

Multipurpose white mulberry: A review

Aqsa Munir¹, Rasheed Ahmad Khera¹, Rafia Rehman¹ and Shafaq Nisar^{1*}

¹Department of Chemistry, University of Agriculture, Faisalabad-38040-Pakistan

Abstract

Morus alba frequently known as white mulberry. *Morus alba* is medical and aromatic plant contains a wide range of essential oils which are rich in phenolic compounds and a large variety of biologically active compounds that are used for the treatment of many diseases. White mulberry is an anti-carcinogenic plant, contains less calories. It is also known as a good source of vitamin C, K1, E and minerals. Mulberry provided excellent material for the preparation of dessert, dairy product, shakes, tea, and also used for the preparation of beverages. White mulberry deals with respiratory disorder, fever and colds. The mulberry fruit and bark also ingested as food. Fruits of mulberry are useful for the treatment of weakness, anemia, dizziness, tinnitus and incontinence. Mulberry plants are vital source of polyphenolic compounds mostly the flavonoids. 3-6- malonylglucoside is an important flavonoid present in mulberry plant and responsible for the anti-oxidant potential. *Morus alba* L. root and bark used as an ancient Chinese medicine and used for the treatment of asthma, cough and other such diseases. Furthermore, *M. alba* contains anthocyanins which may play a vital role in increasing the immunity.

Key words: Essential oils, Stilbene, Cancer, Toxicity, Dizziness, Vitamin C

Full length article *Corresponding Author, e-mail: shafaqnisar12@gmail.com, Tel: +923237628206

1. Introduction

Morus alba, usually called white mulberry is native to China. It is a fast-growing, rounded, deciduous tree that generally grows to 30-50 tall and as large. It normally develops a broad spreading pinnacle with age. The leaves of this tree are used in China since at least 2500 B.C. as the primary diet for silkworms used to make silk. Mulberry is typically dioecious (separate male and female trees), but sometimes is monoecious. Small greenish-yellow flowers in drooping catkins bloom in spring (March-April). Fertilized flowers on female trees are followed by sweet, edible blackberry-like fruits that mature in June. Fruits ripen generally to white or pink color but sometimes darker reds or purple-black also observed. *Morus alba* L. is known by different names in different languages. In English is typically called white mulberry. In Urdu it is called White Shah-toot, in Hindi famous as tut. It is known as Sang Zhi in Chinese [1]. Apparently the most intimate mulberry is white mulberry (*Morus alba* L.), although it has broad range of cultivars and diversity, according to aroma, taste and their uses. There are over 150 cultivars names has been published. *Morus alba* (white mulberry) is commonly cultivated in North West Himalayas, Kashmir, Punjab, Northern parts of trans Indus Valley and Baluchistan. Now these species are being planted in large-scale throughout the world in warm temperature. Over a thousand year it has

been growing, from Afghanistan to Iran and in Southern Europe for leaves to feed silkworms [2]. The white mulberry trees are herbaceous having varying height from 10-20m. The white mulberry fruit is a multiple one as all the flower of inflorescence give rise to one ripe fruit. The ripening fruit is green changes to purple shade through many shades of red, pink and brown, etc. fruits contain geraniol, cineole, alpha-pinene, linalyl-acetate and limone as major components of essential oil which used in the treatment of dyspepsia, sore throat and melancholia. The smooth bark of this tree is yellowish brown in color and become divided into scaly ridges can be used in the treatment of neuralgic pains, stomach-ache and dropsy. The leaves are simple alternate, stipule and petiole. Leaf may be glossy or scabrous in texture, mulberry leaves are directly used in preparing the tea or these together with the mulberry roots and stem are boiled to prepare a both which is effective in lowering down the blood pressure [3].

2. History/origin

Morus alba is native to China, India and Japan, where it has cultivated in North America, Europe and Africa. *Morus alba* frequently known as white mulberry. It has been reported that the general name of *Morus alba* derived from Latin word *Mora* (delay) and *alba* (white). At the time of Virgil, who died in 19 B.C. the word of silkworm was not being understood and silk formed as the

product of mulberry leaves. Justinian from Constantinople (lead from A.D. 527-65) was the first one which introduced silkworm culture. White mulberry is cultivated in every part of the world, wherever silkworms are increased. The major food for silkworms is mulberry leaves. During nineteenth and early twentieth centuries, silk production was important in Europe and it was reached to its maximum point in Korea and Japan in twentieth century. Nowadays silk production is dominated by China and India. In Southern United State, Southern Europe and in Asia, mulberry trees are used for landscaping.

