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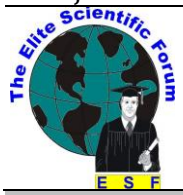


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**RESEARCH ARTICLE**

# Oxidative Stability of Sunflower Oil Blended with Aqueous Methanolic Extracts of *Capparis spinosa* and *Capparis decidua*

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**ABSTRACT**

Synthetic sunflower oil stabilizers like butylated hydroxytoluene (BHT) are being used in oil industries which can cause harmful impacts on human health. These synthetics can be replaced by natural antioxidant extracts for oil stabilization. The present study was conducted to assess the stabilizing potential of antioxidant extracts of different parts (stem bark, shoot, flower, fruit and root) of *Capparis spinosa* and *C. decidua* to determine the promising extract which can stabilize sunflower oil. For this purpose, stabilizing effects of extracts were compared with BHT which is a synthetic oil stabilizer (positive control treatment). It was observed that all plant extracts showed good performance in oil stabilization while aqueous methanolic flower extracts of *C. spinosa* and *C. decidua* exhibited maximum inhibition in oil rancidity indicated by lower peroxide values (5.95, 6.40 meq/kg oil), conjugated dienes (4.63, 5.43) and trienes (5.32, 5.91) and *para*-anisidine (5.44, 5.51), respectively. The results showed that the aqueous methanolic extracts of *C. spinosa* and *C. decidua* are useful in oxidative stabilization of blended sunflower oil stored over six month period. Considering these findings, it can be concluded that aqueous methanolic extracts of *C. spinosa* and *C. decidua* flowers can be successfully used as efficient oil stabilizers in food industry.

## INTRODUCTION

Food lipids and oils undergo different chemical reactions like increase in oxidative damage and thermolysis altering the organoleptic properties that resultantly affect the shelf life, nutritional quality and physiological properties (Zahran et al., 2015; Iqbal et al., 2008; Iqbal and Bhangar, 2007). The vegetables oils using synthetic food stabilizers can cause carcinogenesis, inflammation and cardiovascular disorder to human beings (Adam et al., 2008; Soriguer et al., 2003). Food manufacturing industries are focusing antioxidants for stabilizing food lipids and oils that may affect the consumers' acceptability for these products (Valenzuela et al., 2003). Plants are a rich sources of antioxidant compounds including flavonoids and phenolics which can maintain food and oil quality over a long period under certain storage conditions (Ali et al., 2016, 2013). In sunflower oil, such antioxidant compounds are naturally present but these are insufficient for its stabilization over a longer period unless these are supported by antioxidants from some exogenous sources. Different synthetic antioxidants like butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA) and *tert*-butyl hydroquinone (TBHQ) have been employed for oil stabilization improving their shelf life and storage period but these have been reported to have adverse health effects like carcinogenesis in human beings (Hou, 2003). Therefore, the usage of a synthetic antioxidants like TBHQ has been banned in Japan, Canada and European countries (Goli et al., 2005). Now a day, researchers are trying to explore naturally occurring plant based antioxidants to use them as an alternative source of safer and environment friendly oil stabilizing agents (Artajo et al., 2006).

The *C. spinosa* and *C. decidua* belonging to family capparaceae are shrubs which are collectively called as capar shrubs or capar bushes. These are usually found in plain areas, desert flats, open and sunny areas of

Afghanistan, India, Indonesia, Nepal, Pakistan, North Africa, South West Asia, Australia and South Europe up to an elevation of 1100 m (Tlili et al., 2010; Hamed et al., 2007). These species are rich in phenolics, flavonoids, flavonols, flavons and possess excellent antioxidant activities (Gull et al., 2015a,b,c).

Antioxidant potential of these species make them as possible sources which can provide antioxidant extracts that can be used as oil stabilization agents. Vegetable oils face degradation in its quality at certain temperatures which can be inhibited by using synthetic oil stabilizers. Keeping in view, this study was conducted to evaluate the methanolic extracts of different parts (stem bark, shoot, fruit, flower and root) of *C. spinosa* and *C. decidua* as potential sources for stabilization of sunflower oil under ambient storage (30°C) condition.

