# Mangifera indica peels: A common waste product with impressive immunostimulant, anticancer and antimicrobial potency

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**Abstract**: The volatile components of 3 mango cultivars were investigated by means of GC, and GC-MS. Two hundred and forty compounds were identified, of which eighty five compounds were found for the first time in mango fruit. Terpene hydrocarbons were the major volatiles of all cultivars, the dominant terpenes in the 3 mango cultivars were  $\delta$ -3-carene (2.784-14.904%),  $\alpha$ -terpinolene (4.825-15.879%),  $\alpha$ -copaene (2.281-8.097%), and caryophyllene (3.390-10.897%). peel essential oils of *M. indica* cultivar zebdeya and *M. indica* cultivar cobaneya showed appreciable non specific immunostimulant activity measured by low Macrophage migration index. *M. indica* cultivar zebdeya and *M. indica* cultivar cobaneya had higher phagocytic indices up to 1.47and 1.06 respectively. The cytotoxicity of the essential oils were studied *invitro* against MCF-7, HCT-116 and Hep-G2 cancer cell lines using MTT assay showed significant effect with IC<sub>50</sub> = 1.62-1.77, 2.95-5.56 and 2.76-3.14 µl/ml for respectively. Interestingly, *M. indica* cultivars zebdeya, cobaneya and hindi expressed a valuable cytotoxic effect on MCF-7 breast carcinoma cell line as compared to standard antitumor drug.

The essential oils *M. indica* cultivars were tested by Kirby-Bauer method showing a wide range of antibacterial and antifungal activities. Generally, essential oils of the *M. indica* cultivars showed a moderate to high antibacterial activity with *M. indica* cultivar hindi being the most active showing broad spectrum activity against Gram-positive (18-21 mm) and Gram-negative bacteria (16-19 mm). It also showed significant antifungal activity against *Candida albicans* (16 mm); however, data revealed that all *tested cultivars* were ineffective and have no antifungal activity against *Aspergillus flavus*.

The MIC of the three *M. indica* cultivars essential oils revealed that although essential oils didn't show antimicrobial activities against *Aspergillus flavus* the peel essential oils demonstrated variability in the inhibitory concentrations of each essential oil for the given microorganisms. The essential oils of peels showed activities in the range (concentrations) from 116 to 142  $\mu$ /ml for *M. indica* cultivar zebdeya, 58 to 89  $\mu$ /ml for *M. indica* cultivar hindi and from 121 to 172  $\mu$ /ml for *M. indica* cultivar cobaneya. The present investigation proved the possibility of using *M. indica* peel waste as a source of low-cost natural immunostimulant, anticancer and antimicrobial.

Key words: Mangifera indica peels; waste product; immunostimulant, anticancer; antimicrobial

## 1. Introduction

In view of the beginning of human civilization, we have been exploiting our natural resources for eradication of common human pathogen borne diseases. Various developing countries over the globe have been ravaged by bacterial pathogen borne diseases. Mostly, three diseases, namely, tuberculosis, malaria, and AIDS attributes to the majority of infectious diseases. These diseases on a whole, proves fatal for the human population of 5 million and causes sickness to the human population of 300 million each year, all over the globe (WHO, 2002). These infectious diseases can be prevented by controlling the growth of food borne pathogenic microorganisms and food spoilage.

Mango (*Mangifera indica* L.), a fruit belongs to the family Anacardiaceae, which comprises about 70 genera. Historical records suggest that its cultivation as a fruit tree originated in India more than 4000 years ago (Mukherjee, 1997). With a growing world production, the mango represents one of the most important tropical fruits and is produced worldwide. It is mostly found in tropical countries like India. Various products are found in India as mango processed food products. Mango is mostly used in food processing industries such as Juice industries, jam industries, jelly industries, and pickle industries These processed food leads to enormous generation of mango peel as a waste product. It needs a huge capital to decompose these peels to make sure that it does not pollute the environment. To save this investment in the disposal of mango peels, it can be converted as a raw material for pharmaceutical industries based on the result of the current research work. These waste products can be utilized for their immunostimulant, anticancer as well as antimicrobial activities. Hence, the utilization of mango py-products especially mango peels may be an economical way to reduce the problem of waste disposal from mango production (Kittiphoom, 2012).

Numerous scientific investigations point at consecutive rich eco-friendly sources of immunostimulant, anticancer and antimicrobial properties, especially among fruits and vegetables, but only few of them involve waste parts of fruits, i.e. seeds and peels. Many of the fruits and vegetables skins are thrown in the garbage or fed to livestock. Fruits and vegetables wastes and by-products, which are formed in great amounts during industrial processing, represent a serious problem, as they exert an influence on environment and need to be managed and/or utilized. On the other hand, they are very rich in bioactive components, which are considered to have a beneficial effect on health. Since last decade, efforts have been made to improve methods and ways of reusing fruits and vegetables wastes. The important purpose is the valorization of the biocomponents in byproducts from fruit and vegetable industries. Plant waste is prone to microbial spoilage; therefore drying is necessary before further exploitation. Till now, agro industrial waste often is utilized as feed or fertilizer. But using this agro waste therapeutically is a new idea which is slowly gaining popularity. They are high value products and their recovery will be economically attractive. These are novel, natural, eco friendly and economic sources of antimicrobics, which can be used in the prevention of diseases caused by pathogenic microbes and also reduce pollution.

Immunostimulant compounds are those compounds that enhance body's immune system that may in turn play a major rule in cancer prevention while, antimicrobial compounds are the agents which suppress the growth of bacteria and fungi that can also be fatal. The bacterial pathogens are becoming resistant to the commercially available antibiotics in the market (Goosens *et al.*, 2005; Mathew *et al.*, 2007). This is because of the random use of these drugs. It creates a need to find a new bioactive source of immunostimulant, anticancer and antimicrobial compounds. Thus, the research work was carried on to get an idea of immunostimulant, anticancer and antimicrobial property in mango peels.

Cancer is an abnormal type of tissue growth in which the cells exhibit an uncontrolled division, relatively in an autonomous fashion, leading to a progressive increase in the number of dividing cell (Kanchana and Balakrishna, 2011). There is increasing demands for anticancer therapy (Unno *et al.*, 2005). *Invitro* cytotoxicity testing procedures reduces the use of laboratory animals (Abraham *et al.*, 2004) and hence use of cultured tissues and cells have increased (Byrd *et al.*, 2003).

The discovery and identification of new antitumor drug with low side effects on immune system has become an essential goal in many studies of immuno-therapies (Xu *et al.*, 2009). With this aim, many attentions have been paid to natural compounds and essential oils from plants.

Infectious diseases are leading cause of death worldwide. Natural products provide unlimited opportunities for new drug leads because of the unmatched availability of chemical diversity. Because of increasing threat of infectious diseases, the need of the hour is to find natural agents with novel mechanism of action. Fruit and vegetable peels are thrown into the environment as agro waste which can be utilized as a source of antimicrobics. It will be economic, eco-friendly and reduce pollution. Here we report the antimicrobial activity of peels essential oils against different microorganisms.

Unlike the immunostimulant, anticancer and antimicrobial agents synthesized by chemical sources, those from natural sources are readily accepted by the consumers. Thus, the development of new immunostimulant, anticancer and antimicrobial agents is a major research opportunity for the researchers at present.

In the, present investigation, we report the immunostimulant, anticancer and antimicrobial properties of peels of three cultivars of M. *indica* fruits that are commonly available and readily consumed in Egypt, and to indicate which of them can become a new source of natural immunostimulant, anticancer and antimicrobial for pharmaceutical industries.