3. Demography/location

White mulberry grows in varies environmental condition and climate change but the favorable for mulberry is to grow in warm regions. Sunlight, moisture and warm climate are the basic ecological requirements for white mulberry to grow. White mulberry is growing widely in the following countries: Japan, India, Brazil, Pakistan, Colombia, Mexico, the United Republic, Tanzania, costa rice, EL Salvador, Uzbekistan, Turkmenistan, China, Kyrgyzstan and Tajikistan. The origins of most cultivated mulberry varieties are believed to be in Japan and China area in the Himalayas foothills [4]. In Pakistan mulberries extensively cultured in northern regions, while in the Himalaya-Hindu Kush region they are grown at significantly higher altitudes[5]. The worldwide report for the production of white mulberry is hard to achieve. In many of the European countries including Greece and Turkey, mulberries are grown for fruits production not for foliage. The large quantity of white mulberry is produce in Pakistan, India and Turkmenistan which export it to the other countries. Nevertheless, Karnataka is the largest producer of mulberry silk in the India, approximately 91,128 hectares of mulberry is present here. Now a day's Andhra Pradesh produce raw silk in 117.04 kg of hectares which is more than other. Total white mulberry herbs imported to Asia was near 630-725t/year. India is the biggest importer by 150-212t/year [6]

4. Botany, Morphology, Ecology

White mulberry tree is nearly 30-50 feet tall, forming a woody stem with abundant branches usually wider than the height of the tree. Flowers with 4 free imbricate petals, inconspicuous and greenish. The leaves are alternatively arranged on the stem, fleshly green sepal present at the stand of each filament. Male trees are also named as fruitless mulberries because messy fruit is not produce by them. Since mulberries are wind pollinated [7]. Female flower is a long or short spike, ovary enclosed. Mulberry leaves is the only food for silkworm and grown in many climatic conditions from temperature to humid located north of equator in between 27°N and 56°N latitude. The optimum temperature for growth is from 25 to 29°C. Mulberry grows properly in the region with annual rainfall scale from 625 to 2550mm. The places with low rainfall,

have limited growth of this plant due to moisture stress which cause low yields. For mulberry growth purpose the ideal atmospheric humidity is the range from 66-81%. Mulberry grows with sunlight from 9-14 hours per day in the tropics. White mulberry grows better in the soil that is deep, fertile, porous with holding capacity of good moisture and well drained. The optimum range of soil pH is 6.3 to 6.9 [2].

5. Chemistry

Various aromatic plants contains a wide range of essential oils which are rich in phenolic compounds [8-9] and a large variety of biologically active compounds [10] that are conventionally used for treatment of many diseases [11-12]. The difference of aroma and fragrance in many mulberry species is due to the presence of essential oil present in leaves. GC-MS analysis are used to analyze essential oil [9-13-14]. The leaves of mulberry are also rich in flavonoids, polysaccharides and alkaloids components which are famous as the active major compound as indicated the investigation of chemical constituent. The total flavonoid in mulberry contains rutin, isoquercitrin, quercetin and quercetin 3-6 malonyglucoside. But type and concentration of chemical constituents varies with different season [15]. For their valuable properties flavonoids have found many applications in of food and pharmaceutical industries. In particular medicinal properties of total flavonoids causes much interest, and its leaves have been used as a product of traditional Chinese medicine that have dominant biological activities [16].

5.1. Chemical composition

White mulberry is an anti-carcinogenic plant, contains less calories. It is also known as a good source of vitamin C, K1, E and minerals. One cup of fresh mulberries contains 86-89% water and which have only 60-63% calories approximately. The dried form of berries has 68-71% carbohydrate, 12-14% fiber, 2-3.5% fat and 13-15% protein. The protein content in white mulberry is much more as compare to the other barriers. Vitamin C, which is necessary for skin growth and required by body to do many functions, can be achieved from white mulberry. Iron is an important mineral used for the transportation of oxygen throughout the body, also present in large amount in white mulberries. Mulberries are also a good source for fibers, which are soluble (23-25%) in the form of pectin and insoluble (72-75%) in the form of lignin. Fibers control cholesterol level, improve digestion and reduce the chance of many diseases. White mulberry according to USDA'S GRAS (generally recognized as safe) contains a compound named as arbutin, which lighten the skin tone and make it fair. Arbutin is a hydroquinone present in leaves that contains tyrosinase enzyme, which prevent by lowering melanin release causes skin cancer [17].

