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Metabolomic Profiling and Biological Activity of *Hyphaene thebaica* and *Medemia argun*: A review

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Abstract: *Hyphaene thebaica* and *Medemia argun* are very important desert plants not only as sources of nutrients for human and animal nutrition, but also as potential sources of antioxidant and antimicrobial secondary metabolites agents such as polyphenolics including protoanthocyanidins, flavonoids and phenolics in addition to other classes of secondary metabolites such as alkaloids and saponins. The recently discovering biological activity of *H. thebaica* has increased its importance. Having very narrow ecological amplitude, *M. argun* has received very little attention from researchers. The description of *M. argun* as endangered species may also contributed to decreasing the number of studies on *Medemia*. The objective of this paper is to review the phytochemistry and biological activity of both *H. thebaica* and *M. argun*. The biological activity of both plants will be discussed and evaluated in terms of the content of secondary metabolites in their extracts. Till now *M. argun* has not been biologically exploited yet although it has diverse arrays from active secondary metabolites in different parts of the plant.

Key words: *Hyphaene thebaica*; *Medemia argun*; Secondary metabolites; Polyphenolics; Antioxidants; Anticancer activity; Antimicrobial activity

Introduction

Hyphaene thebaica (Doum palm) is an African palm tree, found close to the side of the River Nile in Sudan and Egypt and found in sub-Saharan Africa and West India (Fletcher, 1997; Aamer, 2015; Aboshora et al., 2014, 2016). It commonly has dichotomously branching stem, 15 m height and 25 cm in diameter with vane shaped leaves. Dom palm is dioecious where male and female flowers are on separated trees. Doum is included as one of the most useful plants in the world (Fletcher, 1997). It is used in many domestic purposes such as utensils, construction charcoal, firing and the leaves used to make mats, bind parcels and writing paper (Orwa et al., 2009; El-Beltagi et al., 2018). The charcoal from the seed kernel is used in treatment of sore eyes in livestock and seed is used for making knobs (Vogt, 1995). Doum palm supplies human with carbohydrates, dietary fibers and anti-hypertension substances. Fruits were sacred since ancient times where the

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ancient Egyptians palm pictured on the pharaonic tombs in different locations (Eldahshan et al., 2008).

Many previous studies had focused on the doum fruit due to its high nutritional value, as it is used in a wide range as a tonic for health and served in the areas for many folk medicinal properties (El-Gendy et al., 2008; Auwal et al., 2013a; Bayad, 2016; Oduje et al., 2016). Epicarp of the doum palm fruits is edible and possesses aromatic odor. It can be ground into powder then dried and used as flavoring agent for food (Orwa et al., 2009). Some countries like Kenya use the powder to get a moderate alcoholic drink by adding water and milk and leaving it to stand (Vogt, 1995). Moreover, doum palm fruits contain high amount of fiber and is used in manufacture of cakes, bread and cookies (Dubois, 1978; Fondroy et al., 1989; Seleem, 2015).

Medemia argun distributed in a narrow scale in the Western and Eastern deserts in Egypt and also in Sudan. It was described as an endangered species (Gibbons and Spanner, 1996). Researcher's team from the Unit of Environmental Studies and Development (UESD) had collected the seeds of *Medemia* from different places in Egypt such as Doungul Oasis and some other places in Western desert and re-cultivated these seeds to conserve this important species. Fifty trees are now growing in the desert garden at Aswan Faculty of Science. Among them four female trees are fruiting (Ibrahim and Baker, 2009). A few studies have been conducted on the phytochemical analysis and biological activity of this plant (Hamed et al., 2012, 2014).

This review will discuss the metabolomics of *H. thebaica* and *M. argun* and the biological activity of their extracts in relation to their secondary metabolites constituents particularly polyphenolics.

