 0.93 g/cm^3, melting point increased from 33.80 to 35.87^{0}C, Smoke point decreased from 191.85 to 188.22°C, flash point decreased from 337.94 to 319.40°C, fire point decreased from 376.10 to 373.60°C and cloud point increased from 3.50 to 5.51°C. Control oil sample had lower moisture, refractive index, melting point, flash point, fire point and cloud point than the experimental oils. Phytochemical results are significantly ($p<0.05$) from each other in all the studied parameters. Flavonoid content ranged from 0.14-8.35 CE mg/g, total phenolic content ranged from 0.00 to 26.73 mg GAE/100 g, tannin content ranged from 0.00 to 0.97 mg/100 g, saponin content ranged from 0.00 to 4.49 mg/100 g and alkaloid content ranged from 0.00 to 8.82 mg/100 g. Control had the lowest values for all phytochemical contents. Conclusively, findings showed that there is need for refining of experimental oil samples and blending African oil bean seed oil with sesame seed oil reduced the moisture content and improved thermal stability.

Keywords: African oil bean, sesame, physicochemical, blending, phytochemical.

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INTRODUCTION

Vegetable oils are regarded a great cooking medium due to their health benefits. There is universal demand for vegetable oil for cooking/frying, and as an ingredient for other food and non-food products (Awogbemi et al., 2019). This demand has stressed the supply of conventional oil, making them unable to meet demand. Therefore, there is increasing need to search for oils from non-conventional sources like African oil bean to augment the available ones (Sarwar et al., 2013). African oil bean is an oilseed often known as ugba in South-Eastern Nigeria. The seed is high in nutrients like protein, amino acids, phosphorus, magnesium, iron, vitamins, calcium, manganese, and copper. It also contains phytonutrients (terpenoids, cardiac glycosides and saponin) which have numerous health benefits (Akinlabu et al., 2019). African oil bean seed possess substantial vegetable oil which its exploration could see the crop compete in the global oil-seed commerce and as well save Nigeria its hard earned foreign exchange spent in importing vegetable oils. Its oil has been reported to contain higher level of unsaturation and can be employed in the manufacture of a wide array of food products.

Sesame (*Sesame indicum*, L.) is popularly known as the queen of oilseeds and among the top-listed economically important oilseeds in the world. It has abundant oleic and linoleic acids (Amandeep and Vinod, 2019). Sesame seed contains both oil-dispersed lignans and glycosylated lignans which have medicinal properties (Adeniyi et al., 2020). Oils from sesame seeds are significantly stable natural vegetable oils with significant content of vitamin K, sterols, tocopherols and natural lignin like sesamol. It also includes a notable amount of polyunsaturated fatty acids, which reduce blood cholesterol, high blood pressure, and have a vital role in avoiding atherosclerosis, heart disease, and malignancies (Imran et al., 2020). Blending of edible oils, particularly from local oil seeds has become necessary because the high cost of obtaining vegetable oil with the desired attributes for food processing has been one of the challenges in the food industry. Therefore, this study investigated the physicochemical properties and phytochemicals present in binary oil blends of African oil bean seed oil and sesame seed oil

Materials and methods

Sources of oil seeds

The Ghana variety of African oil bean seed was purchased from Ndoro market in Ikwuano Local Government Area, Abia State. White sesame seeds were acquired at Gariki Market in Enugu North Local Government Area, Enugu. African oil bean and sesame seed types were identified at Michael Okpara University of Agriculture's Agronomy Department in Umudike.

Processing of African oil bean seed into flour

The method described by Oyinlove and Enujiugha (2019) was used to process African oil bean seeds into flour, with a little change to the drying period. One kilogram of African oil bean seeds were separated and rinsed with tap water. The surface moisture was allowed to dry with air circulation at room temperature. Manual dehulling was then performed by shattering the cotyledons in a mortar and extracting them from the hulls with a kitchen knife. The African oil bean seeds were dehulled, split into 1.5 cm pieces, and dried in an oven (Gallenkamp, Model OV 160, England) at 55˚C for 48 hours before being milled into flour using an attrition mill (Model 178F, GECO, China). The obtained African oil bean seed flour was subjected to oil extraction.