5.2. Phyto-chemistry

The chemical composition of *Morus alba* shown

that it has highest total fat content up to (1.09%-1.12%). Due to different environmental factor and climate conditions chemical ingredients may be differ in variety of white mulberry which make it less or more sweet in taste. The leaves of mulberry contain mulberrofuran G, kuwanon C, and quercetin, where kuwanon G is an anti-microbial bombesin receptor. Albanol B is found in fruits. It is the constituent of bark of white mulberry. Coumarin and stilbene is also present in mulberry flowers. Low amount of riboflavin and niacin contents have been recorded in all part of the fruits and certain amount of ascorbic acid is present in fruit and leaves too [2]. *Morus alba* fatty acid methyl ester GC analysis shown that linoleic acid (C18:2) followed by oleic acid (C18:1), steric acid (C18:2) and palmitic acid (C16:0) were the dominant fatty acid comprising approximately 95-97% of all identified fatty acids.

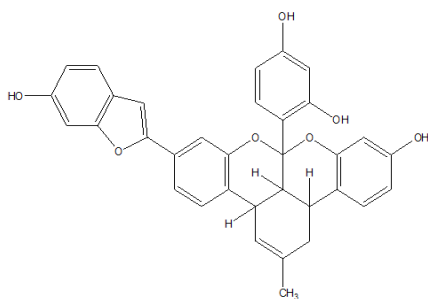


Fig.1. Structure of Mulberrofuran G

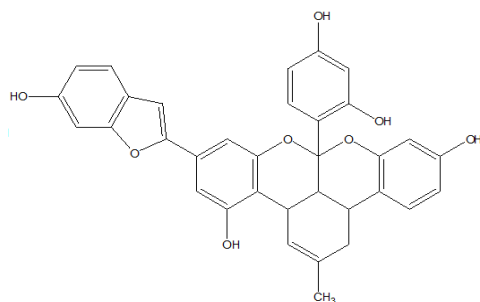


Fig.1. Structure of Albanol B

6. Post-harvest technology

Mulberries are special as they are juicy and it can be found in late spring. Best time for harvesting leaves is in the evening. Perfect way to collect mulberries, is gently shake stems after spreading a trap under each stem which will allow ripened mulberries to fall down. However, a great difference is observed in fresh and dried white mulberries. Fresh white mulberries are juicy with intense flavor whose intensity greatly lost when it used in dry form [16]. It is quite difficult to store them in moist conditions, because they have short life. These can be stored in refrigerator for 2-3 days only. Therefore, for the long term storage white mulberries can be dehydrated in the sun. Dehydrator can also be used for drying purpose. Once white mulberries dried completely they can be used over 1-2 years approximately. As that of ripe fruit, leaves of white mulberry can also be stored for long term after drying. If dried leaves are cut into shreds, they lost most of their

aroma and flavor. White mulberry leaves and ripened fruits are store in closed jars away from temperature and high intensity heat. Another way of storage in freezing, as freezing is the easiest way for preservation [18].

7. Processing

Like other berries, white mulberry is utilized in a various way for variety of purposes. The ripened fruits or leaves of white mulberries are stored by freezing them which increase their shell life. The dried form of white mulberries fruits and leaves can be used for 1-2 years by storing them in air tied boxes protected from heat, moisture and temperature [19]. White mulberry leaves essential oil can be extracted by two different extraction methods named as conventional hydro distillation (HD) and solvent free microwave extraction (SFME). Many reported study show that mulberry leaves are caffeine free, full of amino acids and 16-27% proteins, depending upon species [20].