# 2. Materials and methods

## 2.1. Plant material:

Fruits of *M. indica* cultivars; namely zebdeya, hindi and cobaneya were collected at the ripening stage. The plants were authenticated by Prof. Dr. Monir Mohamed Abdelghany, The Herbarium, Botany Department, Faculty of Science, Cairo University. Edible parts of the fruits were removed and fruits peels were frozen until used for essential oil preparation.

## 2.2. Chemicals:

Penicillin, Streptomycin, Amphotericin B, Erythromycin, Gentamycin, (FCS), RPMI 1640, glutamine and HEPS (Sigma, USA), Mueller- Hinton broth (Oxoid, England). All other chemicals and reagents used were of the highest commercially available purity.

#### 2.3. Preparation of essential oils

The fresh mango cultivars peels (1 kg for each cultivar) were cut into small pieces and subjected to hydrodistillation for 5 h, using a Clevenger-type apparatus. Before analysis and biological activity test, the collected oils were dehydrated with anhydrous  $Na_2SO_4$  and preserved at 4°C (Egyptian Pharmacopeia; 2005).

## 2.4. Gas Chromatography-Mass Spectrometry

The mango peels oils were subjected to gas chromatographic-mass spectral analysis on an Agilent system consisting of a model 6890 gas chromatograph, equipped with a model 5973 mass selective detector (EIMS, electron energy, 70 eV), and an Agilent ChemStation data system. The GC column was an HP-5ms fused silica capillary with a DB-5 (5% phenyl methyl polysiloxane) stationary phase, film thickness of 0.25  $\mu$ m, a length of 30 m, and an internal diameter of 0.25 mm. The carrier gas was helium with a flow rate of 1.0 ml/min. Inlet temperature was 200°C and MSD detector temperature was 270°C. The mass spectrometer was operated in electron impact ionization (EI) mode with 70eV energy. The mass range was 50-700 Da and the ion source temperature was 200 °C. The GC oven temperature program was used as follows: 80°C initial temperature, for 2 min.; then programmed at 15°C/min to 270°C and held for 10min.Each sample was dissolved in acetone to give a 1% w/v solution; 1  $\mu$ L injections using a splitless injection technique were used.

Identification of oil components was achieved based on their retention indices (RI, determined with reference to a homologous series of normal alkanes), and by comparison of their mass spectral fragmentation patterns with those reported in the literature (Pino *et al.*, 2005; Ansari *et al.*, 2004; Dzamic *et al.*, 2008; Pandit *et al.*, 2009; Pino *et al.*, 2010) and stored on the MS libraries [NIST 05; Mass Finder database (G1036A, revision D.01.00 and Wiley7 Mass Finder]. The chemical compositions of the essential oils are compiled in Table 1 and Figure 1.

### 2.5. Immunostimulant activity:

Essential oils of *M. indica* fruit peels under investigation were dissolved in Hank's solution in different concentrations (100, 500, 1000, 1500 and 2000  $\mu$ l. ml<sup>-1</sup>). The tested samples were sterilized by filtration through 0.2  $\mu$ m pore size filters and by addition of 10,000  $\mu$ g penicillin and 10,000  $\mu$ g streptomycin antibiotics. Albino mice of either sex (20-22 g) were used for the following:

### 2.5.1. Preparation of murine (mice) spleen cells:

Spleenocytes were prepared according to conventional procedures, from as eptically removed mouse spleens. The cells were washed three times in RPMI 1640 medium and resuspended in RPMI 1640 supplemented with 10% FCS, 2 mM glutamine, 10 mM HEPS, pencillin 100  $\mu$ g ml<sup>-1</sup>, streptomycin 100  $\mu$ g ml<sup>-1</sup> at a final concentration of 3 x 10 cells ml<sup>-1</sup>. Cell viability was evaluated by trypan blue exclusion test.

### 2.5.2. Lymphocyte cell culture:

Primary lymphoid cell culture was performed by isolating lymphocytes directly from mice spleens. The lymphocytes then were grown in a chemically defined growth medium RPMI 1640 supplemented with 10% FCS.

# 2.5.3. Macrophage culture:

Spleen cell suspension was incubated in flat bottomed microtiter plates at 37°C for 7 hours to allow the cells to adhere to the plates then the medium was removed and the adherent cells were washed three times with RPMI 1640. More than 95% adherent cells were macrophage. The cells were cultured with different concentrations of each plant essential oil for 24 hours. The nonspecific immune response of stimulated macrophages and lymphocytes were assayed, by determination of the macrophage migration index and phagocytic index test in which the viable cells were counted using freshly filtered trypan blue stain and haemocytometer slide (Hifnawy *et al.*, 2006).

## 2.5.4. Macrophage Migration Inhibition Index:

Using a 2 ml syringe filled with silicone, grease the migration chambers (Sterilin) around the rim. Place one dab of grease inside the rim to hold the capillary in place. Prepare the essential oil dilutions in suitable RPMI medium containing 10% fetal calf serum (FCS). Spleen macrophages, of albino mice of either sex (20-22 gm), adherent cells in RPMI medium, washed with the same media, suspended in complete RPMI media containing 10% fetal calf serum (FCS), Resuspend the cells in RPMI medium containing 10% fetal calf serum at a suitable final cell concentration ( $2 \times 10^6$ /ml). Suspension was packed into 6 microheamatocrit capillary tubes (Gelman-Hawksley, haematocrit tubes) of uniform diameter (7.5 cm length X 1 .0-1.2 mm i.d.) by capillarity, one end of the capillary was sealed and plug with wax. Centrifuge at 300 rpm for 5 minutes at room temperature. Score the capillaries at the cell-fluid interface using a diamond pen. Break the capillary at the score-line with forceps. Immediately mount one capillary per migration chamber and fill with RPMI medium containing 10% fetal calf serum, add the plant extract dilution to the well. Cover the migration chamber with a cover-slip ensuring an airtight seal and no bubbles. Repeat until all the chambers are filled. Incubate the plates on a completely horizontal surface at  $37^{0}$ C overnight, (15-18 hours). Project the areas of the migrating cells onto plain paper and draw around the outer margin of the migrating fan. Determine the area of migration by planimetry for treated and untreated macrophages. Express the results as the migration inhibition index (MI) determined from:

Macrophage Migration Inhibition Index (MI) =  $\frac{\text{Area of migration from essential oil treated cells}}{\text{Area of migration from untreated cells (control)}}$ 

Macrophage migration index decrease explains the inhibition of migration of macrophages, which in turn causes liberation of cytokines (i.e. immunostimulation). Any essential oil that causes decrease in the macrophage migration index is considered to have immunostimulant activity.

At least three replicate capillaries (1 per chamber) were set up for each test, the test being one dilution of essential oil or culture supernatant or the control (medium and fetal calf serum alone). The results were presented as mean  $\pm$  standard error (S.E.). Student T test was used for the statistical analysis of data. Results with p < 0.01 were considered as statistically significant and were presented in table 2.

