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Kinetic studies of tyrosinase inhibitory activity of 19 essential oils extracted from endemic and exotic medicinal plants

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ABSTRACT

Essential oils (EOs) extracted from plants have attracted much interest as pharmacologically active compounds and have been recently probed as inhibitors of tyrosinase. The present study was designed to investigate into the tyrosinase inhibitory potential of 19 EOs extracted from exotic and endemic medicinal plants from Mauritius. The nature of inhibition was then evaluated by the double reciprocal Lineweaver–Burk plot in the presence and absence of the active EOs. EOs extracted from *Cinnamomum zeylanicum*, *Citrus grandis* and *Citrus hystrix* showed IC_{50} comparable to the positive control (kojic acid). Kinetic studies showed that only *C. grandis* (IC_{50} of 2.07 ± 0.152 μg/ml compared to kojic acid IC_{50} of 2.28 ± 0.054 μg/ml) exhibited a competitive type of inhibition. Results from the present study tend to show that EOs extracted from these medicinal plants can exhibit potent anti-tyrosinase activities and may be potential candidates for the cosmetic, food and pharmaceutical industries.

1. Introduction

Tyrosinase is a multifunctional enzyme widely distributed in nature (bacteria, fungi, plants and animals). In the human body, it is responsible for the formation of melanin, a biological pigment found in the hair, skin and colored part of the eyes. Tyrosinase catalyses the hydroxylation of tyrosine to L-3,4-dihydroxyphenylalanine (L-DOPA), which is further oxidized to the corresponding *o*-dopaquinone, leading to the formation of melanin (Mora and Baraldi, 2000). However, tyrosinase is also a major problem when produced in surplus which can lead to several pathologies. For instance, the excessive formation and accumulation of melanin leads to skin hyperpigmentation disorders such as, seborrheic keratoses, melasma, diabetic dermopathy, tinea versicolor, melasmas and malignant melanomas (Chang et al., 2013). Inhibitors of the tyrosinase enzyme such as hydroquinone, kojic acid and azelaic acid are used against skin disorders. These active substances have also found their place in the cosmetic industry as whitening agents (Nakayama et al., 2000).

In the food industry, tyrosinase has been linked to the oxidation of phenolic compounds into quinine which leads to browning of vegetables and fruits. Moreover, it has been documented that browning is a reaction which leads to a loss in nutritional value. In order to prevent browning, synthetic food additives have been used massively in the food industry. Tyrosinase also plays a role in neurodegenerative diseases like Parkinson's disease. The excessive production of tyrosinase has been purported to lead to an increase in intracellular dopamine, inducing a large amount of melanin and thus causing cell death (Hasegawa, 2010).

Natural products like essential oils (EOs) have attracted much attention as natural inhibitors of tyrosinase. Additionally, they offer potential novel template molecules and mixtures of bioactive aromatic compounds that can be exploited industrially as bio-products for both the wellness, pharmaceutical and food industries. EOs, which are complex mixtures of biologically active substances, are classified as natural products having a pharmacological potential that can be of therapeutic benefit in the management of a panoply of human diseases (Bakkali et al., 2008; Derwich et al., 2010; Oladipupo and Ogunwande, 2013; Ahmad and Viljoen, 2015). They have also demonstrated a good inhibitory effect on melanogenic activities (Liang et al., 2010; Chou et al., 2013) and may be of use in the cosmetic industry as a whitening agent, as well as an alternative therapy and as a protection against skin darkening. Recently, we have investigated the antimicrobial activities of EOs extracted from 9 exotic and endemic plants from Mauritius (Aumeeruddy-Elalfi et al., 2015). However, the tyrosinase inhibitory activities and the kinetic of inhibition of EOs from such plants have not been investigated so far. The present study was thus designed to assess the anti-tyrosinase activity and the mechanism of inhibition of 19 EOs extracted from endemic and exotic medicinal plants from Mauritius.

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Table 1
Ethnobotanical information and major components of the essential oils.