8. Value addition

Mulberry leaves are often utilized in combination with other herbs, ligustrum, notably chrysanthemum and apricot seeds and can be used in wine, fruit juice, can food, as well as in jams. Mulberry provided excellent material for the preparation of dessert, dairy product, shakes, tea, and also used for the preparation of beverages. Mulberry leaves also consumed as a vegetable just like cucumber, pea and drum strick etc. It contains all necessary element required to the human body and satisfied dietary requirement. Mulberry fruit is well famous as admire dessert fruit and is normally used in jelly, cold drinks and in alcoholic drinks. The fruit is great source of vitamin C also has particular taste and attracts pregnant women due to sour taste caused by vitamin C and makes them to chew fruit again and again [21]. Mulberries are often used in ice-cream, gastriques, sorbet and baked goods, basically pies. They can be used as replacement of blackberries but it has less water content and more sweetness. Inner stem of white mulberry is removed which is fibrous and have unwanted fragrance. Highly flavorful parings include other bramble berries, young cheeses, stone fruit such as citrus, mascarpone, creams, arugula, baking spices, mint, basil and pork. As like other berries mulberry can be used in tarts and pies, as a garnish ingredient for deserts and breakfasts, eat them fresh as a snack or dry them to add in cereals. White mulberry fruits muffins, or puree sauce can be made for both sweet and savory dishes [22].

9. Uses

White mulberry has fewer calories and filled with antioxidants, additionally it is also a good source of certain dietary fiber, vitamins, minerals carbohydrate and protein. White mulberry has a very sharp and sweet flavor that enhanced the appearance of many desserts and also provides good taste to food. Mulberry leaves dried are used for making healthy tea. Essential oil extracted from leaves, stem and bark of the mulberry plant utilized by human in the

treatment of many diseases.

9.1. General uses

In cookery preparation, the tart and sweet flavor of many varieties of mulberries make these berries ideal for jams, sherbets, jellies, pie, fruit tart, wine, tea and cordials. All over the world mulberries varieties have different flavor. Mulberry plant ripe fruits can be used for making wine by drying them. Like other berries, white mulberries also have antioxidants which are famous as antiaging agents. Due to their chemical compositions, mulberries can also be used for the removal of blemishes and dark spots from facial skin by regulating the melanin synthesis. Extremely dry skin can be moisturized by applying mulberry leaves after soaking them in olive oil or coconut oil for few days. Mulberries have some natural compounds that make hair healthier promote hairs growth and prevent from hair loss. White mulberry is a multi- purpose plant may be used in medicine, pharmaceutical industries, in paper industry, in fuel industry and in food industry. White mulberry deals with respiratory disorder, fever and colds. The mulberry fruit and bark also ingested as food. Fruits of mulberry are useful for the treatment of weakness, anemia, dizziness, tinnitus and incontinence. Their fruit has a lot of importance in ancient Chinese drug that utilized it to treat ultimately graying hair. It can also have significant role in curing constipation, purify blood and polygenic diseases in Chinese drugs. Leaves of white mulberry are used as feedstock for silkworms. They're additionally cut as food for stock like cows and goats.

9.2. Pharmacological uses

Recent pharmacological studies have shown that the medicinal uses of plant in polygenic disorder, central nervous system (CNS), high blood pressure, cardiac disease are scientifically valid. The use of white mulberry as a supplement causes shortage of gastric juice, promote digestive gastric juice to stimulate into the internal organ membrane, promote canal activity, raise intestinal fluid secretion and therefore there's strong tonic power.

9.2.1. Antimicrobial activity

The use of anti-biotic in higher amount is dangerous for human body and also resistance occurred against hazardous pathogens [23]. So, the requirement of discovering natural compounds having activity against toxic pathogens is rising gradually. Phytochemicals present in *M. alba* possess effective antimicrobial potential against many bacteria such as *B. subtilis*, *Mycobacterium smegmatis*, *S. aureus* and *Streptococcus faecalis*. Chemicals responsible for the antimicrobial potential present in white mulberry are albanol B, mulberofuran G and kuwanon C.

9.2.2. Antioxidant Activity

Antioxidant properties of plant are due to the presence of phenolic or flavonoid components [8]. Mulberry plants contain Quercetin 3-6-malonylglucoside which is responsible for the anti-oxidant potential. Furthermore, 5,7-

dihydroxy-coumarin 7-methyl ether and oxy-resveratrol also show effective antioxidant potential.

9.2.3. Anti-stress Effect

Morus alba. L. is efficiently used for nerve tonic as an Indian traditional medicine. The study reported that *M. alba* promote ability of physical activities, and showed significant anti-stress activity and increased capability of physical activities.