## MATERIALS AND METHODS

Aqueous methanolic extracts (80% v/v) of selected parts of *C. spinosa* and *C. decidua* (stem bark, root, shoot, fruit and flower) were added to pre heated (50°C) refined sunflower oil (free from any additive). In one liter of sunflower oil, 600 mL of extract was added separately followed by stirring for homogenous dispersion of extracts. Aqueous methanolic extract was selected based on its better antioxidant activity and phenolics composition while sunflower oil was selected being rich in polyunsaturated fatty acids and having linoleic acid in higher concentration. For comparison of stabilizing activities of extracts, synthetic antioxidant BHT was used as a positive control and added at the rate of 200 mL/L of sunflower oil beside one negative control (oil without any extract). Later on, 100 mL of each oil sample (stabilized with plants extracts and control) was stored under ambient storage for six months i.e. February to July 2012 in three replicates. Oil samples were tested for peroxide value (PV), *para (p)* anisidine, conjugated diene (CD) and conjugated triene (CT) values after every 30 days interval.

**Detection of PV, CD, CT and *p*-anisidine values**

AOCS method No. Cd 8-53 was followed to determine the peroxide value (PV) of the stored samples (AOCS, 1997). The IUPAC standard method II.D 23 was used to determine CD and CT values at 232 and 269 nm, respectively. The *p*-anisidine value was determined by using IUPAC method II. D. 26 (IUPAC, 1979).

**Statistical analysis**

The experiment was designed as completely randomized design (CRD) with three replications. The data of each parameter were pooled and computed using Statistix8.1 and LSD test was performed at 5% probability level to test the differences among mean values (Steel et al., 1997).

## RESULTS

Peroxide value is the measurement of peroxide and hydroperoxides formed during initial oxidation of oil and fats and is used as an indicator to determine the oil oxidative rancidity. Results showed that sunflower oil samples blended with aqueous methanolic plant extracts showed different trends in expressing PV values (Table 1). Relative PVs were recorded from day 0 to last day of storage i.e., after six months. With the passage of

**Table 1: Peroxide value (meq/kg of oil) of stabilized and control sunflower oil (SFO) under room temperature**

| Samples | Incubation Period (months) | | | | | | | Increase in PV (relative to control) of SFO from initial after six months | % decline (relative to control) of SFO after six months |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | |
| [a]SFO*-C | 0.85±0.04 | 5.77±0.41 | 7.22±0.28 | 10.01±0.46 | 12.13±0.37 | 18.74±0.76 | 22.95±0.61 | 22.10[a] | |
| [b]SFO-BHT | 0.65±0.06 | 1.32±0.05 | 2.13±0.10 | 7.1±0.21 | 7.73±0.22 | 9.54±0.38 | 10.27±0.51 | 9.62[bcd] | 56.47 |
| [c]SFO-CSSB | 0.74±0.03 | 1.37±0.07 | 2.48±0.09 | 5.80±0.13 | 7.41±0.21 | 10.58±0.26 | 11.21±0.28 | 10.47[bcd] | 52.62 |
| [d]SFO-CSS | 0.66±0.06 | 1.38±0.04 | 3.14±0.03 | 4.70±0.05 | 6.42±0.09 | 7.85±0.16 | 7.88±0.13 | 7.22[cd] | 67.33 |
| [e]SFO-CSFR | 0.59±0.03 | 1.08±0.09 | 1.76±0.11 | 4.38±0.17 | 5.38±0.17 | 6.39±0.11 | 6.54±0.23 | 5.95[d] | 73.07 |
| [f]SFO-CSFL | 0.53±0.05 | 1.1±0.11 | 2.17±0.23 | 4.11±0.18 | 5.16±0.30 | 7.38±0.21 | 7.17±0.46 | 6.64[d] | 69.95 |
| [g]SFO-CSR | 0.87±0.06 | 1.24±0.09 | 2.52±0.16 | 4.76±0.30 | 5.52±0.19 | 9.65±0.41 | 12.41±0.29 | 11.54[bc] | 47.78 |
| [h]SFO-CDSB | 0.64±0.05 | 1.11±0.07 | 2.12±0.18 | 4.81±0.19 | 7.32±0.32 | 10.01±0.32 | 12.06±0.49 | 11.42[bc] | 48.32 |
| [i]SFO-CDS | 0.74±0.08 | 1.37±0.05 | 2.97±0.15 | 5.67±0.80 | 7.03±0.21 | 10.14±0.36 | 12.14±0.60 | 11.40[bc] | 48.42 |
| [j]SFO-CDFR | 0.54±0.02 | 1.11±0.03 | 1.58±0.09 | 3.23±0.12 | 4.12±0.30 | 6.71±0.22 | 9.53±0.46 | 8.99[bcd] | 59.32 |
| [k]SFO-CDFL | 0.64±0.03 | 1.25±0.04 | 2.18±0.12 | 3.14±0.15 | 4.96±0.42 | 7.06±0.15 | 7.04±0.21 | 6.40[d] | 71.04 |
| [l]SFO-CDR | 0.83±0.02 | 1.33±0.11 | 3.57±0.16 | 6.27±0.38 | 8.36±0.68 | 11.1±0.52 | 12.97±0.86 | 12.14[b] | 45.06 |