Processing of sesame seed into flour

Moharram et al. (1990) described a method for dehulling sesame seeds. One (1) kilogram of white sesame seeds was cleaned and sorted to remove unwanted seeds and contaminants. Cleaned sesame seeds were decorticated by soaking them in a solution of 0.04% NaOH and 3% NaCO3 for 40 minutes with a seed-to-lye ratio of 1:3 (w/v), then rubbing them between

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palms to loosen and remove the hulls. Ugwuona and Obeta (2016) described a method for making flour from dehulled sesame seeds. Dehulled seeds were washed with tap water to remove lye solution and dried at 55˚C in a Gallenkamp hot air oven (Model OV 160, England) for 36 hours. Afterwards, the dried sesame seeds were milled with attrition mill (Model 178F Chomgqing GECO, China) to obtained sesame seed flour prior to Soxhlet extraction.

African oil bean seed and sesame seed oil extractions

Musa et al. (2015) described a technique for extracting African oil bean seed and sesame seed oils, which used the Soxhlet extraction method with n-hexane as the solvent. This method was used in the present study.

Preparation of African oil bean seed oil and sesame seed oil blends

Oil blends were prepared by mixing African oil bean seed oil (AB) and sesame seed oil (SS) designated as AB: SS in the following proportions respectively: 100:0 (AB100), 0:100 (SS100), 90:10 (AB90:SS10), 80:20 (AB80:SS20), 70:30 (AB70:SS30), 60:40 (AB60:SS40) and 50:50 (AB50:SS50) (v/v). To ensure consistency, the binary mixes were thoroughly mixed for 3 minutes with a magnetic stirrer (VELP AREX CerAlTop™, UsmateVelate, MB, Italy). (Pan et al., 2020). Commercial soybean oil served as the reference sample.

Determination of physicochemical properties

The moisture content of the oil samples was evaluated in accordance with Enyoh et al. (2017). Onwuka (2018) described the methods used for determining the refractive index, specific gravity, and melting point of the oil samples. The smoke, flash, and fire point of the oil mix samples were determined using the AOCS (2012) method. The cloud point was calculated following the approach presented by Eyankware et al. (2016).

Determination of phytochemical contents

The total flavonoid (TF) content was measured using the aluminium chloride colorimetric test reported by Osuagwu and Ihenwosu (2014). The tannin, saponin, and alkaloid concentrations were determined using the Follins Dennis spectrophotometer, the double solvent extraction gravimetric method, and the alkaline precipitation gravimetric method, as described by Nwalo et al. (2017).

Experimental design

Completely randomnized design (CRD) was used for this study.

Statistical analysis

All experimental data were presented as mean ± SD. The data were subjected to a one-way analysis of variance (ANOVA) using the SPSS software (version 21, IBM, USA) to determine the significant difference among the experimental data, and the Duncan Multiple Range Test (DMRT) method was used to compare the means of the experimental data at 95% confidence interval when a significant difference was observed from the One-way ANOVA.

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RESULTS AND DISCUSSION

Effect of blending African oil bean seed oil with sesame seed oil on the physicochemical properties of the oil blends

Data obtained from physicochemical evaluation are presented in Table 1.

Moisture content

Moisture content of the oil samples ranged from 0.00 to 1.87%. The values differ significantly ($p<0.05$) from each other. AB100 had the highest value, whilst control had the lowest moisture content. SS100 had lower moisture content than AB100 which resulted to lower moisture content in the oil blends. Moisture and oils are immiscible in nature. Their presence in oil is unusual and are mostly undesirable because they influenced the decomposition of triglycerides in oils to free fatty (Olaleye et al., 2018). No moisture was detected in control sample. The moisture contents measured for oil blends were relatively high despite the decrease in moisture content from 1.87% to 1.76% after sesame seed oil quantity was increased in the oil mix from 10 to 50%. Control samples that meet the specified moisture level of 0.2% (FAO/WHO, 2009) have a higher probability to keep their quality criteria for a long time because lower moisture ensures longer storage time (Enengedi et al., 2019) while experimental samples exceeded the limit. Higher moisture content of oil blends indicated their susceptibility to deterioration via hydrolytic rancidity as well as favours microbial growth (Onwuka, 2018). Moisture level for sesame seed oil (1.66%) was below 8.69% estimated by Olaleye et al. (2018). Relative to African oil bean seed oil, Akinlabu et al. (2019) obtained 1.89% which corresponds with the moisture content of 1.87% reported in this study for African oil bean seed oil.