Plants/identification code	Common English name/vernacular name	Ethnobotanical information available locally	Main components	Reference
Pimenta dioica L. (Merr)/2014-AE1	Allspice/quatre-epices	The leaves have a tonic effect on the hair and are also known to be antiseptic. Infusions of the leaves are taken in case of respiratory problem. It is also known as a stimulant, hypotensive and analgesic.	Eugenol (64.3%), methyl eugenol (20.6%), and β caryophyllene (5.53)	Gurib-Fakim, 2008 ; Zabka et al., 2009.
Lavandula x intermedia var. Grosso L./2014-AE2	Lavandin/lavender	Disinfectant, used in household detergents. Reported for the ability to suppress sprouting in potato tubers for storage.	Camphor (32.7%), and eucalyptol (26.9%)	Tucker and Hensen, 1985; Jianu et al., 2013.
Salvia officinalis L./2014-AE3	Sage/sauge	Infusion of the whole plant is used against flatulence and digestive problems.	1,8-cineole (39.5%–50.3%), and camphor (8.8%–25.0%)	Gurib-Fakim, 2007; Abu-Darwish et al., 2013.
Cupressus macrocarpa H./2014-AE4	Gold crest/cypress	Decoction made from the leaves is used to treat rheumatism	Neral (31%–35%), hydroxy citronellal (12%–16%), geraniol (3%–4%), piperitol (trans) (7%–8%), isobornyl isobutrate (0.7%–6.61%), linalool (0.6%–5.21%), terpinyl acetate (0.10%–3.27%), myrcene (0.22%–2.60%), trans-ferrugiol (0.3%–2.25%), abitol (0.4%–2.18%) and eugenol dihydro (0.1%–1.3%).	Sudhir et al., 2014 ; EL-Ghorab et al., 2007.
Citrus grandis L.[b]/2014-AE5	Grapefruit/pamplemousse local	It is used against fatigue, loss of energy, lack of vitality, bruising, wounds, acne or mild skin disorders. Acts as general tonic, diuretic and prevents oily skin.	Limonene (94.8%), α-terpinene (1.8%), and α-pinene (0.5%)	Gurib-Fakim et al., 1997; Njoroge et al., 2005.
Laurus nobilis L./2014-AE6	Bay leaf/laurier	Infusion of the leaves is consumed to help digestion. The leaves are also used as tonic. Preliminary studies on rats showed that the EO of LN has analgesic properties and is a moderate anti-inflammatory agent.	1,8 cineole (35.7%), α-terpinyl acetate (9.3%), methyl eugenol (6.8%), Sabinene (6.5%), and eugenol (4.8%)	Gurib-Fakim, 2007; Verdian-rizi and Hadjiakhoondi, 2008.
Piper betle L./2014-AE7	Betel/betel	Leaves of *Piper betle* to which a layer of warm oil is added are applied on the chest of the child suffering from respiratory problems. Crushed leaf extracts are used to regulate diabetes, soothe coughing, asthma and also in cases of bronchitis.	Safrole (27.5%), eugenol (28.4%), α-selinene (7.3%), α-farnesene (4.7%), and methyl isoeugenol (2.6%)	Gurib-Fakim et al., 1997; Saxena et al., 2014.
Citrus hystrix D.C.[b]/2014-AE8	Combava/combava	Leaf extracts are known to help fight hepatic problems and skin infections.	Terpinen-4-ol (13.0%), β-pinene (10.9%), α-terpineol (7.6%), 1,8-cineole (6.4%), citronellol (6.0%) and limonene (4.7%)	Gurib-Fakim, 2008 ; Waikedre et al., 2010.
Rosmarinus officinalis L./2014-AE9	Rosemary/romarin	Infusion prepared from fresh or dry leaves helps against indigestion and possesses emmenagogue properties. Infusion of the twigs and leaves is used as tonic for the hair and against scalp irritation.	1,8-cineol (38.5%), camphor (17.1%), α-pinene (12.3%), limonene (6.23%), camphene (6.0%) and linalool (5.7%)	Gurib-Fakim, 2007; Hussain et al., 2010.
Cymbopogon citratus D.C. (Stapf)/2014-AE10	Lemongrass/citronelle	Pyretic, insect repellant, helps soothe abdominal pains and also known to be efficient in case of respiratory problem.	Geranial (27.04%), neral (19.93%) and myrcene (27.04%)	Gurib-Fakim, 2008; Gbenou et al., 2013
Melaleuca quinquenervia S.T. Blake (Cav.)/2014-AE11	Niaouli/change écorce	Emmenagogue and stimulant. Helps against skin infection, fever and pulmonary problems. Is an antidote against fish poisoning and is useful in boosting the immune system in case of chronic disease such as cystits and glandular fever.	1,8-cineole (48%), nerolidol (9%) and viridiflorol (5%)	Gurib-Fakim, 2008; Philippe et al., 2002
Cinnamomum zeylanicum Nees/2014-AE12	Cinnamon/canella	Decoction of leaves has antiseptic properties and is used in cases of urinary tract infections. This decoction is also known as an antipyretic.	(E)-cinnamaldehyde (68.95%), benzaldehyde (9.94%) and (E)-cinnamyl acetate (7.44%)	Gurib-Fakim, 2008; Unlu et al., 2010.
Schinus terebinthifolius R. /2014-AE13	Rose pepper/baie rose	Infusion of leaves and bark is used to soothe and treat rheumatism. Infusion is also prescribed as mouth wash in case of toothache. Infusion of the bark gives a drink which is an astringent.	Germacrene δ (23.7%), bicyclogermacrene (15.0%), β-pinene (9.1%) and β-longipinene (8.1%)	Gurib-Fakim et al., 1995; Santana et al., 2012.
Psidium guajava L.[b]/2014-AE14	Yellow guava/goyave jaune	Cramp, flatulence and indigestion. Decoction of the green fruit is an astringent and is helpful against diarrhea and in case of dysentery. Leaf decoction is used against sore throat and throat infection.	β-caryophyllene (27.7%), α-pinene (14.7%) and 1,8-cineole (12.4%)	Gurib-Fakim et al., 1995 ; Chen et al., 2007.