Phytochemistry of *Hyphaene thebaica*

Family Arecaceae comprises around 200 genera and 3000 species and most of them are rich in phytochemicals or secondary metabolites (Deysson, 1979; Uhl, and Dransfield, 1989). These compounds may contribute to human requirements like drugs and foods. Secondary metabolites are not required for the plant growth, development and reproduction, but it is utilized to protect plants from the effect of unfavorable environmental conditions such as severe drought, microbial infections, salinity, herbivorous and harmful insects (Cook et al., 2004; Kennedy and Wightman, 2011; Jahangir et al., 2008, 2009; Urano et al., 2009; Lugan et al., 2010; Abdel-Farid et al., 2010, 2013). Many secondary metabolites which belong to different classes were found in different plants including sterols, flavonoids, terpens, phenylpropanoids, steroids, phenolics, alkaloids and saponins (Kruse et al., 2000). Some of these compounds are present in plant as prohibitins or phytoanticipins (Grayer and Kokubun, 2001) which represent the first chemical barrier against the microbes and unfavorable conditions and subjected to fluctuations in their content based on plant subjection to severe unfavorable conditions. Other secondary metabolites are formed *de novo* in plants in response to microbial attack and known as phytoalexins (Grayer and Kokubun, 2001).

All species of doum palm possess primary metabolites (e.g. fats, amino acids, nucleic acid, carbohydrates.etc) which perform the same biological functions as essential for the plant growth and development (Kennedy and Wightman, 2011). Family Arecaceae have large groups of secondary metabolites such as tannins, phenols, flavonoid, alkaloid, saponin, leuco anthocyanidins, triterpenes and steroids (Lima et al., 2015). The phytochemical analysis of different parts such as leaves and fruits of *H. thebaica* revealed the presence of tannins, steroids, saponins, flavonoids, terpenes and terpinoids (Auwal et al., 2013a; Moawad and EL-Rahman, 2014). Moreover, some primary metabolites such as fatty acids (palmitic, oleic and linoleic acids), some elements such as nickel, iron, cobalt and copper were also identified (Ugochukwu et al., 2003). The last group of elements may be responsible for leukocytosis activity of *H. thebaica* (Ugochukwu et al., 2003). The mesocarp of *H. thebaica* fruits has some minerals such as magnesium, cobalt, copper, zinc, calcium and iron. These minerals supply cattle with the required metal essential for survival (Nwosu et al., 2008).

Several amino acids such as phenylalanine, leucine, glutamic and aspartic acid were identified from the aqueous extract of doum fruit using HPLC (Aamer, 2016). Moreover, several polyphenolics such as 3-OH tyrosol, catechin, E-vanillic, oleuropein, chlorogenic, *p*-OH benzoic, ellagic, salicylic, protocatchoic, caffeic and vanillic acids were also identified (Aboshora et al., 2017). High concentrations of glycoside, saponin and flavonoids were quantified from the methanol extracts of doum fruits (Nwosu et al., 2008). Metabolomic profiling of the methanol extract of doum fruits using RP-HPLC revealed the presence of vitamin B-complex (Aboshora et al., 2014). Eleven flavonoids were identified and quantified in the aqueous extract of doum palm fruit using HPLC (naringin, rutin, hesperidin, rosmarinic acid, quercitrin, quercetin, naringenin, hesperetin, kaempferol, 7-hydroxy-flavone and apigenin (Aamer, 2016). Using ultra-performance photodiode array, seventeen metabolites belonging to different classes such as cinnamic acid derivatives, flavonoids, fatty acids, sphingolipids, lignan and stilbene were detected in the doum palm mesocarp (Farag and Paré, 2013). Steroids, flavonoids, triterpenes and glycosides were also recorded in the pericarp of doum palm (Auwal et al., 2013a). Different classes of polyphenolics were isolated and identified from the aqueous ethanolic extract of doum palm leaves (Eldahshan et al., 2009). The antimicrobial activity of the doum fruit may be attributed to such types of secondary metabolites (Plasuntherum and Lyer, 1982; Palacious et al., 1983; Moniharapon and Hashinaga, 2004).