Specific gravity

Specific gravity ranged between 0.90 and 0.93 g/cm3. The oil samples showed substantial ($p<0.05$) differences, with the control having the lowest value and AB60:SS40 and AB50:SS50 having the highest values. However, there was no significant ($p>0.05$) difference between AB100, SS100, AB90:SS10, AB80:SS20, and AB70:SS30, indicating that combining African oil bean seed and sesame seed oils had little effect on the oils' specific gravity. Specific gravity of this study corresponds to 0.90-0.91 g/cm^3 reported by Garg et al. (2021) for soybean and sesame seed oil blends, as well as 0.92 g/cm^3 reported by Aslam et al. (2021), for sesame seed oils, 0.90 g/cm^3 reported by Ordu and Yingobo (2021) for African oil bean seed oil. The method of extraction, variety of oil seed used, growth and maturation stage of oil seeds prior to harvesting, storage and preliminary processing operations may affect the specific gravity of oils, hence, influencing the molecular weights of the oils. This is consistent with Mengistie et al. (2018) findings that the specific gravity of various edible oils changes with their molecular weights, which are altered by the processing procedure. Consequently, the higher specific gravity of crude oils of the present study compared to the lower value obtained for the control oil samples indicates the presence of impurities, antioxidants and other low molecular weight compounds because of their unrefined nature, in addition to the significant presence of high molecular weight unsaturated fatty-acids such as C20 and C18 polyunsaturated acids

Refractive index

Refractive index of the oil samples did not differ significantly (p<0.05) from each other and ranged from 1.4689 – 1.473. Control and SS100 were the highest and the lowest respectively. Substituting African oil bean seed with sesame seed oil decreased the refractive index value from 1.47 in AB100 to 1.4689 in AB50:SS50 due to lower refractive index of sesame seed oil (SS100), indicating a reduction in unsaturation of the oil mix (Katkade et al., 2018). Similar findings was reported by Garg et al. (2021) on soybean and sesame seed oil blends. Refractive index measures the changes in the unsaturation level of oil samples. Higher refractive index suggest the presence of higher amount of double bonds which decreased with higher temperature. According to Garg et al. (2021), the difference in refractive index between oil samples could be attributable to differences in fatty acid chain length in triglycerides. The values found in this investigation were consistent with the 1.47 reported by Katkade et al. (2018) and the values suggested by FAO/WHO (2009) (1.466-1.470).

Melting point

Values obtained for melting point are between 3.34 and 35.87°C. These values significantly varies (p<0.05) among the oils. Control sample was lowest in melting temperature due to the absence or low level of impurities, free fatty acids, pigments, wax amongst others as a result of refining. Sesame seed oil (SS100) had higher melting point than African oil bean seed oil (AB100) which may be due to but not limited to higher saturation level, difference in the concentration of impurities and pigments, thereby requiring higher temperature to melt (Enengedi et al., 2019). More so, melting point of the oil blends increased steadily from 32.83 to 35.87°C as the percentage of sesame seed oil increased from 10% to 50%. Therefore, it can be estimated that the Oil blends may melt between 32 and 36°C, indicating their appropriateness for bakery (cake) margarine manufacture, as bakery margarine, such as cake margarine, has a melting point of no more than 34 to 45°C (Dewettinck and Frederick, 2011). Okpo and Evbuomwan (2014) found that African oil bean seed oil extracted with ethanol had a melting point of 48°C, whereas African oil bean seed oil extracted with n-hexane had a melting point of 47°C. These values are larger than those in the current study, which could be attributed to differences in geographical location and preprocessing treatment, which could have altered the composition of the oil seed.

Smoke point

Smoke point smoke point of edible oils provides the useful information of determining the maximum heating temperature above which vegetal oil should not exceed. It is also used in checking the purity and efficiency of refining. This makes smoke point a very important criteria for selecting a frying oil (Nangbes*et al* 2013). Smoke point ranged from 188.22 to 232.50°C. Control sample had the highest smoke point of 232.50°C than other samples which may be attributed to it refined state. This conclusion is consistent with Enengedi et al. (2019), who found that the more refined an oil, the higher its smoke point and suitability for high-temperature cooking and frying. Sesame seed oil (SS100) had lower smoke point than African oil bean seed oil (AB100), which consequently, decreased the smoke point of the oil blends. The smoke points of experimental samples (191.85-188.22°C) were below the values accepted by WHO (230-232°C) (Codex, 1995). The findings also indicate that the examined oil samples may not be suited for high temperature cooking and frying beyond 180°C, as important nutrients and phytochemicals found in unrefined oils will be eliminated (Enengedi et al. 2019). Essien et al. (2014) reported a smoke point of 184.86°C for sesame oil, which is comparable to the current value of 186.65°C for sesame seed oil (SS100). The values of smoke point found in this investigation were lower than the 242.50-266.50°C reported by Fareshteh et al. (2022) for sunflower, corn, and sesame seed oil blends.