*SFO: Sun flower oil; Mean values showing different capital letters are statistically different with each other (P<0.05) The data was analyzed in triplicate; [a]SFO control (without extract stabilization); [b]SFO stabilized with butylated hydroxytoluene; [c]SFO stabilized with *C. spinosa* stem bark extract; [d]SFO stabilized with *C. spinosa* shoot extract; [e]SFO stabilized with *C. spinosa* fruit extract; [f]SFO stabilized with *C. spinosa* flower extract; [g]SFO stabilized with *C. spinosa* root extract; [h]SFO stabilized with *C. decidua* a stem bark extract; [i]SFO stabilized with *C. decidua* shoot extract; [j]SFO stabilized with *C. decidua* fruit extract; [k]SFO stabilized with *C. decidua* flower extract; [l]SFO stabilized with *C. decidua* root extract.

time, an increase in PVs was recorded in all blended and control (oil without extract) samples while a significant variation ($P<0.05$) was recorded among all blended samples. It was also observed that aqueous methanolic extracts of *C. spinosa* fruit, *C. decidua* flower and *C. spinosa* flower reduced PV of blended sunflower oil (5.95, 6.40 and 6.64 meq/kg oil, respectively). In comparison to sample without any extract (negative control), sunflower oil stabilized with fruit extract of *C. spinosa* and flower extracts of *C. decidua* and *C. spinosa* exhibited the highest decline (73.07, 71.04 and 69.95%, respectively) in PV value; whereas, lowest response was shown by root, stem bark and shoot extracts of *C. decidua* (45.06, 48.32 and 48.42, respectively) (Table 1).

The contents of CD and CT of sunflower oil are shown in Table 2 and 3, respectively. It was recorded that control sunflower oil sample showed highest CD and CT contents in comparison with oil samples stabilized with *Capparis* extracts. The decline in the rise of CD and CT might be attributed to antioxidant potential of *Capparis* extracts. It was found that stabilized

**Table 2: Conjugated dienes (CD) contents ($\varepsilon_{1cm}$ ($\lambda_{232nm}$) of stabilized and control sunflower oil (SFO) under room temperature**

| Samples | Incubation Period (months) | | | | | | | Increase in CD (relative to control) of SFO from initial after six months | % decline (relative to control) of SFO after six months |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | |
| [a]SFO*-C | 1.75±0.08 | 4.39±0.21 | 8.56±0.42 | 12.17±0.60 | 14.23±0.56 | 17.10±0 | 19.57±0.97 | 17.82[a] | |
| [b]SFO-BHT | 1.28±0.09 | 2.44±0.11 | 3.70±0.27 | 4.06±0.16 | 5.96±0.28 | 7.25±0.38 | 8.97±0.37 | 7.69[bc] | 56.84 |
| [c]SFO-CSSB | 1.07±0.12 | 2.47±0.09 | 3.57±0.14 | 5.34±0.14 | 6.00±0.32 | 7.29±0.23 | 8.17±0.28 | 7.10[bcd] | 60.16 |
| [d]SFO-CSS | 1.37±0.10 | 2.83±0.06 | 3.56±0.17 | 4.79±0.12 | 5.78±0.18 | 6.72±0.33 | 8.12±0.27 | 6.75[bcd] | 62.12 |
| [e]SFO-CSFR | 1.21±0.06 | 1.97±0.29 | 2.87±0.28 | 3.64±0.37 | 4.29±0.26 | 5.88±0.57 | 6.38±0.46 | 5.17[cd] | 70.99 |
| [f]SFO-CSFL | 1.76±0.05 | 2.36±0.14 | 3.20±0.23 | 4.02±0.15 | 4.88±0.21 | 5.69±0.24 | 6.39±0.36 | 4.63[d] | 74.02 |
| [g]SFO-CSR | 1.33±0.04 | 2.99±0.06 | 3.36±0.17 | 5.97±0.23 | 7.43±0.30 | 8.39±0.12 | 10.28±0.32 | 8.95[b] | 49.77 |
| [h]SFO-CDSB | 1.07±0.09 | 3.34±0.08 | 4.16±0.16 | 6.31±0.21 | 6.62±0.24 | 8.28±0.32 | 9.98±0.0.49 | 8.91[b] | 50.00 |
| [i]SFO-CDS | 1.22±0.10 | 2.47±0.090 | 3.61±0.18 | 4.98±0.24 | 5.67±0.28 | 6.38±0.31 | 7.91±0.31 | 6.69[bcd] | 62.46 |
| [j]SFO-CDFR | 1.64±0.06 | 2.74±0.02 | 3.73±0.26 | 4.99±0.19 | 5.93±0.29 | 6.01±0.28 | 7.21±0.21 | 5.57[cd] | 68.74 |
| [k]SFO-CDFL | 1.01±0.01 | 1.98±0.08 | 3.07±0.12 | 4.12±0.12 | 5.07±0.25 | 5.84±0.21 | 6.44±0.18 | 5.43[cd] | 69.53 |
| [l]SFO-CDR | 1.86±0.18 | 2.47±0.24 | 3.76±0.18 | 7.11±0.28 | 8.87±0.44 | 9.33±0.37 | 11.01±0.55 | 9.15[b] | 48.65 |