In comparison between the Egyptian and Saudi doum palm fruits, the Egyptian has more total sugar, saponins and tannins than the Saudi doum palm (Mohammed and Zidan, 2018). Moreover, the Egyptian doum fruit has less flavonoids, protein, phenols, fats and antioxidant activity than Saudi doum fruits (Mohammed and Zidan 2018). Due to the high content of several biological active secondary metabolites in doum palm particularly saponins and polyphenolics, the plant is used as a medicinal plant in many regions all over the world particularly in Egypt and Sudan (Waterhouse, 2003).

Biological activity of *H. thebaica*

Antioxidant potentiality of *H. thebaica*

Antioxidant agents are the substances that are present at low concentration comparing to the oxidizable substrates and have the efficacy to stop or lateness the oxidation of substrates (Halliwell, 1999). Antioxidants play an important role in food protection from oxidation processes and used as dietary supplements to removes potentially damaging oxidizing agents in a living organism (Chandrasekara, 2011; Shahidi and Chandrasekara, 2015).

The medicinal values of the doum plant may be attributed to the production of antioxidant agents (Moawad and EL-Rahman, 2014). This may be attributed to the high content of active secondary metabolites as antioxidant, anticancer and antimicrobial agents including phenolics, flavonoids, tannins, saponins and anthocyanins **(Table 1)**. Human diseases such as viral infections, inflammation, ulcer and autoimmune pathologies had been linked with oxidative stress due to the presence of reactive oxygen species (Surh and Ferguson, 2003). Most biomolecules such as lipids, carbohydrates, DNA and proteins can be reacted and oxidized with the reactive oxygen species causing oxidative damage. The reactive oxygen species can also cause food products damage during processing and storage. Polyphenolics are well documented as antioxidant agents (Soong and Barlow, 2004). Different parts of doum palm were characterized with high content of polyphenolics to which the antioxidant activity was attributed. Polyphenolics affects positively the human health through carcinogenesis inhibitory (Tanaka et al., 1998).

The antioxidant activity of the aqueous and methanolic extracts of doum fruits and leaves was attributed to the presence of high amounts of flavonoids and phenolics (Hsu et al., 2006; Aboshora et al., 2014). The hydrogen donating activity as trolox equivalents was measured in aqueous and ethanolic doum fruit extracts indicating that these extracts had antioxidant activity (Cook et al., 1998; Eldahshan et al., 2009).

Antimicrobial activity of *H. thebaica*

Ethyl acetate extract of *H. thebaica* fruit was potent against five pathogenic bacteria (*Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klesiella pneumonia* and *Staphylococcus aureus*) (Dosumu et al., 2006). Methanol extract was active against *P. aeruginosa* and *Klesiella pneumonia* (Dosumu et al., 2006). Among the evaluated fungi, only *Penicillim sp* was affected with higher concentration of methanol extract, *Aspergillus niger* and *Candida albicans* were not affected by any extract. The potentiality of both ethyl acetate and methanol extracts against the evaluated microorganisms was attributed to the presence of higher contents of flavonoids and saponins in the two extracts, respectively (Dosumu et al., 2006). Methanol and aqueous extracts of *H. thebaica* against *A. niger* and *C. albicans* were evaluated indicating that the inhibitory activity of methanolic extract was more stronger than the aqueous extract against *A. niger* and *C. albicans* (Mohamed et al., 2010).

Methanolic and aqueous extracts of *H. thebaica* against gram positive bacteria (*S. aureus* and *B. subtilis*) and gram negative bacteria *(E. coli*, *P. aeruginosa* and *Salmonella typhi*) were tested. Both extracts showed strong inhibition effect (Mohamed et al., 2010). The antibacterial activity of these extracts may be attributed to the presence of high amounts of polyphenolics and other secondary metabolites such as saponins in *H. thebaica* (Moniharapon and Hashinaga, 2004, Dosumu et al., 2006).