9.2.4. Anti-hyperlipidemic Activity

Leaves of mulberry have capability to be utilized as anti-hyperlipidemic agent due to particular inhibitory effect on *M. alba* on the preparation of fatty acids. They are also widely used in Brazil to protect the liver and reduce cholesterol and high blood pressure. *M. alba* aqueous extract decreased the plasma triglycerides level gradually.

9.2.5. Hepato-protective Activity

The liver is the vital organ controlling all the biochemical pathways related to energy provision, supply of nutrients and growth. Some reports shown that *M. alba* contains stilbene, coumarine and flavonoids which have hepatoprotective activity.

9.2.6. *M. alba* Action against Cancer

Cancer is one of the main causes of death in animals especially canines and felines. Clinical trials and evaluation showed that *M. alba* has therapeutic potential for cytotoxic cells.

9.2.7. Immunomodulatory Effects

M. alba contains a significant amount of flavonoids, specially anthocyanins and other active elements which plays vital role in increasing the immunity. Polysaccharides are separated from mulberry shown immunomodulatory activity. The ranges of serum immunoglobulin enhanced by *M. alba* extract and decreased the mortality in mice. *M. alba* L. importantly promote the circulation of blood, phagocytic index and a particularly enhanced the adhesion of neutrophils.

10. Summary

Morus alba frequently known as white mulberry. *Morus alba* is medical and aromatic plant contains a wide range of essential oils which are rich in phenolic compounds and a large variety of biologically active compounds that are used for the treatment of many diseases. White mulberry is an anti-carcinogenic plant, contains less calories. It is also known as a good source of vitamin C, K1, E and minerals. Mulberry provided excellent material for the preparation of dessert, dairy product, shakes, tea, and also used for the preparation of beverages. White mulberry deals with respiratory disorder, fever and colds. The mulberry fruit and bark also ingested as food. Fruits of mulberry are useful for the treatment of weakness, anemia, dizziness, tinnitus and incontinence. Mulberry plants are vital source of polyphenolic compounds mostly the flavonoids. 3-6-malonylglucoside is an important flavonoid present in mulberry plant and responsible for the anti-oxidant

potential. *Morus alba* L. root and bark used as an ancient Chinese medicine and used for the treatment of asthma, cough and other such diseases. Furthermore, *M. alba* contains anthocyanins which may plays a vital role in increasing the immunity.