### 2.5.5. Phagocytic Index:

Make up a stock solution of Dow latex particles, 1.0  $\mu$ m in diameter (Digby Chemical Services) as follows: Suspend 10  $\mu$ l of latex in 5 ml of Hank's balanced salt solution or Minimum Essential Medium (MEM). Centrifuge 200-300 g for 10-15 minutes. Collect the supernatant and count the number of particles per ml. Adjust to (5-10 x 10<sup>8</sup>/m1) in MEM and store in small aliquots at 4<sup>o</sup>C. Pellet the cells under investigation (macrophages) in a round bottomed plastic tube at 1500 rpm for 10 minutes, decant the supernatant. Add 0.2 ml stock latex and 0.2 ml MEM + 20% FCS. Incubate at 37<sup>o</sup>C for 1-1.5 hours. Wash 3 times at 200 g, and then add the tested concentration of plant extract and incubate for 24 hr. at 37<sup>o</sup>C. Count the number of phagocytosed and non- phagocytosed cells. Divide the number of phagocytosed cells over the non-phagocytosed ones to calculate the treated cells and similarly do that for the control (untreated) cells.

Phagocytic Index = essential oil treated cells / untreated cells.

Phagocytic index increases directly proportional to immunostimulant activity. The results were presented as mean  $\pm$  standard error (S.E.). Student T test was used for the statistical analysis of data. Results with p < 0.01 were considered as statistically significant and were presented in table 3.

Macrophage Migration Inhibition Index (Table 2) and Phagocytic Index (Table 3) were determined relative to the well known immunostimulant drug (*Echinacea purpurea*) root extract as a standard.

## 2.6. Anticacer activity:

### 2.6.1. Cancer cell lines:

Three human adenocarcinoma cell lines; breast adenocarcinoma cell line (MCF-7), colon adenocarcinoma cell line (HCT-116) and liver adenocarcinoma cell line (HEP-G2) were obtained from National Institute of Cancer, Cairo University, Cancer biology department, pharmacology unit, Cairo, Egypt. Cells were routinely cultured in DMEM (Dulbecco's Modified Eagle's Medium), which was supplemented with 10% fetal bovine serum (FBS), 2 mM L-glutamine, containing 100 units/ml penicillin G sodium, 100 units/ml streptomycin sulphate, and 250 mg/ml Amphotericin B.

## 2.6.2. Evaluation of invitro cytotoxic activity of the essential oils on tested cell lines:

MTT assay was performed to determine the cytotoxic property of M. indica cutivars essential oils against MCF-7, HCT-116 and HEP-G2 cell lines (Van Meerloo et al., 2011). Briefly cell lines were seeded in 96-well tissue culture plates. Appropriate concentrations of stock solution (0.5, 5.0, 10.0, 20 µl/ml) were added and incubated for 48 hours at 37°C. Non-treated cells were used as negative control and doxorubicin as positive control. Incubated cultured cell was then subjected to MTT (3-(4,5 Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide, a tetrazole) colorimetric assay. The tetrazolium salt 3-[4,5-dimethylthiazol-2-yl]-2,5diphenyltetrazolium bromide (MTT) is used to determine cell viability in assays of cell proliferation and cytotoxicity. MTT is reduced in metabolically active cells to yield an insoluble purple formazan product. Cells were harvested from maintenance cultures in the exponential phase and counted by a hemocytometer using trypan blue solution. The cell suspensions were dispensed (100µl) in triplicate into 96-well culture plates at optimized concentrations of  $1 \times 10^5$ /well for each cell lines, after a 24 hours recovery period. Assay plates were read using a spectrophotometer at 520 nm. The spectrophotometrical absorbance of the samples was measured using a microplate (ELISA) reader. The cytotoxicity data was standardized by determining absorbance and calculating the correspondent essential oil concentrations.

#### Cell viability (%) = Mean OD/ control OD $\times$ 100

The IC<sub>50</sub> values (concentration of essential oil required to kill 50% of cell population i.e. concentration at which 50% of cells were dead) for colon adenocarcinoma (HCT-116), breast adenocarcinoma (MCF-7) and liver carcinoma (Hep-G2) cell lines are reported as mean $\pm$  S.D. of three independent experiments. IC<sub>50</sub> values that were greater than 30µl/ml considered insignificant, and vice versa. (Table 4)

## 2.7. Antimicrobial activity:

Antimicrobial activity of the essential oils and different cultivars of the *M. indica* was screened using Kirby-Bauer disc diffusion method (Bauer *et al.*, 1966) with slight modification. 100  $\mu$ l of the test bacteria/fungi were grown in 10 ml of fresh media (Mueller-Hinton agar plates (HiMedia) for bacteria and Potato Dextrose Agar plates for fungi (HiMedia)) until they reached a count of approximately 10<sup>8</sup> cells/ml for bacteria and 10<sup>5</sup> cells/ml for fungi. 100  $\mu$ l of microbial suspension was spread onto agar plates corresponding to the broth in which they were maintained. Isolated colonies of each organism that might be playing a pathogenic role should be selected from primary agar plates and tested for susceptibility by disc diffusion method.

Plates inoculated with filamentous fungi as *Aspergillus flavus* Link (ATCC 204304) at 25°C for 48-72 hours; Gram-positive bacteria as *Staphylococcus aureus* (ATCC 12600) and *Bacillus subtilis* (ATCC 6051); Gram-negative bacteria *Escherichia coli* (ATCC 11775) and *Pseudomonas aeuroginosa* (ATCC 10145) they were incubated at 35-37° C for 24-48 hours and yeast as *Candida albicans* (ATCC 26555) incubated at 30°C for 24-48 hours. Then the diameters of the inhibition zones were measured in millimeters.

DMSO with a concentration up to 2% was used to dissolve the essential oils. Filter paper discs (6 mm in diameter) saturated with  $20\mu$ L of the tested essential oils and extracts or DMSO (solvent control) were placed on the surface of the inoculated plates. The plates were incubated at 37°C for 24 h. The diameter of the inhibition zone was measured in millimeter with slipping calipers of the National Committee for Clinical Laboratory Standards., and was recorded as mean  $\pm$  SD of a triplicate experiment. Standard discs of Gentamycin (10µg, Oxoid, UK, Antibacterial agent), Amphotericin B (5µg, Sigma Chemical Co., St. Louis, Mo., Antifungal agent) served as positive controls for antimicrobial activity but filter discs impregnated with 10 µl of solvent (DMSO) were used as a negative control. Results were shown in table 5.

Determination of the Minimal Inhibitory Concentration (MIC) was carried out by a serial broth dilution method described by (NCCLS, 1993). Briefly; The essential oils and extracts were diluted in DMSO and were added to 5 ml sterile Muller Hinton Broth tubes to give different concentrations  $(1.0 - 50.0 \,\mu\text{L/ml})$ . Later, 0.5 ml of the exponentially growing microbial broth culture of the strains that were sensitive by disc diffusion test was inoculated into respective test tubes. Another set of tubes containing only the growth medium without DMSO (control) and with DMSO (solvent control up to 2% in the culture media) showed no inhibitions in preliminary studies whereas Gentamicin was used as a positive control for bacterial strains, Amphotericin B was used as a positive control for fungi and each of the test strains was set up separately. In 96-well plates organisms, at a concentration of approximately  $1.5 \times 10^8$  colony forming units (CFU)/ml, were added to each well. The tubes were incubated at  $37^{\circ}$ C for 24 h and the growth was measured by measuring optical density at 520 nm using spectrophotometer comparing the sample readout with the non inoculated nutrient broth. The MIC was regarded as the lowest concentration (without turbidity) of the essential oil that inhibited the growth of bacteria or fungi. The plates were done in triplicate. Antimicrobial MIC results are listed in table 6.

# 3. Statistical analysis:

Statistical analysis was performed using SPSS (statistical package of social sciences, version 16). Student T test was used for the statistical analysis of data. Statistical significance was acceptable to a level of p < 0.01.