The growth of both *E. coli* and *S. aureus* was inhibited by the AgNps synthesized from the aqueous *H. thebaica* fruit extract (Bello et al., 2017). Flavonoids and alkaloids were isolated from flowers and stem of *H. thebaica* and showed an antibacterial activity (Ayoola et al., 2006, 2008; Savithramma et al., 2011). Methanolic flowers and stem extracts of *H. thebaica* showed stronger antibacterial activity against *S. aureus*, *E. coli*, *P. aeruginosa*, *E. fecalis, V. cholera*, *S. Enteritidis* and *S. odorifera* than extraction with ethyl acetate (Abakar et al ., 2014).

Extracts of different solvents of doum fruit were tested against many Gram positive and negative bacteria. Among the evaluated solvents, methanol and ethanol extracts were more effective than other extracts against the evaluated bacteria. Methanol extract showed the strongest antibacterial activity against Gram positive and negative bacteria (Aboshora etal., 2014). Saponins isolated from the crude extract of *H. thebaica* inhibited the growth of *Candida albicans* (Aboaba et al., 2011; Mohanta et al., 2007; Sen and Amla, 2012). Aqueous extract of *H. thebaica* fruits showed antifungal activity against *C. albicans*, *Microsporum gypseum*, *Trichophyton rubrum*, *Mucor sp.*, *Fusarium solani* and *Aspergillus niger* (Irobi and Adedayo, 1999).

Table 1. Biological activity of *H. thebaica* (Doum palm)

Plant part	Type of extract	Type of assay, cells or strains	Reference
Fruits	Aqueous	Antifungal activity	Irobi and Adedayo, 1999
Fruits	Aqueous	Antibacterial and antifungal activity (Gram positive, negative bacteria and fungi)	Hassan and Aumara, 2005
Fruits	Methanol	Antibacterial activity (Gram positive and negative bacteria)	Dosumu et al., 2006
Fruits	Methanol	Biochemical feature (total cholesterol)	Hetta and Yassin, 2006
Fruits	Aqueous	Antioxidant activity (DPPH, hydroxyl radical scavenging activity, superoxide radical scavenging activity, RP)	Hsu et al., 2006
Fruits	Supplement (25 mg/kg BW)	Biochemical features and blood pressure	El-Gendy et al., 2008
Fruits	Aqueous	Anti cancer (cytotoxicity) (Myeloid leukemia (ML)	Abou-Elalla, 2009
Fruits	Aqueous	Antioxidant activity (DPPH radical scavenging activity)	Abou-Elalla, 2009
Fruits	Aqueous and Methanol	Antioxidant activity (DPPH and superoxide scavenging activity).	Mohamed et al., 2010
Fruits	Aqueous and Methanol	Antibacterial activity (Gram positive and negative bacteria)	Mohamed et al., 2010
Fruits	Methanol	Gram positive and negative bacteria	Aboaba et al., 2011
Fruits	Supplement	Histobathological changes of pancreas and liver	Tohamy et al., 2013
Fruits	Methanol	Anti-inflammatory (cyclooxygenase-1 enzyme inhibition)	Farag and Paré, 2013
Fruits	Methanol, ethanol and aqueous	Antibacterial activity (Gram positive and negative bacteria)	Aboshora et al., 2014
Fruits	aqueous methanol, aqueous ethanol	Antioxidant activity (β-carotene bleaching, DPPH and RP)	Aboshora et al., 2014
Fruits	Ethanol extract	Antibacterial activity (Gram positive and negative bacteria)	Moawad and EL-Rahman, 2014
Fruits	Aqueous methanol	Antioxidant activity (DPPH)	Al-Ayed, 2016
Fruits	Aqueous	Biochemical features	Mohammed et al.,