*SFO: Sunflower oil; Mean values showing different capital letters are statistically different with each other ($P<0.05$). The data was analyzed in triplicate; [a]SFO control (without extract stabilization); [b]SFO stabilized with butylated hydroxytoluene; [c]SFO stabilized with *C. spinosa* stem bark extract; [d]SFO stabilized with *C. spinosa* shoot extract; [e]SFO stabilized with *C. spinosa* fruit extract; [f]SFO stabilized with *C. spinosa* flower extract; [g]SFO stabilized with *C. spinosa* root extract; [h]SFO stabilized with *C. decidua* a stem bark extract; [i]SFO stabilized with *C. decidua* shoot extract; [j]SFO stabilized with *C. decidua* fruit extract; [k]SFO stabilized with *C. decidua* flower extract; [l]SFO stabilized with *C. decidua* root extract

**Table 3: Conjugated trienes (CT) contents ($\varepsilon_{1cm}$ ($\lambda_{268nm}$) of stabilized and control sunflower oil (SFO) under room temperature**

| Samples | Incubation Period (months) | | | | | | | Increase in CT (relative to control) of SFO from initial after six months | % decline (relative to control) of SFO after six months |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | |
| [a]SFO*-C | 0.98±0.04 | 3.96±0.15 | 5.97±0.23 | 7.11±0.28 | 9.43±0.37 | 11.23±0.56 | 13.98±0.69 | 13.00[a] | |
| [b]SFO-BHT | 0.74±0.07 | 1.68±0.08 | 2.13±0.08 | 3.09±0.22 | 4.56±0.18 | 5.44±0.28 | 7.16±0.33 | 6.42[cde] | 50.61 |
| [c]SFO-CSSB | 0.68±0.03 | 1.54±0.07 | 2.32±0.09 | 3.21±0.08 | 4.11±0.07 | 5.14±0.17 | 6.73±0.19 | 6.05[ef] | 53.46 |
| [d]SFO-CSS | 0.71±0.06 | 1.60±0.18 | 2.49±0.12 | 3.31±0.09 | 4.01±0.15 | 5.98±0.07 | 7.11±0.38 | 6.4[cde] | 50.76 |
| [e]SFO-CSFR | 0.76±0.02 | 1.33±0.21 | 2.14±0.08 | 3.04±0.13 | 3.97±0.21 | 5.47±0.13 | 6.38±0.14 | 5.62[fg] | 56.76 |
| [f]SFO-CSFL | 0.69±0.08 | 1.56±0.05 | 2.47±012 | 3.02±0.12 | 4.29±0.23 | 5.04±0.38 | 6.01±0.26 | 5.32[g] | 59.07 |
| [g]SFO-CSR | 0.60±0.02 | 1.30±0.26 | 2.23±015 | 3.18±0.32 | 4.98±0.18 | 6.71±0.20 | 7.66±0.33 | 7.06[bc] | 45.69 |
| [h]SFO-CDSB | 0.71±0.03 | 1.48±0.07 | 2.64±0.26 | 3.48±0.18 | 4.97±0.15 | 6.14±0.18 | 7.89±0.39 | 7.18[b] | 44.76 |
| [i]SFO-CDS | 0.69±0.08 | 1.45±0.07 | 2.38±0.17 | 3.97±0.19 | 4.24±0.28 | 5.15±0.16 | 6.97±0.31 | 6.28[def] | 51.69 |
| [j]SFO-CDFR | 0.72±0.05 | 1.78±0.08 | 2.83±0.13 | 3.34±0.16 | 4.79±0.13 | 5.14±0.22 | 6.37±0.17 | 5.65[fg] | 56.54 |
| [k]SFO-CDFL | 0.66±0.03 | 1.55±0.06 | 2.28±0.18 | 3.12±0.15 | 4.64±0.16 | 5.48±0.21 | 6.57±0.26 | 5.91[efg] | 54.54 |
| [l]SFO-CDR | 0.73±0.04 | 1.18±0.04 | 2.06±0.15 | 3.01±0.21 | 3.97±0.19 | 5.79±0.28 | 7.62±0.39 | 6.89[bcd] | 47.00 |