# 4. Results and discussion:

## 4.1. Essential oil analysis:

Two hundred and forty compounds were identified, of which eighty five compounds were found for the first time in mango fruit. Terpene hydrocarbons were the major volatiles of all cultivars. The dominant terpenes in the 3 mango cultivars were  $\delta$ -3-carene (2.784 - 14.904%),  $\alpha$ -terpinolene (4.825 - 15.879%),  $\alpha$ -copaene (2.281 - 8.097%), and caryophyllene (3.390 - 10.897%), ethyl tetradecanoate (0.693-1.260%), 2-heptadecanone (0.895 - 5.144 %), hexadecanoic acid (1.215 - 4.612%) and ethyl hexadecanoate (0.543 - 4.029%) that could considered as marker phytoconstituents of mango species. Some components were found only in 2 cultivars in an appreciable amounts as menth-1-ene-4,8-Diol (3.079- 4.570%), α-humulene (2.183 – 5.819%), caryophyllene oxide (2.897- 4.901 %), tetradecanoic acid (1.168 - 1.384%),1-hexadecanol (4.040 - 10.025 %). Also some components were found in relatively high amounts as p-cymene (13.390%), 1-(1, 1-dimethylethyl)-3-methyl benzene (1.203%), pinan-2-ol (1.081%), menthol (0.450%), cis-calamenene (0.674%), methyl hexdecanoate (0.145%), nonacosane (1.074%) in *M. indica* cultivar Zebdeyia and pentanal (0.111%), 2-methylpropanoic acid (0.890%), cyclohexanol (0.190%), 2,5-hexanedione 0.432%), hexanoic acid (0.230%), 1-(1, 1-dimethylethyl)-4methyl benzene (0.513%), 1-(2-methylphenyl) ethanone (26.214%), methylchavicol (0.131%), pulegone (0.730%), 2,6,6-trimamethyl-1-cyclohexene-1-acetaldehyde (0.111%),  $\alpha$ -terpinene -7-al (0.890%) and transcarvyl acetate (0.151%), geranyl acetate (0.121%),  $\alpha$ -cedrene (0.211%), 9-epi-(E)-caryophyllene (0.112%),  $\gamma$ muurolene (0.311%), (E)- $\beta$ -ionone (0.102%),  $\delta$ -decalactone (0.190%), pentadecane (0.441%), Tridecanal