			2015
Fruits	Aqueous	Antioxidant activity (ABTS and DPPH radical scavenging activity)	Oduje et al., 2016
Fruit	Aqueous	Antioxidant activity	Aamer, 2016
Fruits	Supplement	Antioxidant (DPPH and RP)	Aboshora et al., 2016
Fruits	Methanol	Antioxidant activity (DPPH)	Seleem, 2015
Fruits	Nano particles from aqueous extract	Human prostrate (PC3), breast (MCF7) and liver (Hep-G2) cancer cell lines	Bello et al., 2017
Fruits	Nano particles from aqueous extract	Antibacterial activity (*E. coli* and *S. aureus*)	Bello et al., 2017
Fruits	Aqueous	Antioxidant activity	Mohammed and Zidan, 2018
Fruits pericarp	Aqueous	Antibacterial activity (Gram positive and negative bacteria)	Auwal et al., 2013a
Fruits mesocarp	Aqueous	Biochemical features	Auwal et al., 2013b
Fruit mesocarp	Aqueous	Biochemical features	Mohammed et al., 2015
Fruits pulp	Hexane – dichloromethane	Antioxidant activity (DPPH and FRAP)	Salih and Yahia, 2015
Fruits pulp	Aqueous	Biochemical features	Bayad, 2016
Seeds	Ethanol	Biochemical and histological features	Hassan et al., 2018
Leaves	Aqueous ethanol	Antioxidant activity (superoxide anion radical scavenging activity)	Eldahshan et al., 2008, 2009
Leaves	Aqueous ethanol	*In vitro* cytotoxicity (breast human adenocarcinoma cells (MCF-7)	Ali et al., 2014
Flowers and stem	Methanol and ethyl acetate	Antibacterial activity (Gram positive and negative bacteria)	Abakar et al., 2014

Anticancer activity of *H. thebaica*

Many factors are responsible for cancer diseases such as smoking, pesticides, smoked foods, overheated cooking oils, and alcohol. Presence of some phytochemicals in vegetables and fruits may reduce the risk of cancer (Surh and Ferguson, 2003). Secondary metabolites especially polyphenolics are distributed in plants. Polyphenolics aid plants to survive and provide defense against eating by herbivores, attacking by microbes and against oxidative stresses. Polyphenolics act as antimicrobial agents (Rauha et al., 2000), antioxidant (Dapkevicius et al., 1998; Proestos et al., 2006) and anticancer agents (Dai and Mumper, 2010; Benayad et al., 2014). Few studies were carried out evaluating the effect of doum palm extracts as anticancer. Fruit extract of doum palm showed *in vitro* anticancer activity against acute myeloid leukemia (AML) (Abou-Elalla, 2009). The anticancer potentiality of the extract against myeloid leukemia was attributed to the presence of many antioxidant agents such as phenolics and flavonoids. AgNps synthesized from fruit extract of *H. thebaica* was active against human prostate (PC3), breast (MCF7) and liver (HepG2) cancer cell lines (Bello et al., 2017). The effect of AgNps was more prominent in prostrate cell lines than breast and liver cancer cell lines (Bello et al., 2017).

Pharmacological activity of *H. thebaica*

Medicinal plants that are possess biologically active secondary metabolite with therapeutic properties are used for treatment of various diseases such as cardiovascular and hepatic diseases, inflammation and urinary complications (Cousins and Huffman, 2002; Tian et al., 2014). Many studies have been focused on biologically active compounds containing plants to obtain derived drugs which considered safer than the synthetic drugs (Egamberdieva et al., 2017). Alkaloids are antioxidant secondary metabolites extracted from natural plants which characterized with many pharmacological activities such anti-inflammatory drug and drugs used to treat neurodegenerative diseases such as Alzheimer's disease (Chaves et al., 2016). Recently, scientists have been synthesized many new drugs such as morphine, quinine and paclitaxel from natural sources (Yan et al., 2015).

Hypertension is another name for high blood pressure is an everywhere problem which increases the possibility of certain diseases such as causing stroke and increased heart disease among the persons aged 40-70 years (Chobanian et al., 2003). *H. thebaica* contributed positively to control the high blood pressure and blood lipids through providing antihypertension secondary metabolites. Doum extracts inhibited the risk of cardiovascular diseases, atherosclerosis and reduced serum total cholesterol (Hetta and Yassin 2006). Crude ethanolic extract of *H. thebaica* seeds had hypolipidemic properties through inhibition of the levels of cholesterol in blood (Bayad, 2016; Shehu et al., 2015; Shattat, 2014; Hetta and Yassin, 2006). *H. thebaica* extract may improve the immunity against diseases through increasing the white blood cells (WBC) count and hemoglobin in the experimental animals subjected to different doses of the ethanol extract of *H. thebaica* fruit (Hassan et al., 2018).