References

- [1] R. Venkatesh Kumar, S. Chauhan. (2008). Mulberry: life enhancer. *Journal of Medicinal Plants Research*. 2(10): 271-278.
- [2] J.R. Barbour, R.A. Read, R.L. Barnes. (2008). *Morus L.: mulberry*.
- [3] A.N.B. Singab, H.A. El-Beshbishy, M. Yonekawa, T. Nomura, T. Fukai. (2005). Hypoglycemic effect of Egyptian *Morus alba* root bark extract: effect on diabetes and lipid peroxidation of streptozotocin-induced diabetic rats. *Journal of ethnopharmacology*. 100(3): 333-338.
- [4] C. Fields-Johnson, C. Zipper, J. Burger, D. Evans. (2012). Forest restoration on steep slopes after coal surface mining in Appalachian USA: soil grading and seeding effects. *Forest Ecology and Management*. 270: 126-134.
- [5] Y. Lee, D.-E. Lee, H.-S. Lee, S.-K. Kim, W.S. Lee, S.-H. Kim, M.-W. Kim. (2011). Influence of auxins, cytokinins, and nitrogen on production of rutin from callus and adventitious roots of the white mulberry tree (*Morus alba* L.). *Plant Cell, Tissue and Organ Culture (PCTOC)*. 105(1): 9-19.
- [6] M.S. Zafar, F. Muhammad, I. Javed, M. Akhtar, T. Khaliq, B. Aslam, A. Waheed, R. Yasmin, H. Zafar. (2013). White mulberry (*Morus alba*): a brief phytochemical and pharmacological evaluations account. *Int J Agric Biol*. 15: 612-20.
- [7] M.S. Butt, A. Nazir, M.T. Sultan, K. Schroën. (2008). *Morus alba* L. nature's functional tonic. *Trends in Food Science & Technology*. 19(10): 505-512.
- [8] M.M. Khan, M. Iqbal, M.A. Hanif, M.S. Mahmood, S.A. Naqvi, M. Shahid, M.J. Jaskani. (2012). Antioxidant and antipathogenic activities of citrus peel oils. *Journal of Essential Oil Bearing Plants*. 15(6): 972-979.
- [9] M.A. Hanif, M.Y. Al-Maskari, A. Al-Maskari, A. Al-Shukaili, A.Y. Al-Maskari, J.N. Al-Sabahi. (2011). Essential oil composition, antimicrobial and antioxidant activities of unexplored Omani basil. *Journal of Medicinal Plants Research*. 5(5): 751-757.
- [10] M.A. Hanif, H.N. Bhatti, M.S. Jamil, R.S. Anjum, A. Jamil, M.M. Khan. (2010). Antibacterial and antifungal activities of essential oils extracted from medicinal plants using CO₂ supercritical fluid extraction technology. *Asian journal of chemistry*. 22(10): 7787.
- [11] I. Ahmad, M.A. Hanif, R. Nadeem, M.S. Jamil, M.S. Zafar. (2008). Nutritive evaluation of medicinal plants being used as condiments in South Asian Region. *JOURNAL OF THE CHEMICAL SOCIETY OF PAKISTAN*. 30(3): 400-405.
- [12] Z. Arshad, M.A. Hanif, R.W.K. Qadri, M.M. Khan. (2014). Role of essential oils in plant diseases protection: a review. *International Journal of Chemical and Biochemical Sciences*. 6: 11-17.
- [13] M.A. Hanif, A.Y. Al-Maskri, Z.M.H. Al-Mahruqi, J.N. Al-Sabahi, A. Al-Azkawi, M.Y. Al-Maskari. (2011). Analytical evaluation of three wild growing Omani medicinal plants. *Natural product communications*. 6(10): 1934578X1100601010.
- [14] I. Shahzadi, R. Nadeem, M.A. Hanif, S. Mumtaz, M.I. Jilani, S. Nisar. Chemistry and biosynthesis pathways of plant oleoresins: Important drug sources.
- [15] A.Y. Al-Maskri, M.A. Hanif, M.Y. Al-Maskari, A.S. Abraham, J.N. Al-sabahi, O. Al-Mantheri. (2011). Essential oil from *Ocimum basilicum* (Omani Basil): a desert crop. *Natural product communications*. 6(10): 1934578X1100601020.
- [16] A. Bagachi, A. Semwal, A. Bharadwaj. (2013). Traditional uses, phytochemistry and pharmacology of *Morus alba* Linn.: a review. *Journal of Medicinal Plants Research*. 7(9): 461-469.
- [17] N. Asano, T. Yamashita, K. Yasuda, K. Ikeda, H. Kizu, Y. Kameda, A. Kato, R.J. Nash, H.S. Lee, K.S. Ryu. (2001). Polyhydroxylated alkaloids isolated from mulberry trees (*Morus alba* L.) and silkworms (*Bombyx mori* L.). *Journal of Agricultural and Food Chemistry*. 49(9): 4208-4213.
- [18] S. Kafkas, M. Özgen, Y. Doğan, B. Özcan, S. Ercişli, S. Serçe. (2008). Molecular characterization of mulberry accessions in Turkey by AFLP markers. *Journal of the American Society for Horticultural Science*. 133(4): 593-597.
- [19] M.D. Sánchez. (2002). World distribution and utilization of mulberry and its potential for animal feeding. mulberry for animal production. FAO animal production and health paper. FAO, Rome. 1.
- [20] A. Ali, M. Ali. (2013). New triterpenoids from *Morus alba* L. stem bark. *Natural product research*. 27(6): 524-531.
- [21] A.H. Gilani, N.u. Rehman, A. Khan, K.M. Alkharfy. (2015). Studies on Bronchodilator Activity of *Salvia officinalis* (Sage): Possible Involvement of K⁺ Channel Activation and Phosphodiesterase Inhibition. *Phytotherapy Research*. 29(9): 1323-1329.
- [22] A. Ahmad, G. Gupta, M. Afzal, I. Kazmi, F. Anwar. (2013). Antiulcer and antioxidant activities of a new steroid from *Morus alba*. *Life sciences*. 92(3): 202-210.
- [23] E.M. Abdallah, A.E. Khalid. (2012). A preliminary evaluation of the antibacterial effects of *Commiphora molmol* and *Boswellia papyrifera* oleo-gum resins vapor. *International Journal of Chemical and Biochemical Sciences*. 1: 1-15.