# Table1. Identified constituents of essential oils of Mangifera indica cultivars

No.         Compone         Rt         D         Ref         D         Ref         M. L.         M. L.	No.	Compound	KI	ID		Area %	
1       acetaldehyde       528       A       t       0.124       t         2       1-propanol       568       A       0.124       t          4       1-panten-3-ol       673       A       0.029        t         5       1-panten-3-one*       678       A       0.029        t         6       2.3-pentanedione*       096       A        0.111          7       pentanal       698       A        0.111          9       ethyl propanoate       714       A       0.030       t       0.037         11       (E)-3-penten-2-one       735       A       0.103       t       0.024         12       ethyl z-methylopanoate       785       A       t       t       1.032         15       2-methylpropanoic acid*       790       A      t       t       1.032         16       butanoate       802       A       0.234       0.023       0.035         16       butanoate       847       A       0.766       0.890          17       ethyl 3-bydroxy butanoate*       858       A	INO.	Compound	KI	ш	М 7		
2         1-propanol         568         Λ         0.124         t            4         1-panten-3-one*         6073         Λ         0.029          t           5         1-panten-3-one*         678         Λ         0.020         t            6         2.3-pentancione*         698         Λ          0.174           7         pentanal         698         Λ          0.174           8         3-pentanone         700         Λ         0.135         t            9         ethyl propanote         732         Λ         0.031         t            10         methyl methacylate*         732         Λ         0.031         t         0.032           11         (f)-3-penten-2-one         755         Λ         0.104         t         0.032           12        ethyl 2-methylpropanotac id*         783         Λ         t         t         t         1.032           13        ethyl 2-methylpropanotac id*         783         Λ         t         t            14        penthylerathydrofuran-3-one         804         Λ        <	1	acetaldehyde	528	Δ			
3         efnyl actate         605         A          0.019            4         I-panten-3-one*         673         A         0.029          1           6         2,3-pentancione*         678         A         0.102         t            6         2,3-pentancione*         696         A          0.111            7         pentanal         698         A          0.111            9         ethyl propanote         713         A         0.033         t          0.024           11         (E)-3-penten-2-one         733         A         1         0.024          0.024           12         ethyl z-methylpropanote         785         A         t         0.024           14         2-presting/propanote acid*         785         A         t         1.032           14         butanote acid         700         A          1.032           14         butanote acid         807         A         0.217            15         z-methylpropanote         854         A <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>							
4         1-panten-3-one*         673         A         0.029          t           5         1-panten-3-one*         678         A          0.174           7         pentanal         698         A          0.174           7         pentanal         698         A          0.174           7         pentanal         698         A          0.174           8         3-pentanone         732         A         0.030             10         methyl propanote         735         A         0.103         1         0.032           13         3-methyl-2-buten-1-01         778         A         t          0.032           14         2.4-pentanctione         785         A         1.0         0.032         0.032           15         2-methylpropanotic acid         790         A          t         1.032           16         butanote         802         A         0.234         0.023         0.031           16         butanote         804         A          1.032           16         butanote							
5         l-pantem-3-one*         678         A         0.102         t            6         2,3-pentanadione*         696         A          0.174           7         pentanal         698         A          0.111            8         3-pentanone         700         A         0.103         t         0.021           9         ethyl propanoate         715         A         0.104         t         0.024           10         methyl methacrylate*         735         A         t         t          0.024           11         (E)3-penten-2-one         735         A         t         t          0.023           2         a-methylp-buten-1-ol         778         A         t          0.023         0.035           16         butanoate         785         A         t         t         1.032         0.102            16         butanoate         802         A         0.767         0.809          t           17         ethyl I-butanoate         802         A         0.768         0.989         0.327 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>							
6       2,3-pentanedione*       696       A        -0.174         7       pentanal       698       A        0.111          8       3-pentanone       700       A       0.135       t          9       ethyl propanoate       732       A       0.103       t       0.037         11       (E)-3-penten-2-one       735       A       0.104       t       0.023         12       ethyl 2-methylpropanoic acid*       785       A       t        0.023         13       3-methyl-2-buten-1-ol       778       A       t        0.032         14       2.4-pentanedione       785       A       t       0.023       0.035         15       2-methylpropanoic acid*       785       A       t       1.032         16       butanoic acid       790       A        t           16       butanoic acid       804       A       0.212							ι
7       penfand       698       A        0.111          8       3-pentanone       700       A       0.135       I          9       ethyl propanoate       714       A       0.050           10       methyl methacrylate*       732       A       0.031       I       0.032         11       (E)-3-penten-2-one       735       A       1.0       0.032         0.032         12       ethyl 2-methylpropanoate       785       A       I       0.032       0.032         12       2-methylpropanoic acid*       785       A       I       0.023       0.033         16       butanoate       802       A       0.241       0.023       0.032         17       ethyl butanoate       802       A       0.67       0.890          10       2-firtfral       303       A       0.231       0.212          10       12-hextanol       854       A       0.670       0.890           11       -1-bxanol       867       A       0.223       0.021							0.174
8         3-pentanone         700         A         0.135         t            9         ethyl propanoate         714         A         0.050             9         ethyl propanoate         735         A         0.031         t         0.037           11         (E)-3-penten-2-one         735         A         0.104         t         0.023           12         ethyl 2-methylpropanoite         778         A         t          0.032           14         2.4-pentancdione         785         A         t         0.023         0.033           15         2-methylpropanoite acid*         788         A         t          t         1.032           16         butanote acid         700         A          t         1.023         0.032         0.032           16         butanoate         804         A         0.234         0.023         0.032          -           19         2-furfaral         800         A         0.123         t         t         1.022           21         (E)-2-bexenal         857         A         0.232         0.021							
9ethyl propanoate714 $\lambda$ $0.050$ $\cdots$ $\cdots$ 10methyl methacrylate*732 $\lambda$ $0.031$ t $0.037$ 11(E).3-penten-2-one735 $\lambda$ $0.104$ t $0.032$ 12ethyl 2-methylpropanoate755 $\lambda$ $0.104$ t $0.032$ 133-methylpropanoic aid*785 $\lambda$ t $0.032$ $0.035$ 142.4-pentancdione785 $\lambda$ t $0.890$ $-$ 152-methylptoranoic aid*785 $\lambda$ t $0.231$ $0.023$ $0.031$ 17ethyl butanoate802 $\lambda$ $0.214$ $0.212$ $-$ 192-furfural830 $\Lambda$ $0.211$ $0.212$ $-$ 192-furfural830 $\Lambda$ $0.223$ $0.021$ $-$ 10(E).2-hexenal887 $\Lambda$ $0.123$ tt21(E).2-hexenal886 $\Lambda$ t $0.190$ $-$ 22veptonone889 $\Lambda$ $-$ t $1.062$ 231-hexanol886 $\Lambda$ t $0.023$ $0.034$ 231-hexanol886 $\Lambda$ t $0.023$ $0.327$ 244-heptanone*895 $\Lambda$ $0.224$ $0.223$ $0.034$ 27cyclohexanone895 $\Lambda$ $0.232$ $0.212$ $-$ 262-heptanone895 $\Lambda$ $0.322$ $0.212$ $-$ 27cyclohexanone933		-					
10         methyl methacrylate*         732         A         0.103         t         0.037           11         (E)-3-penten-2-one         735         A         0.203             ethyl 2-methylpropanoate         755         A         0.104         t         0.024           13         3-methyl-2-butten-1-ol         778         A         t          0.032           14         2.4-pentanedione         783         A         t         0.032         0.032           16         butanoic acid         790         A          t         1.032           16         butanoic acid         790         A          t         1.032           17         ethyl 3-methyl butanoate         847         A         0.067         0.890            19         2-furfural         854         A         0.123         t         t         t           21         methyl 3-hydroxy butanoate*         858         A         0.123         t         t           22         nethyl 3-hydroxy butanoate         869         A         t         t            21         methyl 3-bydroxy butanoate							
