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# The antioxidant and tyrosinase inhibitory activities of some essential oils obtained from aromatic plants grown and used in Yemen

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**The antioxidant and skin whitening properties of essential oils as natural products is the cornerstone to replace synthesized preservatives and to obtain safer source with better biological activities. The present study was designed to investigate the antioxidant and tyrosinase inhibitory activities of twenty essential oils obtained from aromatic plants grown and used in Yemen. Essential oils were hydrodistilled using Clevenger apparatus. The antioxidant activity was examined by three different methods, namely: the ability to scavenge free radicals 2,2-diphenyl-1-picrylhydrazyl (DPPH), the capacity to inhibit lipid peroxidation thiobarbituric acid reactive species (TBARS), and the total reduction power activity (TRPA). The new findings have shown that all the tested essential oils have variable free radical scavenging activity as measured by the DPPH decoloration assay. The new findings have shown that all the tested essential oils have variable antioxidant activities. These activities were dependent on the essential oil and the method used. In addition, the present study showed that most of the tested essential oils have low to high inhibitory effect on tyrosinase inhibitory activity. The current findings suggest that the tested essential oils could be used as an important source for pharmaceutical and neutraceutical applications.**

**Key words:** Antioxidation, essential oils, skin whitening, *Ocimumbasillicum*, *Ocimumforskolie, Thymus laevigatus, Acalyphafruticosa*, *Conyzaincana.*

## INTRODUCTION

Essential oils gain great importance due to the increase of their application in perfumery, cosmetics, pharmaceutical and food industries. They have shown great biological activities such as antimicrobial, antifungal, antiviral and antioxidant activities (Abdelwahab et al., 2011; Aligiannis et al., 2001; Burt, 2004; Kordali et al., 2005; Magwa et al., 2006; Salehi et al., 2005). In addition, some of them have been used in cancer treatment (Sylvestre et al., 2006), aromatherapy, food preservation (Faid et al., 1995) and fragrance industries. As a result, there are great efforts to replace synthetic antimicrobial and antioxidant compounds by natural secondary metabolites, such as essential oils. Essential oils (or volatile oils), are aromatic oily liquids from plant materials (AidiWannes et al., 2010). They are very complex mixtures of compounds. Chemically, they are derived from terpenes and their oxygenated compounds such as monoterpenes and sesquiterpines, which are hydrocarbons with the general formula $(C_5H_8)_n$ (Mohamed et al., 2010). The oxygenated compounds derived from these hydrocarbons include alcohols,

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**Abbreviations: DPPH**, 2,2-diphenyl-1-picrylhydrazyl; **TBARS**, thiobarbituric acid reactive species;**TRPA**, total reduction power activity; **BHA**, butylatedhydroxyanisole.

**Table 1.** Botanical names of aromatic plants, site of their collection, and parts used for essential oils hydrodistillation.

| Botanical name | Site of collection | Part used |
|---|---|---|
| *Chenopodiumambrosioides* | Sana'a | Fresh whole plant |
| *Cinnamomumzylanicum* | Imported (India) | Bark |
| *Shinusmolle* | Sana'a | Fruits |
| *Pulicariajaubertii* | Sana'a | Fresh areal parts |
| *Tagetesminuta* | Sana'a | Fresh areal parts |
| *Artemisia abrotanum* | Thamar | Areal parts |
| *Origanummajorana* | Sana'a | Fresh areal part |
| *Eucalyptus camaldulesis* | Sana'a | Dried leaves |
| *Clove eugeniacaryophill* | Imported (India) | Fruits |
| *Thymus laevigalus* | Sana'a-Alhimah | Dried areal parts |
| *Lantana camara* | Sana'a | Fresh leaves |
| *Rosmarinusofficinalis* | Sana'a | Fresh leaves |
| *Ammiviasnag* | Imported (India) | Fresh leaves |
| *Conyzaincana (Vah) willd* | Taiz-Hojariah | Seeds |
| *Menthapiperit* | Amran | Fresh leaves |
| *Coriandumsativum* | Sana'a | Seeds |
| *Elettariacardamonum* | Imported (India) | Fruits |
| *Ocimumbasillicum* | Sana'a | Fresh leaves |
| *Ocimumforskolie* | Taiz-Hojariah | Dried areal parts |
| *Acalyphafruticosa* | Taiz-Hojariah | Dried areal parts |

aldehydes, esters, ethers, ketones, phenols and oxides. It was also observed that the citrus essential oils exhibited tyrosinase inhibitory activities, which could protect human skin from the ultraviolet light of the sun. In other words, essential oils could play an important role against melanogenesis, because abnormal melanin pigmentation, such as, melasma, freckles, ephelide, and senile lentigines is a serious aesthetic problem. In addition, tyrosinase in human brain plays an important role in neuromelanin formation, which could be central to dopamine neurotoxicity as well as contribute to the neurodegeneration associated with Parkinson's disease (Asanuma et al., 2003).