Root of *H. thebaica* is used for treatment of bilharzias (Orwa et al., 2009). The fruit of doum has pharmacological properties which used in the treatment of haematuria, bleeding especially after child birth (Adaya et al., 1977; Hassan et al., 2018). The fruits of doum improve hepato and renal functions and regulate lipid profile (Bayad, 2016). Charcoal from the hard seed inside the fruit is used to treat sore eyes in livestock (Wolarafe et al., 2007). Other studies showed that the aqueous extract of doum stimulated rat intestine and the constrictions of frog's heart but reduced or inhibited uterine contractions in rats (Sharaf et al., 1972). Egyptian people believe that tea of doum is good for diabetes. The resin of the doum tree is used in treatment of diuretic and against animal stinging (Boulos, 1983). Due to all these advantages of utilizing doum palm, the extensive use of doum palm in folk medicine is not surprising.

From **Table 1**, it is clear that most research has been focused on fruits due to its high content from active secondary metabolites. Very few studies have been carried out on leaves, where no studies have been performed on male parts of *H. thebaica.*

Medemia argun

Background

Medemia argun is a species of fan palm belongs to the subtribe Hyphaeninae of the tribe Borasseae (Arecaceae), with commonly Arabic names is "Argun", also has a hieroglyphic name, Mama-n-Khanen (or Mama-n-Xanin). It has unbranched stem. It was known as *Areca passalacquae* (Kunth 1826). *Medemia argun* is similar to genus *H. thebaica* especially in flowers, leaf morphology and inflorescence. *M. argun* is distinguishable from Doum easily by the bright yellow petiole that lacks a hastula at its top and is not as heavily armed as that of *Hyphaene*) **(Fig. 1)**. Fruit resembles plum-shaped with purple-brown and contains a seed with ruminate endosperm (Ibrahim and Baker, 2009).

(A)

.......(B)

Fig. 1. *Medemia argun* (A) and *H. thebaica* (B)

M. argun is spread from the Northern Sudan and Nubian Desert Oases of Southern Egypt. It is one of the most vague plant and rare wild palm tree species. Archaeologists found fruits in the Egyptian tombs including the famous tomb of Tutankhamun (Kunth, 1826; Tackholm, 1974; Newton, 2001; Pain, 2006). Accordingly, *M. argun* fruit is very important in ancient Egypt, although the reason for that is still unknown. In 1837, the German Prince Friedrich Paul Wilhelm von Württemberg discovered *M. argun* in the Nubian Desert at the north of Sudan. It was not discovered as a living organ of the Egyptian flora until 1963. In 1963 *Medemia* was discovered in Dungul Oasis, south of Egypt, and recorded in three sites of Wadi Allaqi in the Eastern Desert and Nakhila Oasis in the Western Desert (Boulos, 1968, 2008). After its discovery in Egypt, *Medemia* lapsed into obscurity for more than three decades. Suspicions were raised that it might even have become extinct. In October 1995, *Medemia* was rediscovered in northern Sudan (Langlois, 1976, Gibbons and Spanner, 1996). In 1998, *Medemia* was rediscovered in Egypt at Dungul Oasis. In 2000, the Unit of Environmental Studies and Development (UESD) at the South Valley University started a program to conserve *M. argun*. The seeds were collected from Dungul Oasis and planted in the farm of the Unit at Aswan (Ibrahim and Baker, 2009). *M. argun* has adapted to resist the extreme environmental conditions such as drought and very high temperatures for long times. The plant can survive in places where it can reach ground water by producing very long root up to 3 m in length (Johnson, 1996).

Bedouin use *Medemia* for making gropes and the wood of the palm used for construction of houses. In some placed of the Nubian Desert, the plant supports the wild life by providing food and shelter for the mammals and to those living in the desert where fruit is scarce. The leaves of *Medemia* have been used for making mats (Gibbons and Spanner, 1996).