11         (E)-3-penten-2-one         755         A         0.203            12         ethyl 2-methylpropanoate         755         A         0.104         t         0.024           13         3-methyl-2-buten-1-ol         778         A         t         t          0.032           14         2,4-pentancdione         783         A         t         t          0.032           15         2-methylpropanoic acid*         780         A          t            16         butanoic acid         700         A          t         1.032           17         ethyl 3-methyltotanylorobutanoate         802         A         0.234         0.023         0.035           20         ethyl 3-methyltotanoate         804         A          t            2         -furfural         830         A         0.231         0.212            21         (E)-2-hexenal         857         A         0.233         0.021            24         4-beptanone         889         A         t         t         1.062           27         cyclohexanone							0.037
12       ethyl 2-methylpropanote       755       A       0.104       t       0.024         13       3-methyl-2-buten-1-ol       778       A       t							
13       3-methyl-2-buten1-ol       778       A       t       -       0.032         14       2,4-pentanedione       783       A       t       t       -         15       2-methylpropanoic acid*       780       A       t       t       -         15       2-methylptopanoic acid*       790       A       -       t       1.032         16       butanoic acid       700       A       -       t       -       1.032         17       ethyl hutanoate       802       A       0.234       0.023       0.035         18       2-methylletrahydrofuran-3-one       804       A       -       t       -         19       2-furfural       830       A       0.321       0.212       -       -         20       ethyl 3-methyl butanoate       854       A       0.768       0.098       0.321       -       t         21       1-bexanol       867       A       0.223       0.021       -       -         25       cyclohexanon       899       A       0.321       0.212       -       -         25       cyclohexanone       899       A       0.321       0.212							
14       2.4-pentanedione       783       A       t       t          15       2-methylpropanoic acid*       785       A       t       0.890          15       butanocia acid       790       A        t       1.032         21       ethyl butanoate       802       A       0.231       0.023       0.035         18       2-methyltetrahydrofuran-3-one       804       A        t          20       ethyl 3-methyl butanoate       847       A       0.067       0.890          21       (E)-2-hexenal       854       A       0.123       t       t          21       methyl 3-hydroxy butanoate*       858       A       0.123       t       t          25       cyclohexanone       897       A       t       t           26       2-heptanone       895       A        t           29       heptanal       899       A       0.232       0.212           20       santolinatriene*       908       B       0.017       0.890							
15       2-methylpropanoic acid*       785       A       t       0.890          16       butanoic acid       790       A        t       1.032         16       butanoic acid       700       A        t       1.032         17       ethyl butanoate       802       A       0.234       0.023       0.035         2-methyltertahydrofuran-3-one       804       A        t          19       2-furfural       830       A       0.321       0.212          20       ethyl 3-hydroxy butanoate*       854       A       0.768       0.098       0.327         21       methyl brytonoy butanoate*       857       A       0.123       t       t          23       1-hexanol       867       A       t       t           25       cyclohexanone       895       A       0.234       0.023       0.034         29       heptanal       896       A        t          20       heptanal       896       A        t          30       santolinatrine*       90							
16butanole acid790At1.03217ethyl butanoate802A0.2340.0230.035182-methyltetralydrofuran-3-one804At192-furfural830A0.3210.21220ethyl 3-methyl butanoate847A0.0670.89021(E)-2-hexenal854A0.7680.0980.32721methyl 3-hydroxy butanoate*856Attt231-hexanol867A0.2330.021244-heptanone*869At25cyclohexanol886At0.0230.034262-heptanone899At27cyclohexanone899At28propyl butanoate896At29heptanal899A0.3220.21331butyl propanoate*910A0.4680.0980.32732tricyclene923B0.1170.432tt31methyl hexanoate924A0.22133methyl hexanoate933A5.579372-methylene cyclohexanol*933A34d -hujene93							
17       ethyl butanoate       802       A       0.234       0.035         18       2-methyltertahydrofuran-3-one       804       A							
18         2-methyltetrahydrofuran-3-one         804         A          t            19         2-furfural         830         A         0.321         0.212            19         2-furfural         830         A         0.321         0.212            21         (E)-2-hexenal         847         A         0.067         0.890            21         1-hexanol         867         A         0.223         0.021            24         4-heptanone*         869         A         t         t            25         cyclohexanol         886         A         t         0.190            25         cyclohexanone         895         A          t            26         2-heptanone         896         A          t            30         santolinatriene*         890         A         0.322         0.212            30         santolinatriene*         910         A         0.480             31         butyl propanoate*         910         A         0.221							
19       2-furfural       830       A       0.321       0.212          20       ethyl 3-methyl butanoate       847       A       0.067       0.890          21       (E)-2-bexenal       854       A       0.076       0.890          22       methyl 3-hydroxy butanoate*       858       A       0.123       t       t         23       1-bexanol       867       A       0.223       0.021          24       4-beptanone*       866       A       t       0.190          25       cyclohexanone       895       A       0.234       0.023       0.034         27       cyclohexanone       895       A       0.322       0.212          30       santolinatriene*       908       B       0.017       0.890          31       butyl propanoate*       910       A       0.468       0.098       0.327         32       tricyclene       923       B       0.132       t       t         33       A        0.432           35       2,5-hexanedione*       933       A      <							
20ethyl 3-methyl butanoate847A $0.067$ $0.821$ $0.820$ 21(E)-2-hexenal854A $0.768$ $0.098$ $0.327$ 22methyl 3-hydroxy butanoate*857A $0.123$ tt211-hexanol867A $0.223$ $0.021$ 244-heptanone*869Attt25cyclohexanol886At $0.023$ $0.034$ 262-heptanone889At $1.062$ 27cyclohexanone895A $0.234$ $0.023$ $0.034$ 28propyl butanoate896At30santolinatriene*908B $0.017$ $0.890$ 31butyl propanoate*910A $0.468$ $0.098$ $0.327$ 32tricyclene923B $0.132$ tt33methyl hexanoate923A $$ $$ $5.579$ 372-methylene cyclohexanol*933A $$ $$ $5.579$ 372-methylene cyclohexanol*941B $0.835$ $$ $$ 38ethyl-3-hydroxy butanoate*962B $0.498$ $0.098$ $0.327$ 40cthyl-2-furfural964A $0.176$ tt42sabinene976B $0.280$ $$ $$ 43 $\beta$ -pinene991A <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>							
21       (E)-2-hexenal       854       A       0.768       0.098       0.327         22       methyl 3-hydroxy butanoate*       858       A       0.123       t       t         23       1-hexanol       867       A       0.223       0.021          24       4-heptanone*       869       A       t       0.190          25       cyclohexanol       886       A       t       0.190          26       2-heptanone       895       A       0.234       0.023       0.034         26       2-heptanone       895       A       0.322       0.212          27       cyclohexanone       895       A       0.322       0.212          29       heptanal       899       A       0.322       0.212          20       satolinatriene*       900       A       0.468       0.098       0.327         31       butyl propanoate*       910       A       0.468       0.098       0.327         32       tricyclene       923       A         5.579         32       .netnee       933       A							
22methyl 3-hydroxy butanoate*858A0.123tt231-bexanol867A0.2230.021244-heptanone*867A0.2230.02125cyclohexanol886At0.190262-heptanone889At1.06227cyclohexanone895A0.2340.0230.03428propyl butanoate896At29heptanal899A0.3220.21230santolinatriene*908B0.0170.89031butyl propanoate*910A0.4680.0980.32731methyl hexanoate924A0.2010.045t34α -thujene931At352.5-hexanedione*933A5.579372-methylene cyclohexanol*941B0.83538ethyl-3-hydroxy butanoate*945A0.0220.21239camphene933A1.7ttt41s-binene976B0.2880.065tt42sabinene976B0.2880.065tt43β-pinene996A44hexanoic acid981A <td< td=""><td></td><td>• •</td><td></td><td></td><td></td><td></td><td></td></td<>		• •					
231-hexanol867A0.2230.021244-heptanone*869Att25cyclohexanol886At0.0230.034262-heptanone895A0.2340.0230.03427cyclohexanone896At1.06227cyclohexanone896At29heptanal899A0.3220.21230santolinatriene*908B0.0170.89031butyl propanoate*910A0.4680.0980.32732tricyclene923B0.132tt33methyl hexanoate924A0.2010.43236α-pinene931At36α-pinene939A5.579372-methylene cyclohexanol*941B0.83538ethyl-3-hydroxy butanoate*945A0.0220.21239camphene953A0.0370.89040ethyl-2,3-epoxy butanoate*962B0.4980.0980.327415-methyl-2-furfural964A0.176tt42sabinene976B0.2880.665t43β-pinene995A0.121							
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262-heptanone800A-t1.0627cyclohexanone895A0.2340.0230.03428propyl butanoate896At-9heptanal899A0.3220.212-30santolinatriene*908B0.0170.89031butyl propanoate*910A0.4680.0980.32732tricyclene923B0.132tt33methyl hexanoate924A0.2010.045t34α -thujene931At352,5-hexanedione*933A0.43236α-pinene939A5.579372-methylene cyclohexanol*941B0.83538ethyl-3-hydroxy butanoate*945A0.0220.21239camphene953A0.0370.89040ethyl-2-furfural964A0.76ttt415-methyl-2-furfural964A0.76ttt43β-pinene976B0.2880.065t144hexanoic acid981At0.37045β-myrcene995A0.12166butyl butanoate994A							
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28propyl butanoate896At29heptanal899A0.3220.21230santolinatriene*908B0.0170.89031butyl propanoate*910A0.4680.0980.32732tricyclene923B0.132tt33methyl hexanoate924A0.2010.045t34α-thujene931At352,5-hexanedione*933A0.43236α-pinene939A5.579372-methylene cyclohexanol*941B0.83538ethyl-3-hydroxy butanoate*945A0.0220.21239camphene953A0.0370.89040ethyl-2,2-sepoxy butanoate*964A0.176tt42sabinene976B0.2880.065t43β-pinene980At44hexanoic acid981At0.370472-carene991A0.4152.82046butyl butanoate994At0.370472-carene995A0.12148ethyl hexanoate996A0.042							