*SFO: Sunflower oil; Mean values showing different capital letters are statistically different with each other ($P<0.05$). The data was analyzed in triplicate; [a]SFO control (without extract stabilization); [b]SFO stabilized with butylated hydroxytoluene; [c]SFO stabilized with *C. spinosa* stem bark extract; [d]SFO stabilized with *C. spinosa* shoot extract; [e]SFO stabilized with *C. spinosa* fruit extract; [f]SFO stabilized with *C. spinosa* flower extract; [g]SFO stabilized with *C. spinosa* root extract; [h]SFO stabilized with *C. decidua* a stem bark extract; [i]SFO stabilized with *C. decidua* shoot extract; [j]SFO stabilized with *C. decidua* fruit extract; [k]SFO stabilized with *C. decidua* flower extract; [l]SFO stabilized with *C. decidua* root extract.

**Table 4: *P*-anisidine value (*P*-AV) of stabilized and control sunflower oil (SFO) under room temperature**

| Samples | Incubation Period (months) | | | | | | | Increase in *P*.AV (relative to control) of SFO from initial after six months | % decline (relative to control) of SFO after six months |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | |
| [a]SFO*-C | 0.75±0.04 | 2.77±0.25 | 3.73±0.32 | 6.30±0.27 | 7.71±0.38 | 9.71±0.48 | 11.31±0.56 | 10.56[a] | |
| [b]SFO-BHT | 0.69±0.05 | 1.43±0.07 | 2.34±0.12 | 3.97±0.18 | 4.57±0.14 | 5.82±0.21 | 7.18±0.39 | 6.49[bcd] | 38.54 |
| [c]SFO-CSSB | 0.65±0.03 | 1.29±0.02 | 2.16±0.07 | 3.92±0.07 | 4.64±0.23 | 5.77±0.15 | 6.91±0.25 | 6.26[bcd] | 40.71 |
| [d]SFO-CSS | 0.66±0.07 | 1.28±0.04 | 2.21±0.14 | 3.74±0.24 | 4.33±0.41 | 6.12±0.45 | 7.01±0.23 | 6.35[bcd] | 39.86 |
| [e]SFO-CSFR | 0.63±0.05 | 1.47±0.32 | 2.29±0.13 | 3.86±0.17 | 4.51±0.39 | 5.96±0.35 | 6.41±0.38 | 5.78[cd] | 45.26 |
| [f]SFO-CSFL | 0.67±0.04 | 1.24±0.12 | 2.56±0.15 | 3.09±0.09 | 4.37±0.14 | 5.10±0.25 | 6.11±0.28 | 5.44[d] | 48.48 |
| [g]SFO-CSR | 0.61±0.03 | 1.38±0.08 | 2.41±0.14 | 3.67±0.15 | 4.83±0.19 | 6.10±0.15 | 7.57±0.21 | 6.96[bcd] | 34.09 |
| [h]SFO-CDSB | 0.68±0.04 | 1.87±0.07 | 2.38±0.22 | 3.37±0.21 | 4.38±0.21 | 7.41±0.21 | 8.44±0.25 | 7.76[b] | 26.51 |
| [i]SFO-CDS | 0.55±0.02 | 1.34±0.12 | 2.13±0.16 | 3.76±0.24 | 4.29±0.16 | 5.88±0.33 | 7.13±0.28 | 6.58[bcd] | 37.68 |
| [j]SFO-CDFR | 0.61±0.02 | 1.31±0.10 | 2.37±0.21 | 3.87±0.20 | 4.41±0.38 | 5.24±0.30 | 6.12±0.36 | 5.51[d] | 47.82 |
| [k]SFO-CDFL | 0.61±0.01 | 1.47±0.15 | 2.11±0.11 | 3.34±0.27 | 4.58±033 | 5.61±0.40 | 6.48±0.30 | 5.87[cd] | 44.41 |
| [l]SFO-CDR | 0.66±0.03 | 1.34±0.09 | 2.34±0.22 | 3.29±0.30 | 4.43±0.28 | 6.28±0.48 | 8.27±0.24 | 7.61[bc] | 27.93 |