At present time, various industries are looking into sources of alternative, more natural and safer biologically active compounds, such as, antioxidants, and tyrosinase inhibitory agents, especially, there have been concerns about synthetic compounds, which could be promoters of carcinogensis, such as, butylatedhydroxyanisole (BHA) and butylatedhydroxytoluene (BHT) (Barlow, 1990). In other words, pharmaceutical firms are mainly interested in the discovery of active chemical structures from which can develop and prepare synthetic analogues. These are more controllable from point of reproducibility, patentability, safety, and are more economically viable (Newman, 2008; Svoboda and Hampson, 1999). Therefore, the present work, aims to screen different essential oils hydrodistilled from different aromatic plants grown and used in Yemen for their antioxidant properties and inhibitory action against tyrosinase activity as natural sources for pharmaceutical and cosmetic purposes, which may be more effective and safer than the synthetic ones. In other words, melanin biosynthesis inhibitory compounds are useful not only as materials used in cosmetics as skin-whitening agents, but also as a remedy for disturbances in pigmentation.

## MATERIALS AND METHODS

### Plant materials

Twenty aromatic plant materials were collected from different regions in Yemen. They were identified by botanists at the Department of Biology, Faculty of Sciences, Sana'a University. The plants, sites of collection and the parts which were screened for their biological activities are shown in Table 1.

### Extraction of essential oils

Samples (200 g) were subjected to hydrodistillation for approximately 3 h using a Clevenger type apparatus. The aqueous layer from the distillate was extracted with diethyl ether. The ether layer was dehydrated with anhydrous sodium sulfate and the solvent was distilled at slightly reduced pressure to recover the dissolved oil. The yield was calculated. The oils were kept in brown and well stoppered vials, and then stored at -20°C until needed.

### Antioxidant activity test of essential oils

The antioxidant activity of the obtained essential oils was carried

out using three different *in vitro* methods, namely: the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay, the total reducing power activity method (TRPA), and the thiobarbituric acid reactive species (TBARS) method. The essential oils were dissolved in methanol to obtain the stock solution at the concentration of 100 µl/ml. All assays were carried out in triplicate and the average value was obtained. All methods were carried out spectrophotometrically using UV-VIS spectrophotometer (1061-Shimadzu, Japan).

***DPPH radical scavenging activity***

The antioxidant activity of essential oils was measured in terms of hydrogen donating or radical scavenging ability using the stable radical DPPH (Kordali et al., 2005). A methanolic stock solution of each essential oil was prepared (100 µl/ml). Then, 100 µl of each stock solution (i.e., equivalent to 10 µl of crude essential oil) were transferred to different test tubes and their volumes were adjusted to 1 ml with methanol (solvent). Prepare a positive control (that is, butylated hydroxyl anisole, BHA, 100 µg/ml) in the same way as essential oils. Then, 2 ml of DPPH ($6 \times 10^{-5}$ mol/l) in methanol were added to each test tube (samples and positive control). Finally, a solution containing only 1 ml methanol and 2 ml of DPPH was prepared and used as a blank. Incubate all test tubes in a dark place at room temperature for 1 h. The spectrophotometer was set at 517 nm and the absorbance was adjusted at zero for methanol. The absorbances of blank, BHA (as a positive control), and samples were recorded. All determinations were carried out in triplicates. The disappearance of DPPH was recorded and the percent inhibition of the DPPH radical by sample is calculated as follows:

% Inhibition (Or % Radical scavenging activity) = $[(A_b - A_s) / A_b] \times 100$

Where $A_b$- is the absorbance of blank, $A_s$- is the absorbance of positive control or sample.