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30santolinatriene*908B0.0170.89031butyl propanoate*910A0.4680.0980.32732tricyclene923B0.132tt33methyl hexanoate924A0.2010.045t34 $\alpha$ -thujene931At352,5-hexanedione*933A0.43236 $\alpha$ -pinene939A5.579372-methylene cyclohexanol*941B0.83538ethyl-3-hydroxy butanoate*945A0.0220.21239camphene953A0.0370.88040ethyl-2,3-epoxy butanoate*962B0.4980.0980.327415-methyl-2-furfural964A0.176tt42sabinene976B0.2880.065t43β-pinene980At44hexanoic acid981A0.23045β-myrcene995A46butyl butanoate996A0.042472-carene995A48ethyl hexanoate996A0.2120.0980.21150δ-3-carene1011A14.9042.784<							
31butyl propanoate*910A0.4680.0980.32732tricyclene923B0.132tt33methyl hexanoate924A0.2010.045t34 $\alpha$ -thujene931At352,5-hexanedione*933A5.57936 $\alpha$ -pinene939A5.579372-methylene cyclohexanol*941B0.83538ethyl-3-hydroxy butanoate*945A0.0220.21239camphene953A0.0370.89040ethyl-2,3-epoxy butanoate*962B0.4980.0980.327415-methyl-2-furfural964A0.176tt42sabinene976B0.2880.065t43 $\beta$ -pinene980At44hexanoit acid981A0.12145 $\beta$ -myrcene994At0.370472-carene995A0.12148ethyl hexanoate996A0.04249 $\alpha$ -phellandrene1015A0.2120.0980.21150 $\delta$ -3-carene1016A0.1210.011511,4-cineole*1016A1.3390<							
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33methyl hexanoate924A0.2010.045t34 $\alpha$ -thujene931At352,5-hexanedione*933A0.43236 $\alpha$ -pinene939A5.579372-methylene cyclohexanol*941B0.83538ethyl-3-hydroxy butanoate*945A0.0220.21239camphene953A0.0370.89040ethyl-2,3-epoxy butanoate*962B0.4980.0980.327415-methyl-2-furfural964A0.176tt42sabinene976B0.2880.065t43β-pinene980At44hexanoic acid981A2.82045β-myrcene991A0.4152.82046butyl butanoate994At0.370472-carene995A0.12148ethyl hexanoate996A0.04249 $\alpha$ -phellandrene1005A0.1210.01150δ-3-carene1011A14.9042.78413.583511,4-cineole*1016A0.1210.01152 $\alpha$ -terpinene1026A13.390							
34α -thujene931At352,5-hexanedione*933A0.43236α-pinene939A5.579372-methylene cyclohexanol*941B0.83538ethyl-3-hydroxy butanoate*945A0.0220.21239camphene953A0.0370.89040ethyl-2,3-epoxy butanoate*962B0.4980.0980.327415-methyl-2-furfural964A0.176tt42sabinene976B0.2880.065t43β-pinene980At44hexanoic acid981A0.23045β-myrcene991A0.4152.82046butyl butanoate994At0.370472-carene995A0.12148ethyl hexanoate996A0.04249α-phellandrene1005A0.1210.01150δ-3-carene1011A14.9042.78413.583511,4-cincole*1016A0.1210.01152α-terpinene1026A13.39054limonene1031At5.775 <t< td=""><td></td><td>,</td><td></td><td></td><td></td><td></td><td></td></t<>		,					
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372-methylene cyclohexanol*941B0.83538ethyl-3-hydroxy butanoate*945A0.0220.21239camphene953A0.0370.89040ethyl-2,3-epoxy butanoate*962B0.4980.0980.327415-methyl-2-furfural964A0.176tt42sabinene976B0.2880.065t43β-pinene980At44hexanoic acid981A0.23045β-myrcene991A0.4152.82046butyl butanoate994At0.370472-carene995A0.12148ethyl hexanoate996A0.04249α-phellandrene1005A0.2120.0980.21150δ-3-carene1011A14.9042.78413.583511,4-cineole*1016A0.1210.01152α-terpinene1026A13.39054limonene1031At5.575551,8-cineole1032At56(E)-β-ocimene1062A0.2150.130582,5-dimethyl-4-methoxy-3(2H) furanone1065A<							
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39camphene953A0.0370.89040ethyl- 2,3-epoxy butanoate*962B0.4980.0980.327415-methyl-2-furfural964A0.176tt42sabinene976B0.2880.065t43β-pinene980At44hexanoic acid981A0.23045β-myrcene991A0.4152.82046butyl butanoate994At0.370472-carene995A0.12148ethyl hexanoate996A0.04249α-phellandrene1005A0.2120.0980.21150δ-3-carene1011A14.9042.78413.583511,4-cineole*1016A0.1210.01152α-terpinene1018A0.21653p-cymene1026A13.39054limonene1031At5.575551,8-cineole1032At56(E)-β-ocimene1065At0.12161β-terpinene1067A0.04257γ-terpinene1066At0.12159acetophen							
40ethyl- 2,3-epoxy butanoate*962B0.4980.0980.327415-methyl-2-furfural964A0.176ttt42sabinene976B0.2880.065t43β-pinene980At44hexanoic acid981A0.23045β-myrcene991A0.4152.82046butyl butanoate994At0.370472-carene995A0.12148ethyl hexanoate996A0.04249α-phellandrene1005A0.2120.0980.21150δ-3-carene1011A14.9042.78413.583511,4-cineole*1016A0.1210.01152α-terpinene1018A0.21653p-cymene1026A13.39054limonene1031A551,8-cineole1032At56(E)-β-ocimene1060A0.2150.13057γ-terpinene1065At0.070582,5-dimethyl-4-methoxy-3(2H) furanone1065A61β-terpinene1067A0.042 <trr< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></trr<>							
415-methyl-2-furfural964A0.176tt42sabinene976B0.2880.065t43β-pinene980At44hexanoic acid981A0.23045β-myrcene991A0.4152.82046butyl butanoate994At0.370472-carene995A0.12148ethyl hexanoate996A0.04249α-phellandrene1005A0.2120.0980.21150δ-3-carene1011A14.9042.78413.583511,4-cineole*1016A0.1210.01152α-terpinene1018At0.21653p-cymene1026A13.39054limonene1031At5.575551,8-cineole1032At56(E)-β-ocimene1062A0.2150.130582,5-dimethyl-4-methoxy-3(2H) furanone1065At0.07059acetophenone1067A0.04261β-terpinene1067A0.04261β-terpinene1067A0.042 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>							
42sabinene976B0.2880.065t43β-pinene980At44hexanoic acid981A0.23045β-myrcene991A0.4152.82046butyl butanoate994At0.370472-carene995A0.12148ethyl hexanoate996A0.04249α-phellandrene1005A0.2120.0980.21150δ-3-carene1011A14.9042.78413.583511,4-cineole*1016A0.1210.01152α-terpinene1016A0.1210.01153p-cymene1026A13.39054limonene1031At5.575551,8-cineole1032At56(E)-β-ocimene1065A0.13057 $\gamma$ -terpinene1065At0.070582,5-dimethyl-4-methoxy-3(2H) furanone1065A0.12160o-tolualdehyde*1067A0.04261β-terpinene1071B0.741611-(1, 1-dimethylethyl)-3-methyl benzene1072B1.203-						0.098	0.327
43β-pinene980At44hexanoic acid981A0.23045β-myrcene991A0.4152.82046butyl butanoate994At0.370472-carene995A0.12148ethyl hexanoate996A0.04249α-phellandrene1005A0.2120.0980.21150δ-3-carene1011A14.9042.78413.583511,4-cineole*1016A0.1210.01152α-terpinene1018A0.21653p-cymene1026A13.39054limonene1031At5.575551,8-cineole1032At56(E)-β-ocimene1050B0.13057 $\gamma$ -terpinene1065At0.07059acetophenone1066A0.12160o-tolualdehyde*1067A0.04261 $\beta$ -terpinene1071B0.741611-(1, 1-dimethylethyl)-3-methyl benzene1073At63dihydromyrecenol1073At0.011 <td></td> <td>-</td> <td></td> <td></td> <td></td> <td>t</td> <td></td>		-				t	
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472-carene995A0.12148ethyl hexanoate996A0.04249 $\alpha$ -phellandrene1005A0.2120.0980.21150 $\delta$ -3-carene1011A14.9042.78413.583511,4-cineole*1016A0.1210.01152 $\alpha$ -terpinene1018A0.21653p-cymene1026A13.39054limonene1031At5.575551,8-cineole1032At56(E)-\beta-ocimene1050B0.03057 $\gamma$ -terpinene1062A0.2150.130582,5-dimethyl-4-methoxy-3(2H) furanone1065At0.07059acetophenone1066A0.12160o-tolualdehyde*1067A0.04261 $\beta$ -terpinene1071B0.741611-(1, 1-dimethylethyl)-3-methyl benzene1072B1.20363dihydromyrecenol1073At0.011							
48ethyl hexanoate996A $0.042$ $$ $$ 49 $\alpha$ -phellandrene1005A $0.212$ $0.098$ $0.211$ 50 $\delta$ -3-carene1011A $14.904$ $2.784$ $13.583$ 51 $1,4$ -cineole*1016A $0.121$ $0.011$ $$ 52 $\alpha$ -terpinene1018A $$ $$ $0.216$ 53p-cymene1026A $13.390$ $$ $$ 54limonene1031A $$ t $5.575$ 55 $1,8$ -cineole1032At $$ $$ 56(E)- $\beta$ -ocimene1050B $$ $0.030$ $$ 57 $\gamma$ -terpinene1062A $0.215$ $$ $0.130$ 58 $2,5$ -dimethyl-4-methoxy-3(2H) furanone1065A $$ t $0.070$ 59acetophenone1066A $$ $$ $0.121$ 60 $o$ -tolualdehyde*1067A $0.042$ $$ $$ 61 $\beta$ -terpinene1071B $$ $$ $0.741$ 611-(1, 1-dimethylethyl)-3-methyl benzene1072B $1.203$ $$ $$ 63dihydromyrecenol1073At $$ $0.011$		•					
49 $a$ -phellandrene1005A0.2120.0980.21150 $\delta$ -3-carene1011A14.9042.78413.583511,4-cineole*1016A0.1210.01152 $a$ -terpinene1018A0.21653p-cymene1026A13.39054limonene1031At5.575551,8-cineole1032At56(E)- $\beta$ -ocimene1050B0.03057 $\gamma$ -terpinene1062A0.2150.130582,5-dimethyl-4-methoxy-3(2H) furanone1065At0.07059acetophenone1066A0.12160o-tolualdehyde*1067A0.04261 $\beta$ -terpinene1071B0.741611-(1, 1-dimethylethyl)-3-methyl benzene1072B1.20363dihydromyrecenol1073At0.011							
$50$ $\delta$ -3-carene1011A14.9042.78413.583 $51$ 1,4-cineole*1016A0.1210.011 $52$ $\alpha$ -terpinene1018A0.216 $53$ p-cymene1026A13.390 $54$ limonene1031At5.575 $55$ 1,8-cineole1032At $56$ (E)- $\beta$ -ocimene1050B0.030 $57$ $\gamma$ -terpinene1062A0.2150.130 $58$ 2,5-dimethyl-4-methoxy-3(2H) furanone1065At0.070 $59$ acetophenone1066A0.121 $60$ o-tolualdehyde*1067A0.042 $61$ $\beta$ -terpinene1071B0.741 $61$ 1-(1, 1-dimethylethyl)-3-methyl benzene1072B1.203 $63$ dihydromyrecenol1073At0.011							
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52 $\alpha$ -terpinene1018A0.21653p-cymene1026A13.39054limonene1031At5.575551,8-cineole1032At56(E)- $\beta$ -ocimene1050B0.03057 $\gamma$ -terpinene1062A0.2150.130582,5-dimethyl-4-methoxy-3(2H) furanone1065At0.07059acetophenone1066A0.12160o-tolualdehyde*1067A0.04261 $\beta$ -terpinene1071B0.741611-(1, 1-dimethylethyl)-3-methyl benzene1072B1.20363dihydromyrecenol1073At0.011							
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54limonene1031At5.575551,8-cineole1032At56(E)- $\beta$ -ocimene1050B0.03057 $\gamma$ -terpinene1062A0.2150.130582,5-dimethyl-4-methoxy-3(2H) furanone1065At0.07059acetophenone1066A0.12160o-tolualdehyde*1067A0.04261 $\beta$ -terpinene1071B0.741611-(1, 1-dimethylethyl)-3-methyl benzene1072B1.20363dihydromyrecenol1073At0.011							
551,8-cineole1032At56(E)- $\beta$ -ocimene1050B0.03057 $\gamma$ -terpinene1062A0.2150.130582,5-dimethyl-4-methoxy-3(2H) furanone1065At0.07059acetophenone1066A0.12160o-tolualdehyde*1067A0.04261 $\beta$ -terpinene1071B0.741611-(1, 1-dimethylethyl)-3-methyl benzene1072B1.20363dihydromyrecenol1073At0.011							
56(E)- $\beta$ -ocimene1050 B0.03057 $\gamma$ -terpinene1062 A0.2150.130582,5-dimethyl-4-methoxy-3(2H) furanone1065 At0.07059acetophenone1066 A0.12160o-tolualdehyde*1067 A0.04261 $\beta$ -terpinene1071 B0.741611-(1, 1-dimethylethyl)-3-methyl benzene1072 B1.20363dihydromyrecenol1073 At0.011							
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61β-terpinene1071 B0.741611-(1, 1-dimethylethyl)-3-methyl benzene1072 B1.20363dihydromyrecenol1073 At0.011							
61       1-(1, 1-dimethylethyl)-3-methyl benzene       1072       B       1.203           63       dihydromyrecenol       1073       A       t        0.011							
63 dihydromyrecenol 1073 A t 0.011							
64 1-(1, 1-dimethylethyl)-4-methyl benzene 1075 C 0.513							
	64	1-(1, 1-dimethylethyl)-4-methyl benzene	1075	С		0.513	