*SFO: Sunflower oil; Mean values showing different capital letters are statistically different with each other (P<0.05). The data was analyzed in triplicate; [a]SFO control (without extract stabilization); [b]SFO stabilized with butylated hydroxytoluene; [c]SFO stabilized with *C. spinosa* stem bark extract; [d]SFO stabilized with *C. spinosa* shoot extract; [e]SFO stabilized with *C. spinosa* fruit extract; [f]SFO stabilized with *C. spinosa* flower extract; [g]SFO stabilized with *C. spinosa* root extract ; [h]SFO stabilized with *C. decidua* a stem bark extract; [i]SFO stabilized with *C. decidua* shoot extract; [j]SFO stabilized with *C. decidua* fruit extract; [k]SFO stabilized with *C. decidua* flower extract; [l]SFO stabilized with *C. decidua* root extract.

sunflower oil samples showed decline in CD and CT contents i.e. 48.65-74.02% and 44.76-59.07%, respectively. Oil samples stabilized with methanolic extracts of *C. decidua* root and stem bark extracts showed lowest decline in CD and CT contents (48.65, 44.76%, respectively). Data given in Table 4 revealed that oil samples which were blended with *Capparis* extracts showed a significant decline (P<0.05) in *p*-anisidine value in comparison to negative control. The negative control sample showed highest *p*-anisidine value (10.56) while the lowest values were recorded for *C. spinosa* flower, *C. decidua* fruit, *C. spinosa* fruit and *C. decidua* flower extracts (5.44, 5.51, 5.78 and 5.87, respectively). On the whole, aqueous methanolic extracts of *C. spinosa* flower and *C. decidua* fruit maximally stabilized the oil showing a decrease of 48.48, 47.82% in *p*-anisidine value, respectively while *C. decidua* stem bark extract showed only 26.51% decline in PV in comparison to negative control (Table 4).

## DISCUSSION

This study was conducted to assess stabilization of sunflower oil blended with aqueous methanolic extracts of stem bark, shoot, flower, fruit and root of *C. spinosa* and *C. decidua*. The PV is considered as formation of primary oxidation products, the least PV value shows stabilized oil (Othman and Ngassapa, 2012). In present study, aqueous methanolic extracts lowered down the magnitude of sunflower oil deterioration which might be due to antioxidant compounds. It has been previously reported that the antioxidants rich extracts prevent or delay oil oxidation with the decomposition of phenolic compounds to a specific time period (Ali et al. 2016; Rubilar et al. 2012). The antioxidant extracts have been used which are effective over a long period of time towards the primary and secondary oxidation of oil (Shahidi and Wanasundara, 1997). A relative decrease in PV in sunflower oil stabilized with plant extracts is in line with previous studies which revealed that oil samples which were blended with antioxidants extracted from various sources showed less peroxid PVs with increase in incubation time (Oomah et al., 2000). In another study, Anwar et al. (2006) studied the efficiency of different sources of plant extract to delay the peroxides formation in sun flower oil and reported a prominent decrease in peroxide formation in stored samples. Estimation of PV provided a clearly indicated lipid autoxidation. For its confirmation, other parameters including CD and CT are also considered as necessary parameters assessing oil quality as these predict oxidative damage (Proteggente et al., 2002; Chattha et al., 2006). In present investigation, CD and CT were also measured as it has been reported earlier that deteriorated oils show higher values of CD and CT degeneration. Previously, other plant extracts like garlic extracts have also been used to stabilize sunflower oil determining CD and CT values as indicators. A significant decline was recorded by Iqbal and Bhanger (2007) when sunflower oil was blended with garlic extracts. CD and CT contents are analyzed to find oxidative stability of oils. In this study, an increase in CD and CT magnitudes was recorded with increase in storage period. Initially the value of CD is greater due to presence of polyunsaturated fatty acid.

However, the CD decreases with storage time and the value of CT increased as CT were produced due the dehydration of CD hydroperoxides (Fishwick and Swoboda, 1977). In present investigation, less increase in CD and CT values was noted that shows stabilization of sunflower oil stabilized with *C. decidua* root and stem bark (Table 2 and 3). Similarly, Siddiq et al. (2005) also reported the methanolic extract of *Moringa oleifera* leaves as efficient antioxidants for the stabilization of SFO under accelerated storage using the measurement of CD and CT contents.