Flash point

Flash point of the oil blends decreased with increasing substitution of sesame seed oil because sesame seed oil have lower flash point than African oil bean seed oil in the present study. Flash point ranged from 309.08 to 337.94°C. The values observed in this investigation for sesame seed oil (SS100) were greater than 309°C reported by Shanthi and Syed (2017). Significant variation in flash point of the oil samples could possibly be due to variation in fatty acid composition. This agrees with the assertion that composition of vegetable oil affects their flammability characteristic (Boukandoul et al., 2019). More so, lower flash point values obtained in control sample could be attributed to its absence in moisture content. Shanthi and Syed (2017) reported that moisture prevent oil vapour from igniting and hence raise the flash point. This may be the reason why extracted experimental samples had higher flash point than control sample. Oils with flash point above 66°C are considered as safe oils (Zaharadden et al., 2013). This means that experimental samples have the potential to reduce the risk of fire, which could result in inadvertent ignition.

Fire point

The fire point values varied significantly ($p<0.05$) and ranged from 311.26 to 376.10°C. Control sample had lower fire point than other oil samples which may be attributed to the source of oil and their composition. Blending proportions had a considerable effect on the fire point temperature, thus as the amount of sesame seed oil increased, the fire point temperature reduced. Fire point is the lowest temperature point where the oil/fat vapour will ignite when exposed to a fire source and will last for at least 5 seconds. Therefore, oil blends containing higher amount of sesame seed oil may ignite faster under available light source which may be due to its lower moisture content. Arawande and Alademeyin (2018) reported that crude sesame seed oil had 339°C fire point, degummed sesame seed oil had 339.00°C fire point, neutralized sesame seed oil had 340.00°C fire point while bleached sesame seed oil had 342.00°C fire point, all of which are below the result of the present study

Cloud Point (CP)

The cloud point ranged from -6.15 to 6.10°C. The cloud point is the temperature at which a cloudy look is visible as a result of wax production. The amount of unsaturated fatty acid chains in edible oils has a significant impact on their low temperature capabilities. A high degree of unsaturation improves edible oil performance at low temperatures (Hoekman et al., 2012). Experimental samples clouds at higher temperature of 3.50 to 5.51°C than control sample which clouds at -6.15°C. Oil bends containing higher proportion of sesame seed oil had higher cloud point. This may be due to the higher saturation level of sesame seed oil compared to

African oil bean seed oil. Karim et al. (2014) and Sarve et al. (2015) reported that sesame seed oils cloud at temperatures of 3°C and 1°C, respectively. These results differ from those obtained in the current study, which could be attributed to the variety, geographic location, and extraction procedure. Consequently, 100% African oil bean seed oil may become cloudy at around 4°C while substituting with sesame seed oil may increase the chances of wax formation at a higher temperature up to 5.51°C for AB50:SS50.

Effect of blending African oil bean seed oil with sesame seed oil on the phytochemical contents of the oil blends

Results of phytochemical properties are presented in Table 2.

Flavonoid content

Flavonoids scavenge free radicals and protect rat liver microsomes from oxidative stress (Xiaohui et al., 2017). Flavonoid content ranged between 0.14 and 8.35 CE mg/g. Sesame seed oil (SS100) had more flavonoids than African oil bean seed oil (AB100). The flavonoid concentration of oil blends varied substantially ($p<0.05$) and increased with the percentage of sesame seed oil used. Hence, AO50:SO50 has the highest concentration of flavonoids. This suggests higher antioxidant capabilities and stability.