***The total reducing power activity (TRPA) of essential oils***

The reducing power was determined according to the method described earlier (Oyaizu, 1986). Then 100 µl from each crude essential oil were transferred to different test tubes. The volumes in test tubes were adjusted to 1 ml with methanol. Then, 2.5 ml of 200 mM sodium phosphate buffer (pH 6.6), and 2.5 ml of 1% potassium ferricyanide were added to each test tube. The mixture was incubated at 50°C for 20 min. Then, 2.5 ml of 10% trichloroacetic acid was added. The mixture was centrifuged at 2000 g for 10 min. The upper layer (2.5 ml) was mixed with 2.5 ml of deionized water and 0.5 ml of 0.1% ferric chloride. The absorbance was measured at 700 nm against a blank. The reducing power increases with the increase of absorbance. BHA was used as a positive control. All determinations were carried out in triplicates. The reducing power of each essential oil was expressed as µg of BHA equivalent to 1 µl of essential oil.

***Total antioxidant activity of essential oils using thiobarbituric acid reactive species (TBARS) method***

The TBARS method was used as described earlier (Ruberto et al., 2000), which measures the total antioxidant activity with slight modifications. Briefly, this method was carried out using egg yolk homogenate (10%) in phosphate buffer (pH 7.4) as lipid rich media.

A stock solution of each essential oil in methanol (100 µl/ml) was prepared. Then, 100 µl from each stock solution (that is, equivalent to 10 µl of crude essential oil) were transferred to different test tubes. The volumes in test tubes were adjusted to 1 ml with the same solvent (methanol). Then, to each test tube 3.0 ml of 10% yolk homogenate were added. Incubate the test tubes for 30 min. Add to each test tube 0.1 ml of ferrous sulfate solution (50 µmol/l $FeSO_4$; 1 mmol/l $KH_2PO_4$;0.2 mmol/l ascorbic acid in 0.15 M Tris-HClbuffer, pH 7.4). Incubate test tubes for 30 min at 37°C. Add to each test tube 3.0 ml of 10% trichloroacetic acid. After 10 min, centrifuge the test tubes at 2000 g for 5 min. Take 1.0 ml of the supernatant and mix with 3.0 ml of 0.67% thiobarbituric acid solution in 50% glacial acetic acid. Heat the mixture in a boiling water bath for about 30 min to complete the reaction. The appearance of turbidity, in this stage, must be centrifuge again at 2000 g for 5 min. The absorbance was measured at 535 nm. BHA was used as a positive control. The decrease of absorbance indicates to the increase of antioxidant activity. All determinations were carried out in triplicates. The values of antioxidant activity were expressed as the percentage inhibition of egg yolk lipid peroxidation and compared with the value obtained from the egg yolk lipid peroxidation, which was not treated with any essential oil (that is it must give the highest absorbance). Thus, the antioxidant activity (% Inhibition of peroxidation) = $[(A_b - A_s) / A_b] \times 100$.

Where $A_b$- is the absorbance of blank, $A_s$- is the absorbance of positive control or sample.

**Colorimetric tyrosinase inhibition assay**

Colorimetric tyrosinase inhibition assay was conducted according to previously described method (Momtaz et al., 2008). Each essential oil was dissolved in dimethyl sulfoxide (DMSO) to obtain concentration of 20 mg/ml. These stock solutions were then diluted to make 600 µg/ml in 50 mM potassium phosphate buffer (pH 6.5). Arbutin acid was prepared in a similar way and used as a positive control. Then, 70 µl of each sample solution or positive control were combined with 30 µl of tyrosinase (333 Units/ml in phosphate buffer, pH 6.5) in triplicate in a 96-well microtitre plates. After incubation at room temperature for 5 min, 110 µl of substrate (2 mM tyrosine) were added to each well. Final concentration of the essential oil or positive control was 100 µg/ml. Microtitre plates were incubated for 30 min at room temperature. The absorbance of the wells were then determined at 492 nm with the Infinite® 200 PRO plate reader (TECAN, Männedorf, Switzerland).

**Statistical analyses**

Results were expressed as the means ± SD of three simultaneous assays carried out independently in all methods. Statistical significance of the differences between mean values was assessed by analysis of variance (ANOVA) test and *P-value* of 0.05.