The *p*-anisidine value is used to measure the level of secondary oxidation products of oil which are formed by the oxidative degradation of lipids/oils and are mainly non-volatile carbonyl (alkanels and 2, 4 dialkanels) (Sultana et al., 2008; Anwar et al., 2006). The aldehydes formed during lipid oxidation react with *p*-anisidine reagent under acidic conditions, resulting in the formation of yellow colored product, whose concentration is determined by spectrophotometry. Greater the absorbance, higher will be the concentration of aldehydes with low oxidative stability of the oil (Anwar et al., 2004). Previously, Mohdaly et al. (2011) also studied the antioxidant effects of sesame (*Sesamum indicum*) cake extract (SCE) for stabilizing sunflower and soybean oil in comparison to synthetic antioxidants by measuring their *p*-anisidine value during accelerated storage condition. The SCE exhibited better antioxidant activity in sunflower and soybean oils as compared to synthetic oil stabilizers including BHT and BHA.

In conclusion, extracts of different parts of *C. spinosa* and *C. decidua* were found as potential sources for sunflower oil stabilization. Among these species, *C. decidua* was found as more promising specie for oil stabilization while among different parts, roots and fruits were most promising parts. On the whole, aqueous methanolic extracts of roots and flowers of *C. spinosa* and *C. decidua* can be successfully used as sunflower oil stabilization agents.

**Authors' contributions**

All authors contributed equally in this manuscript.

## REFERENCES


Adam SK, IN Soelaiman, NA Umar, N Mokhtar, N Mohamed and K Jaarin, 2008. Effects of repeatedly heated palm oil on serum lipid profile, lipid peroxidation, and homocysteine levels in a post-menopausal rat model. McGill Journal of Medicine, 11: 145-151.

Ali Q, F Anwar, M Ashraf, N Saari and R Perveen, 2013. Ameliorating effects of exogenously applied proline on seed composition, seed oil quality, and oil antioxidant activity of maize (*Zea Mays* L.) under drought stress. International Journal of Molecular Sciences, 14: 818-835.

Ali S, SAS Chatha, Q Ali, AI Hussain, SM Hussain and R Perveen, 2016. Oxidative stability of cooking oil blend stabilized with leaf extract of *Eucalyptus citriodora*. International Journal of Food Properties, 19: 1556-1565.

Anwar F, A Jamil, S Iqbal and MA Sheikh, 2006. Antioxidant activity of various plant extracts under ambient and accelerated storage of sunflower oil. Grasas y Aceites, 57: 189-197.

Anwar F, M Manzoor and JR Bajwa, 2004. Antioxidant activity of solvent extracts of strawberry (*F. Ananassa*) using various antioxidant assays. Pakistan Journal of Analytical Chemistry, 5: 28-37.

AOCS. 1997. American Oil Chemists Society. Official Methods and Recommended Practices of the AOCS, (5th edition), AOCS Press, Champaign, Illinois, USA.

Artajo LS, MP Romero and MJ Motilva, 2006. Transfer of phenolic compounds during olive oil extraction in relation to ripening stage of the fruit. Journal of Science of Food and Agriculture, 86: 518-527.

Chattha SAS, F Anwar, M Manzoor and JR Bajwa, 2006. Evaluation of the antioxidant activity of rice bran extracts using different antioxidant assays. Grasas Y Aceites, 57: 328-335.

Fishwick MJ and PAT Swoboda, 1977. Measurement of oxidation of polyunsaturated fatty acids by spectrophotometric assay of conjugated derivatives. Journal of Science of Food and Agriculture, 28: 387-391.

Goli AH, M Barzegar and MA Sahari, 2005. Antioxidant activity and total phenolic compounds of pistachio (*Pistachia vera*) hull extracts. Food Chemistry, 92: 521-525.

Gull T, Z Mahmood, F Anwar, B Sultana, W Nouman, SA Shahid and MZ Iqbal, 2015a. Variation of proximate composition and minerals within different parts of *Capparis decidua* (Forssk.) Edgew. as a function of harvesting seasons. Pakistan Journal of Botany, 47: 1743-1748.

Gull T, B Sultana, IA Bhatti and A Jamil, 2015b. Seasonal variation in proximate composition and minerals profile of different parts of wildly grown *Capparis spinosa*. Pakistan Journal of Agricultural Sciences, 52: 747-754.