Tannin content

The oil samples had a low tannin level, ranging from 0.00 to 0.97 mg/100 g. African oil bean seed oil (AB100) contained more tannin than sesame seed oil (SS100). Tannin was not detected in the control sample, which could be related to refining. A high tannin concentration inhibits cellulose and may affect intestinal digestion (Huang et al., 2014). The results of this investigation are significantly low, particularly when the amount of sesame seed oil increases. It might be concluded that the low tannin level has little effect on intestinal digestion, enzyme activity, and iron absorption.

Saponin content

Saponins have been shown to lower nutritional bioavailability and enzyme activity, and they impact protein digestibility by inhibiting various digestive enzymes such as trypsin and chymotrypsin. Saponin, on the other hand, functioned as a natural antibiotic, assisting the body in combating infections and microbial invasions. The saponin concentration of oil samples ranged between 0.00 and 4.49 mg/100 g. These values differ significantly ($p<0.05$) from one another. Tannin concentration was lacking in the control sample, presumably due to the refining process. High saponin content in crude oil blends indicates the need for refining because it can form complexes with zinc and iron, reducing their bioavailability (Bergantin et al., 2018). However, the findings of this investigation revealed that the examined samples contained decreased concentration of saponin with increasing amount of sesame seed oils in the blends.

Alkaloid content

The alkaloid content ranged from 0.00 to 8.82 mg/100 grams. Oil seeds, such as African oil bean seed, contain alkaloid (8.96 mg/100 g) and are basic therapeutic agents with analgesic, antispasmodic, and bacterial properties (Hendek-Ertop and Bektas, 2018). The therapeutic and medicinal benefits of African oil bean, as well as its use in herbal medicine in Nigeria, Ghana, and Cameroon, can be attributed to its high alkaloid concentration. The alkaloid content ranged from 0.00 to 8.82 mg/100 g. Increasing the percentage of sesame seed oil in the blends reduced the alkaloid concentration. However, the alkaloid content of oil blends is rather high, which may increase their ability to provide alkaloid-related health benefits.

CONCLUSION

This work primarily investigated the impact of blending African oil bean seed oil with sesame seed oil on their physicochemical properties and phytochemical contents. Findings revealed that the studied oil samples requires refining process to eliminate moisture, contaminants and impurities that affects processing capability and quality. Blending had beneficial impact on African oil bean seed by reducing the level of moisture, improving the specific gravity, refractive index, flash and fire points, total flavonoid and reduce the content of tannin and saponin that affect digestion and nutrient absorption. However, there was no clear benefit of experimental oil samples, both pure and binary oil blends, over control oil samples in terms of physicochemical properties but had higher bioactive contents.

Declaration of Competing Interest

The authors state that they have no known competing financial interests or personal relationships that could have influenced the work presented in this study.

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Table 1: Effect of blending African oil bean seed oil on the physicochemical properties of the oil blends. .

Samples	Moisture content (%)	Specific gravity (g/cm^3)	Refractive index	Melting point (°C)	Smoke point(°C)	Flash Point (°C)	Fire point (°C)	Cloud point (°C)
CONTROL	$0.00^{h}\pm0.03$	$0.90^{c}\pm0.01$	$1.473^{a}\pm0.00$	$3.34^{g}\pm0.14$	$232.50^{a}\pm0.71$	$309.08^{h}\pm0.05$	$311.26^{g}\pm0.04$	$-6.15^{g}\pm0.21$
AB100	$1.87^{a}\pm0.01$	$0.92^{b}\pm0.01$	$1.47^{a}\pm0.00$	$33.80^{e}\pm0.02$	$191.85^{b}\pm2.14$	$337.94^{a}\pm0.09$	$376.10^{a}\pm0.14$	$3.50^{f}\pm0.14$
SS100	$1.66^{g}\pm0.01$	$0.92^{b}\pm0.01$	$1.468^{a}\pm0.00$	$35.51^{b}\pm0.04$	$186.65^{e}\pm0.57$	$324.26^{b}\pm0.05$	$362.70^{f}\pm0.43$	$6.10^{a}\pm0.14$
AB90:SS10	$1.85^{b}\pm0.01$	$0.92^{b}\pm0.02$	$1.4698^{a}\pm0.00$	$32.83^{g}\pm0.11$	$190.98^{bc}\pm1.49$	$323.05^{c}\pm0.07$	$375.40^{b}\pm0.14$	$3.94^{e}\pm0.11$
AB80:SS20	$1.83^{c}\pm0.01$	$0.92^{b}\pm0.01$	$1.4696^{a}\pm0.00$	$33.56^{f}\pm0.08$	$189.78^{bcd}\pm0.36$	$322.30^{d}\pm1.41$	$375.10^{b}\pm0.14$	$4.16^{de}\pm0.05$
AB70:SS30	$1.81^{d}\pm0.01$	$0.92^{b}\pm0.01$	$1.4695^{a}\pm0.00$	$34.34^{d}\pm0.13$	$189.06^{ede}\pm0.08$	$321.40^{e}\pm1.41$	$374.60^{c}\pm0.14$	$4.39^{cd}\pm0.01$
AB60:SS40	$1.78^{e}\pm0.01$	$0.93^{a}\pm0.02$	$1.4692^{a}\pm0.00$	$35.01^{c}\pm0.02$	$188.71^{cde}\pm0.01$	$320.65^{f}\pm0.07$	$374.10^{d}\pm0.14$	$4.64^{c}\pm0.05$
AB50:SS50	$1.76^{f}\pm0.01$	$0.93^{a}\pm0.00$	$1.4689^{a}\pm0.00$	$35.87^{a}\pm0.18$	$188.22^{de}\pm0.11$	$319.40^{g}\pm0.14$	$373.60^{e}\pm0.14$	$5.51^{b}\pm0.01$

