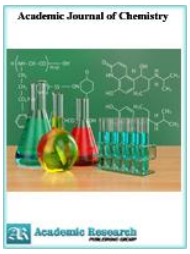


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# Effects of Green Tea Extracts on the Oxidation Stability of Olive and Melon Seed Oils

**Maduelosi, N. J.***
Department of Chemistry, Rivers State University of Science and Technology, Nkpolu Oroworukwo, P M B 5080, Port Harcourt, Nigeria

**Angaye, S. S.**
Department of Chemical Sciences, Niger Delta University, Wilberforce Island

**Abstract:** The present study is aimed at exploring singlet oxygen quenching ability of methanolic extract of green tea in methylene-blue sensitized photo-oxidation of olive and melon seed oils. Purified and oven-dried samples of melon seed oil and Goya brand olive oil as obtained from the manufacturer were used for the study. In this research, the effects of methanolic extracts of green tea as an antioxidant on the oxidative stability of olive and melon seeds oils were studied. The oil samples were subjected to methylene blue sensitized photoxidation in 10% methanol in dichloromethane for a duration of 10 hours with and without added green tea extract. The oxidized oil samples were analyzed for the following parameters: peroxide value, iodine value and % free fatty acid value. The results of the study suggest that green tea extract exhibit singlet oxygen quenching ability under sensitized photoxidation, which is dose dependent for both oils under the experimental conditions.

**Keywords:** Melon seed oil; Olive oil; Photoxidation; Green tea extract; Methylene-blue sensitizer.

## 1. Introduction

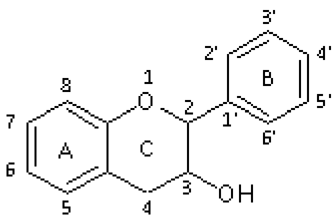
The term "vegetable oil" can be used to refer to water insoluble natural products that are liquids at room temperature. Vegetable oils are extracted from various plant parts such as seeds, nuts, and kernels either by mechanical pressure or solvent extraction. They serve as good sources of vitamins, lipids and fatty acids for human nutrition [1]. Their metabolic processes assist in the repair of worn out tissues, new cell formation and a useful source of energy [2].

Vegetable oils are of importance in human diet, pharmaceutical industries, chemical and cosmetic industries [3].

Oxidation of oil results in reduction of nutritional quality of oils. Vegetable oils undergo oxidative degradation on exposure to heat, air and light. The ease of a given oil sample to undergo oxidation is dependent on the fatty acid composition of the oil among other parameters. The resistant to oxidative changes by oil samples is referred to as the oxidative stability of the oil. The stability of oils to oxidation is an important indicator in determining oil quality and shelf-life [4]. Oxidative stability of oil depends on the fatty acid composition as well as the triacylglycerols (TAG) composition and structure. Angaye, *et al.* [5] examined the oxidative stabilities of palm oil and olive oil by subjecting samples of both oils methylene-blue sensitized photoxidation. The authors observed that olive oil oxidizes faster than the palm oil. They attributed their observations to the higher degree of unsaturation in the fatty acid components of olive oil compared to those in palm oil which is more saturated in nature.

Green tea, a product from camellia sinensis plant contains antioxidant ingredients known as flavonoids. The main flavonoids present in the leaves of the tea (as in cocoa beans) are catechin and epicatechin, monomeric flavanols, together with their gallate derivatives such as epigallocatechin gallate (EGCG) [6]. Epigallocatechin gallate (EGCG) is the most abundant catechin in green tea and it seems to have an important role in determining green tea benefits, as in the reduction of vascular inflammation, blood pressure; concentration of oxidized LDL.

**Fig-1.**Basic Flavanol Skeleton




Chemically they differ from many other flavonoids as:

- they lack the double bond between positions 2 and 3 of the C ring;

*Corresponding Author

- they do not have a keto group at position 4;
- they have a hydroxyl group in position 3 in ring C. For this reason, they are also calledflavan-3-ols**.**

The oxidation of vegetable oils involves a reaction between various reactive oxygen species (ROS) and the double bonds present in the fatty acids of their constituent triacylglycerols. The reactions are accelerated by the presence of a source of energy as light or heat or photosensitizer [7]. In other to minimize the oxidative deterioration of oils, most of the factors enhancing oxidation are to be curtailed.

Studies have shown that some vitamins, minerals and phenolic components of fruits and vegetables have antioxidant properties [8, 9].

The addition of antioxidants to vegetable oil and oil-based product slow down the oxidation process and extend their shelf lives and eventually increase the utility of oils [10]. The antioxidants are known to prevent the formation of peroxides and may react with oxygen (ROS) itself and become oxidized.

$$\text{Anti-oxidant} + O_2 \longrightarrow \text{Oxidized antioxidant.}$$

The fatty acid composition of olive and melon seed oils are shown in Table 1.

**Table-1.** The fatty acid composition of olive and melon seed oils

| Fatty acid | Olive oil | Melon oil |
|---|---|---|
| Palmitic acid | 7.5-20 | 13.4% |
| Palmioleic acid | 0.3-3.5 | --- |
| Stearic acid | 0.55-5.0 | 13.71% |
| Oleic acid | 55.0-83.0 | 14.50% |
| Linoleic acid | 3.5-21.0 | 56.94% |
| Linolenic acid | L1.0 | 0.46% |
| Arachidic | L0.6 | --- |
| Gadoleic | L0.4 | --- |

## 2. Materials and Methods

REAGENT: n-hexane, dichloromethane, potassium iodide, methylene blue, silica gel, methanol, ethyl acetate, iodine crystals, Wiji's reagent, sodium thiosulphate, tetrachloromethane, starch indicator, ethanol, sodium hydroxide, phenolphthalein indicator, calcium sulphate, acetic acid and chloroform.