Gull T, F Anwar, B Sultana, MAC Alcayde and W Nouman, 2015c. *Capparis* species: A potential source of bioactives and high-value components: A review. Industrial Crops and Products, 67: 81-96.

Hamed AR, KA Abdel-Shafeek, NS Abdel-Azim, SI Ismail and FM Hammouda, 2007. Chemical investigation of some *Capparis* species growing in Egypt and their antioxidant activity. Evidence

based Complementary and Alternative Medicine, 4: 25-28.

Hou DX, 2003. Potential mechanism of cancer chemoprevention by anthocyanin. Current Advancements in Molecular Medicines, 3: 149-159.

Iqbal S and MI Bhangar, 2007. Stabilization of sunflower oil by garlic extract during accelerated storage. Food Chemistry, 100: 246-254.

Iqbal S, S Haleem, M Akhtar, M Zia-ul-Haq and J Akbar, 2008. Efficiency of pomegranate peel extracts in stabilization of sunflower oil under accelerated conditions. Food Research International**,** 41: 194-200.

IUPAC, 1979. Standard methods for the analysis of the oils, fats and derivatives (6th edition), Pergamon Press, Oxford, UK.

Mohdaly AAA, I Smetanska, MF Ramadan, MA Sarhan and A Mahmoud, 2011. Antioxidant potential of sesame (*Sesamum indicum*) cake extract in stabilization of sunflower and soybean oils. Industrial Crops and Products 34: 952-959.

Oomah, B.D., S. Ladetn, D.V.Godfrey, J. Liang, B. Girard. 2000. Characterization of raspberry (*Rubus ideaus* L.) seed oil. Food Chemistry, 69: 187-193.

Othman OC and FN Ngassapa, 2012. Physio-chemiacl characteristic of some impotent edible oils and fats marketed in Dar-es-Salaam. Tanzania Journal of Natural and Applied Sciences, 1: 138-147.

Proteggente AR, AS Pannala, G Paganga, LV Buren, E Wagner, S Wiseman, FVD Put, C Dacombe and CAR Evans, 2002. The antioxidant activity of regularly consumed fruit and vegetables reflects their phenolic and vitamin C composition. Free Radical Research, 36: 217-233.

Rubilar M, E Morales, R Saez, F Acevedo, B Palma, M Villarroel and C Shene, 2012. Polyphenolic fractions improve the oxidative stability of microencapsulated linseed oil. European Journal of Lipid Science and Technology, 114: 760-771.

Shahidi F and UN Wanasundara, 1997. Measurement of lipid oxidation and evaluation of antioxidant activity. In: F. Shahidi (Ed.), Natural antioxidants, chemistry, health effects and applications, AOCS Press Champaign, Illinois, USA, pp: 1-10.

Siddiq A, F Anwar, M Manzoor and A Fatima, 2005. Antioxidant activity of different solvent extracts of *Moringa oleifera* leaves under accelerated storage conditions of sunflower oil. Asian Journal of Plant Science, 4: 630- 635.

Steel RCD, JH Torrie and DA Deekey, 1997. Principles and procedures of statistics a biometric approach. (3rd edition), McGraw Hill Book Co. Inc., New York, USA, pp: 400-428.

Soriguer F, G Rojo-Martínez, MC Dobarganes, JMG Almeida, I Esteva, M Beltrán, MSRD Adana, F Tinahones, JM Gómez-Zumaquero, E García-Fuentes and S González-Romero, 2003. Hypertension is related to the degradation of dietary frying oils. The American Journal of Clinical Nutrition, 78: 1092-1097.

Sultana B, F Anwar, MR Asi and SAS Chatha, 2008. Antioxidant potential of extracts from different agro wastes: Stabilization of corn oil. Grasas y Aceites, 59: 205-217.

Tlili N, N Nasri, E Saadaoui, A Khaldi and S Triki, 2010. Sterol composition of Caper (*Capparis spinosa*) seeds. African Journal of Biotechnology, 9: 3328-3333.

Valenzuela BA, J Sanhueza and S Nieta, 2003. Naturales en Alimentos Funciolales: De la seguridad alimentaria a los beneficios en la salud [Functional foods: From food security to health benefits]. Grasas y Acetites, 54: 295-303.

Zahran HA, MH El-Kalyoubi, MM. Khallaf and AG Abdel-Razek, 2015. Improving oils stability during deep-fat frying using natural antioxidants extracted from olive leaves using different methods. Middle East Journal of Applied Sciences, 5: 26-38.