## RESULTS

At the tested level, which is equivalent to 10 µl of essential oil, the results of antioxidant activities of essential oils according to the DPPH method as indicators to the ability to remove free radicals can be arranged as follows:

*Ocimumbasillicum>Conyzaincane(vah)willd>Ocimumforskolei>Cinnamomumzeylanicum>Acalyphafruticosa>Ammi*

**Table 2.** The inhibition of tyrosinase and antioxidant activities of essential oils obtained from twenty aromatic plants Grown and used in Yemen.

| No. | Source of essential oil | Inhibition of tyrosinase activity (%) | DPPH (%) | TBARS (%) | TRPA (as µg BHA) |
|---|---|---|---|---|---|
| 1 | *Chenopodiumambrosioides* | 64.44 ± 1.70 | 22.72 ±1.39 | 85.04 ± 1.35 | 23.80 ± 3.02 |
| 2 | *Cinnamomumzylanicum* | 77.88 ± 0.43 | 83.92 ± 0.30 | 90.45 ± 0.63 | 30.43 ± 3.69 |
| 3 | *Shinusmolle* | 64.09 ± 2.44 | 9.24 ± 0.47 | 72.17 ± 2.84 | 28.53 ± 2.88 |
| 4 | *Pulicariajubertii* | 62.25 ± 0.82 | 17.28 ± 0.16 | 88.21 ± 0.75 | 22.53 ± 0.95 |
| 5 | *Tagesetminuta* | 59.89 ± 2.54 | 47.50 ± 0.47 | 80.06 ± 1.44 | 37.78 ± 1.08 |
| 6 | *Artemisia abrotanum* | 63.60 ± 0.26 | 18.59 ± 0.46 | 80.11 ± 0.16 | 50.42 ± 3.41 |
| 7 | *Origanummajorana* | 5.89 ± 1.19 | 12.61 ± 0.62 | 85.26 ± 3.75 | 31.01 ± 2.00 |
| 8 | *Eucalyptus camaldulesis* | 7.55 ± 0.89 | 8.05 ± 0.30 | 57.96 ±1.66 | 31.32 ± 3.55 |
| 9 | *Clove eugeniacaryophyll* | 20.78 ± 0.69 | 60.58 ± 0.76 | 94.17 ± 6.14 | 131.36 ± 4.34 |
| 10 | *Thymus laevigatus* | 5.94 ± 1.14 | 63.70 ± 1.53 | 97.63 ± 8.94 | 78.36 ± 1.93 |
| 11 | *Lantana camara* | 1.5 ± 0.62 | 5.22 ± 0.00 | 23.58 ± 2.31 | 25.48 ± 2.96 |
| 12 | *Rosmarinusofficinalis* | 1.74 ± 0.33 | 10.33 ± 3.54 | 69.72 ± 2.98 | 17.56 ± 2.46 |
| 13 | *Ammivisnaga* | 22.63 ± 1.35 | 64.23 ± 1.06 | 34.67 ± 1.15 | 56.23 ± 2.11 |
| 14 | *Conyzaincana (vahl) willd* | 31.68 ± 0.51 | 86.74 ± 0.00 | 72.70 ± 0.88 | 26.19 ± 2.07 |
| 15 | *Menthapiperita* | 25.93 ± 1.12 | 10.44 ± 2.16 | 43.89 ± 0.71 | 18.02 ± 1.60 |
| 16 | *Coriandumsativum* | 31.73 ± 1.50 | 4.78 ± 0.00 | 46.87 ±1.78 | 26.55 ± 2.60 |
| 17 | *Elettariacardamomum* | 29.70 ± 0.65 | 54.36 ± 1.04 | 65.23 ± 2.13 | 42.56 ± 1.02 |
| 18 | *Ocimumbasillicum (**)* | 83.76 ± 1.33 | 95.52 ± 0.13 | 69.95 ±3.71 | 91.68±2.68 |
| 19 | *Ocimumforskolie* | 18.83 ± 1.54 | 85.16 ±1.56 | 82.32 ± 2.24 | 86.54 ± 2.31 |
| 20 | *Acalyphafruticosa* | 10.71 ± 0.69 | 79.45 ± 0.79 | 78.37 ± 2.29 | 68.46 ± 2.34 |
| 21 | Arbutin (Positive control) | 91.45 ± 3.47 | - | - | - |
| 22 | BHA | - | 87.61 ± 2.12 | 93.23 ± 3.41 | - |

**TBARS**, Thiobarbituric acid reactive substances; **DPPH**, 2,2-diphenyl-1-picrylhydrazyl; **TRPA**, total reduction power activity; **BHA**, butylatedhydroxyanisole.