Values are means ± standard deviation of duplicate determination. Mean values in the same column with different superscript (a-h) are significantly different ($p<0.05$) AB100= 100% African oil bean seed oil. SS100= 100% Sesame seed oil. AB90:SS10= 90% African oil bean seed oil: 10% Sesame seed oil. AB80:SS20= 80% African oil bean seed oil: 20% Sesame seed oil. AB70:SS30= 70% African oil bean seed oil: 30% Sesame seed oil. AB60:SS40= 60% African oil bean seed oil: 40% Sesame seed oil. AB50:SS50= 50 %African oil bean seed oil: 50% Sesame seed oil. CONTROL= commercial oil sample (soybean oil).

Table 2: Effect of blending African oil bean seed oil on the phytochemical properties of the oil blends.

Samples	Flavonoid (CE mg/g)	Tannin (mg/100 g)	Saponin (mg/100 g)	Alkaloid (mg/100 g)
CONTROL	$0.14^{f}\pm0.01$	$0.00^{h}\pm0.00$	$0.00^{f}\pm0.00$	$0.00^{h}\pm0.00$
AB100	$0.88^{ef}\pm0.01$	$0.97^{a}\pm0.03$	$4.49^{a}\pm0.66$	$8.82^{a}\pm0.19$
SS100	$8.35^{a}\pm2.33$	$0.18^{g}\pm0.02$	$0.45^{f}\pm0.03$	$1.35^{g}\pm0.02$
AB90:SS10	$1.64^{def}\pm0.02$	$0.88^{b}\pm0.01$	$4.06^{ab}\pm0.04$	$8.20^{b}\pm0.01$
AB80:SS20	$2.39^{cde}\pm0.02$	$0.78^{c}\pm0.03$	$3.68^{bc}\pm0.01$	$7.44^{c}\pm0.01$
AB70:SS30	$3.12^{bcd}\pm0.01$	$0.73^{d}\pm0.02$	$3.28^{cd}\pm0.01$	$6.66^{d}\pm0.02$
AB60:SS40	$3.87^{bc}\pm0.01$	$0.64^{e}\pm0.01$	$2.88^{de}\pm0.01$	$5.93^{e}\pm0.02$
AB50:SS50	$4.65^{b}\pm0.02$	$0.58^{f}\pm0.02$	$2.48^{e}\pm0.01$	$5.17^{f}\pm0.04$

Values are means $\pm$ standard deviation of duplicate determination. Mean values in the same column with different superscript (a-h) are significantly different ($p<0.05$) AB100= 100% African oil bean seed oil. SS100= 100% Sesame seed oil. AB90:SS10= 90% African oil bean seed oil: 10% Sesame seed oil. AB80:SS20= 80% African oil bean seed oil: 20% Sesame seed oil. AB70:SS30= 70% African oil bean seed oil: 30% Sesame seed oil. AB60:SS40= 60% African oil bean seed oil: 40% Sesame seed oil. AB50:SS50= 50 %African oil bean seed oil: 50% Sesame seed oil. CONTROL= Commercial oil (soybean