APPARATUS: Photoxidation set with 200-watt photoflood lamp, chromatographic columns, thin layer chromatographic plates, hot air oven, beaker, volumetric flask, funnel, pipette, porcelain evaporating dishes.

### 2.1. Sample Collection/ Preparations

The melon seeds and green tea were purchased from Mile 3 market in Port Harcourt, Nigeria. The melon seeds were washed, dried, milled and the oil was extracted with Soxhlet extractor and n-hexane as solvent. The extracted oil was dried in a hot air oven at $120^0$C. The extra virgin olive oil (Goya brand) was purchased from a supermarket in Port Harcourt, Nigeria.

### 2.2. Extraction of the Anti-Oxidant

20g of the green tea was placed in 600ml of methanol and left to stand for 48 hours with intermittent shaking. The supernatant extract was decanted and allowed to desolventize in order to obtain a solid extract. The oil samples and the tea extract were stored in freezer till when used to prevent oxidation.

### 2.3. Irradiation

20g of each oil sample was dissolved in 100ml of 10% methanol in dichloromethane. 0.2g of methylene blue was added as sensitizer. Oxygen gas was gently bubbled into the solution through an impinger while cooling in an ice/water bath. The reaction set up was irradiated externally with a 200 watts photoflood lamp. The reactions were carried out for ten hours.

In a second set of experiments, the oil samples were similarly photo-oxidized with the addition of 1g and 2g of the green tea extract respectively. Control solutions of the un-photoxidized oil samples were also made up.

The iodine values, peroxide values and free fatty acid values of both the photo-oxidized and un-photoxidized oil samples, were determined by AOCS Official methods of analysis, [11].

## 3. Results and Discussions

The results obtained from the different tests carried out on the oil samples are displayed in Table 2.

**Table-2.** Results of tests carried out on the oil samples

| | Olive Oil | | | Melon seed oil | | |
|---|---|---|---|---|---|---|
| Samples/Parameters | Iodine value (Wiji's) | Peroxide value(meq/kg) | %FFA | Iodine value (Wiji's) | Peroxide value(meq/kg) | %FFA |
| Control(Unphotoxidized oil) | 27.5 | 15.4 | 1.0 | 20.9 | 9.4 | 0.92 |
| Photoxidized oil without green tea extract | 22.3 | 18.6 | 1.5 | 12 | 12 | 1.19 |
| | 18.9% | 20.8% | 57.1% | 42.6% | 27.7% | 29.3% |
| Photoxidized oil with 1g of green tea extract | 24 | 12.6 | 0.7 | 15.4 | 10.6 | 0.56 |
| | 12.7% | 18.2% | 27.6 | 26.3% | 12.8% | 39.1% |
| Photoxidized oil with 2g of green tea extract | 25.5 | 8.6 | 0.5 | 16.8 | 6.8 | 0.28 |
| | 7.3% | 44.2% | 53.1% | 19.6% | 27.7% | 69.6% |

## 4. Discussions

### 4.1. Iodine Value

The results of the iodine value of the samples in Table 2 show that the values decreased on irradiation. The decrease was in the order photoxidized oil without green tea extract > photoxidized oil with 1g green tea extract > photoxidized oil with 2g green tea extract. The decrease is attributed to loss of unsaturation in the oil samples with irradiation. Maduelosi, *et al.* [12], Angaye, *et al.* [5] have made similar reports. The results show that green tea extracts provide protection against photo-oxidation of the oil samples.

### 4.2. Peroxide Value

The peroxide values of the study samples without added tea extracts increased on irradiation while a decrease was observed in the samples with the 1g and 2g of the green tea extracts. The increase was more in the melon seed oil than the olive oil and is attributed to the higher degree of unsaturation in the melon seed oil. The observed decrease in peroxide value observed in the samples containing the tea extract suggests a quenching activity of the singlet oxygen by some components of green tea extract. A similar quenching activity was observed by Angaye, *et al.* [13] when the authors used methanol extracts of pepper, carrot and onion as components in methylene-blue sensitized photoxidation of six edible oils.

### 4.3. Free Fatty Acid(FFA)

The % free fatty acid values of the oil samples without added green tea extracts increased on irradiation. The increase is as a result of the breakdown of triacylglycerols during photo-oxidation. Fekarurhobo, *et al.* [3] made similar reports. A decrease in %FFA was observed in the oil samples with added green tea extract. This shows an inhibition of the photo- oxidation in the oil samples suggesting some singlet oxygen quenching activity due to the presence of the green tea extracts.

## 5. Conclusion/Recommendation

The results of the present study indicate that green tea extract inhibits photo-oxidation of the vegetable oils under the study conditions. The inhibition was more in the melon seed oil than in the olive oil. The results also suggest that it may be beneficial to fortify edible vegetable oils with green tea extracts. Further studies should be carried out to determine the optimal quenching capacity/dose of this extract.

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