*visnaga>Thymuslaevigatus>Cloveeugeniacaryophill>Elettariacardamonum>Tagetesminuta>Chenopodiumambrosioides>Artemisiaabrotanum>Pulicariajubertii>Origanummajorana>menthapiperita=Rosmarinusofficinalis>Shinusmolle>Eucalyptuscamadulesis>Lantanacamara>Corriandumsativum.*

The ability of essential oils to prevent lipid peroxidation was also studied (Table 2) using the TBARS method. The inhibition of lipid peroxidation by these essential oils can be arranged as follows:

*Thymuslaevigatus>Cloveeugeniacaryophill>Cinnamomumzylanicum>Pulicariajubertii>Origanummajorana>Chenopodiumambrosioides>Ocimumforskolei>Artemisiaabrotanum=Tagetesminuta>Acalyphafruticosa>Conyzaincane(vah)willd=Shinusmolle>Ocimumbasillicum=Rosmarinusofficinalis>Elettariacardamonum>Eucalyptuscamadulesis>Coriandumsativum>Menthapiperita>Ammivisnaga> Lantana camara.*

The new findings have shown that all tested essential oils are able to reduce the system $Fe^{+3}$ to $Fe^{+2}$ ions. However, most of them have shown low reducing ability and can be arranged according to the following order:

*Cloveeugeniacaryophill>Ocimumbasillicum>Ocimumforskolei>Acalyphafruticosa>Thymus laevigalus> Ammivisnaga> Artemisia abrotanum> Elettariacardamonum>Tagetesminuta> Eucalyptus camadulesis=Origanummajorana>Cinnamomumzylanicum>Shinusmolle>Corriandumsativum= Conyzaincane(vah)willd=Lantanacamara>Chenopodiumambrosioides=Pulicariajubertii>>menthapiperita=Rosmarinusofficinalis.*

The effect of essential oils on tyrosinase activity was studied as part of our effort to find a treatment for hyper pigmentation skin disorder. The tyrosinase inhibitory activity of tested essential oils (Table 2) was found to be in the following order:

*Cinnamomumzylanicum>Chenopodiumambrosioides=Shinusmolle>Artemisiaabrotanum>Pulicariajubertii>Tagetesminuta>Ocimumbasillicum>Corriandumsativum=Conyzaincane(vah)willd>Elettariacardamonum>menthapiperita>Ammivisnaga>Cloveeugeniacaryophill>Ocimumforskolei>Acalyphafruticosa>Eucalyptuscamadulesis>Thymuslaevigalus=Origanummajorana>Rosmarinusofficinalis= Lantana*

*camara.*

## DISCUSSION

It should be mentioned that some of the aromatic plants, which subjected to the present study are added to foods as flavors or appetizers, while others are used in cosmetics and decoration (Mothana and Lindequist, 2005). The results of antioxidant activities and tyrosinase inhibitory effect of the tested essential oils are shown in Table 2. Due to the chemical complexity of essential oils, different methods are required to assess their antioxidant activity. Therefore, three complementary methods were followed to evaluate their antioxidant activity such as the ability to scavenge free radicals DPPH, the capacity to inhibit lipid peroxidation TBARS, and the TRPA.

The present study has shown that, the essential oils from five aromatic plants, namely: *Ocimumbasillicum* >*Conyzaincane*>*Ocimumforskolei*>*Cinnamonumzylanicum*>*Acalyphfruticosa,* could be used as potential sources of natural antioxidants with possible applications of *Ocimumbasillicum, Ocimumforskolei, Cinnamomum-zeylanicum* and *Acalyphfruticosa*in food systems, because these plants are added to foods as flavors and appetizers, while the *Conyzaincane* can be used as a source of natural antioxidants for pharmaceutical and cosmetics industry. Generally, all tested aromatic plants showed different degree of antioxidant activity, but the first six essential oils, exhibited a marked DPPH scavenging activity (Table 2) and even the *Ocimumbasilicum* essential oils exhibited significantly higher ability to neutralize free radicals than the positive control BHA. Again, it was evident that these essential oils could serve as hydrogen donors, and consequently terminating the radical chain reactions. In other words, these oils could be used as good sources of natural preservatives to inhibit food, pharmaceutical and cosmetics spoilage. The present results are similar to those obtained by other researchers and have shown that monoterpenes found in essential oils may act as radical scavenging agents, but it seems to be a general trend that the essential oils, which contain monoterpene hydrocarbons, oxygenated monoterpenes and/or sesquiterpenes have greater antioxidative properties (Burits et al., 2001; Cheng et al., 2003; Hussain et al., 2008; Mau et al., 2003; Tepe et al., 2004).