Phytochemistry of *Medemia argun*

Very few researches have been carried out on the phytochemistry of *M.*

argun. The essential oils from different parts of fruits (mesocarp and headspace of seeds) were profiled and the results indicated that there was a significant variation of essential oils among the evaluated parts of fruits (Hamed et al., 2012). The oxygenated hydrocarbon derivatives were dominant in fleshy mesocarps and considered the main contents in the headspace, while sesquiterpene derivatives were the main volatile constituents in the headspace (Hamed et al., 2012). High performance liquid chromatography and electrospray ionization mass spectroscopy were used to profile the proanthocyanidin in *M. argun* nut and the results revealed that the nut of *M. argun* was a rich source of proanthocyanidin (Hamed et al., 2014). Masullo et al., 2016 investigated the butanol extract of *Medemia* fruits resulted into the presence of a total of eight compounds.

Biological activity of *M. argun*

Antioxidant potentiality of *M. argun*

Proanthocyanidin are class of polyphenolic compounds identified from *M. argun* nut and considered as antioxidant, antitumor and antimicrobial agents acting against oxidative/nutritive damages of blood platelet and plasma components (Morel et al., 2014). The proanthocyanidin fraction from *Medemia* nuts has antioxidative properties and may protect biomolecules (lipids, DNA, and proteins) (Hamed et al., 2014). The incubation of the proanthocyanidin fraction with blood platelets and plasma reduced the formation of 3-nitrotyrosine and diminish the oxidation of thiol groups in addition to the reduction of the level of carbonyl groups in proteins caused by treatment with pyroxynitrite (Morel et al., 2014). The essential oil containing cadinane skeleton compounds from *M. argun* showed antioxidative properties (Hamed et al., 2012). The antioxidant potentiality of male parts of *Medemia* was attributed to the richness of male parts with high content of phenolics (Said et al., 2017).

Antimicrobial activity

The antimicrobial activity of *M. argun* has received less attention from the researchers. Proanthocyanidins extracted from *M. agrun* nuts had no effect on the growth of fungus *Cephalosporium gramineum* and reduced significantly the growth of *Gaeumannomyces graminis var. tritici*. *Azotobacter chroococcum* was more sensitive to protoanthocyanidins than fungal strains (Martyniuk etal., 2017). The essential oil containing cadinane skeleton compounds (tau-cadinol, δ-cadinene and trans-γ-cadinene) identified in *M. argun* exhibit inhibition activity against pathogenic fungi and bacteria (Hamed et al., 2012).

Anticancer activity of *M. argun*

Until now, there are no reports regarding the anticarcinogenic activity of *M. argun* either *in vitro* or *in vivo*.

Conclusion

Few trees from *Medemia* has distributed in Egypt and Sudan which was reflected on the number of studies on the phytochemistry and biological activity of *M. argun*. The fruit of *Medemia* was the only organ which has been studies from the phytochemistry point of view. The biological activity including antimicrobial activity, antioxidant capacity, *in vitro* and *in vivo* anticancer activity have not been studied yet. Although, *H. thebaica* was extensively studied from the metabolomic and phytochemistry point of view and also its biological activity, the studies have been focused only on fruits and leaves. The preliminary studies on the metabolomic profiling and biological activity of some parts of both plants revealed that both plants will be promising in future on the level of the biological activity against microorganisms and carcinogenic cell lines.

Future prospects

The male parts and leaves of *H. thebaica* and *M. argun* will be evaluated for their phytochemistry and metabolomic profiling with emphasizing on getting a whole picture of secondary metabolites in different parts of both plants. This goal could be achieved using different analytical techniques including targeted and non-targeting analytical techniques. The antioxidant capacity and antimicrobial activity of these parts in both plants should be assessed. Also the *in vitro* anticancer activity of methanol extracts of the leaves and male parts of both *H. thebaica* and *M. argun* needed to be evaluated against different carcinogenic cell lines.

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