The values of the total antioxidant activity of different essential oils on the oxidation of egg yolk homogenate as a rich source of lipid peroxides were expressed as percentage inhibition of TBARS formation (Table 2). The present data showed that all the tested essential oils had the ability to prevent lipid peroxidation in egg yolk homogenate. However, about half of them have been shown to be very strong antioxidant agents (78-98%) according to this method. In addition, some of these essential oils, such as, *Thymus laevigatus, Clove eugeniacaryophill, Cinnamomumzylanicum,* and *Pulicariajubertii* have shown significantly higher ability to prevent lipid peroxidation than the positive control (Table 2). Actually, most of the tested essential oils showed similar results as those obtained from other studies (Wang et al., 2010).

The evaluation of the reducing ability of essential oils was carried out on the bases of the oxidizability of their chemical constituents, which could reduce $Fe^{+3}$ to $Fe^{+2}$ ions (Aruoma, 1996). The total reducing ability of each essential oil was compared to a positive control BHA, and the results were expressed as BHA equivalent (μg of BHA). Volatile oils are very complex mixtures of compounds and their constituents are mainly monoterpenes and sesquiterpines which are hydrocarbons with the general formula $(C_5H_8)_n$. Oxygenated compounds derived from these hydrocarbons include alcohols, aldehydes, esters, ethers, ketones, phenols and oxides (Svoboda and Hampson, 1999) can play very important role in their biological activities of essential oils. The data showed that essential oils having relative reducing power ability were *Clove eugeniacaryophill,* Ocimumbasillicum and *Ocimumforskolei*. The reducing power of the these oils as measured by this method could be related to some compounds, such as, aldehydes, ketones, and phenolic compounds, which reduced ferricyanide ions ($[Fe(CN)_6]^{3-}$) to ferrocyanide ions ($[Fe(CN)_6]^{4-}$), and the latter reacts with $Fe^{3+}$ ions to give what is called the Prussian blue colored complex (that is, ferric ferrocyanide, $Fe_4[Fe(CN)_6)]_3$). This reduction does occur due to the electron (or $^{\bullet}H$) donating ability of essential oils containing compounds having hydrolysable OH groups. These OH groups act as more powerful reducing agents, because they have more electrons (or $^{\bullet}H$) donating ability, which results in the termination of free radical chain reactions (Black, 1987).

The determination of tyrosinase inhibitory activity due to treatment with essential oils, which serves as a useful target in the treatment of hyper pigmentation skin disorder (Perez-Bernal et al., 2000). Essential oils are found to be rich in compounds consisting of hydrophobic part which would have acted as competitive inhibitors on the enzyme tyrosinase and thereby on melanin synthesis. Hence, the determination of tyrosinase inhibitory potential of the present essential oils may lead to develop skin whitening agents (Momtaz et al., 2008). Also the results obtained showed that the essential oils possess increased reducing power which forms the basis for exploring the tyrosinase inhibitory potential of plant. Tyrosinase is a copper containing enzyme hence any substance which reduces this metal ion was considered as an effective tyrosinase inhibitor (Amin et al., 2010). The reducing power reported might be due to phytoconstituents such as phenolics, carbonyl compounds and also other constituents which are present in crude essential oils. The possible mechanism underlying behind the tyrosinase inhibitory ability might

be chelation of copper ion present in tyrosinase enzyme by phytoconstituents and thereby suppression of tautomerisation to dopochrome by the oils, thereby the oils act as reducing agents on melanin intermediates by blocking oxidation chain reaction at various points from tyrosinase/ DOPA to melanin and hence causing reduction of skin pigmentation (Slominski et al., 2004).

## Conclusion

The present study has shown that, some essential oils could be used as potential sources of natural antioxidants with possible applications of *Ocimum basillicum, Ocimumforskolei, Cinnamomum zylanicum,* and *Acalyphfruticosa* in food systems because these plants are added to foods as flavors and appetizers, while the *Conyzaincane* can be used as a source of natural antioxidants for pharmaceutical and cosmetics industry.

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