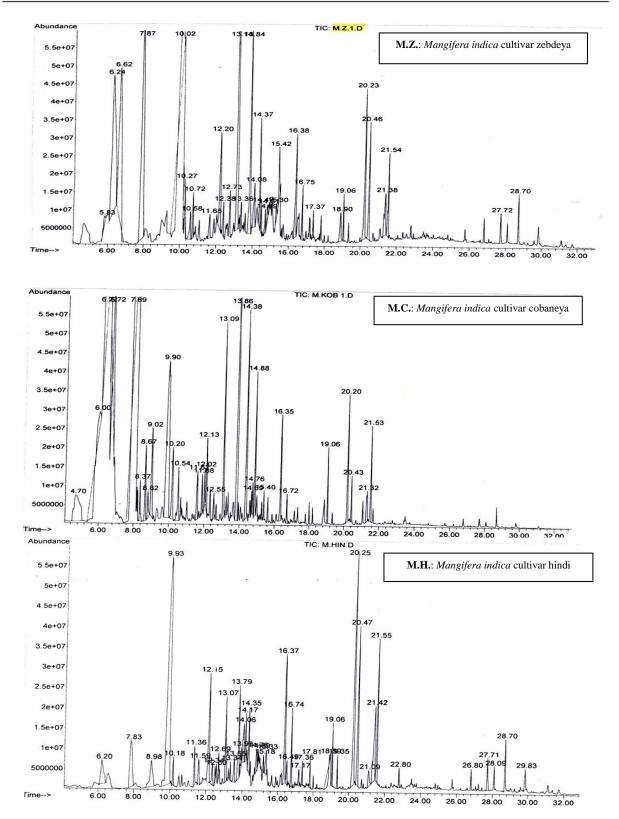
65	Table 1. Continue     n toluoldohudo	1070 4			0.211
	p-tolualdehyde	1079 A 1087 A	 15.879	t 4.825	0.211 7.940
66	α-terpinolene				
67	p-cymenene	1089 A		t	0.151
68	ethyl heptanoate	1095 A	t		0.133
69	linalool	1098 A	t		0.098
70	cis-thujone*	1102 A		t	
71	p-1,3,8-menthatriene*	1110 B	0.015		1.032
72	α-fenchone	1112 A	0.021		0.004
73	isophorone*	1118 A			0.234
74	cis-p-2-menthen-l-ol	1121 B		0.095	
75	methyl octanoate	1126 A	t	0.049	t
76	ethyl 3-hydroxy hexanoate	1133 A		0.087	
77	pinan-2-ol*	1139 B	1.081		
78	neo-allo-ocimene*	1140 B			2.267
79	camphor	1143 A	t	0.023	t
80	4-ketoisophorone*	1142 B	0.100	t	
81	trans-verbenol	1144 B		0.019	
82	isopulegol	1146 A	0.020	t	t
83	menthone	1154 A	0.102	t	
84	borneol	1164 A			0.114
85	p-tolyl acetate	1166 A		0.111	
86	p-mentha-1,5-dien-8-ol*	1167 B	0.135	t	
87	menthol	1173 A	0.450		
88	1-(2-methylphenyl) ethanone*	1176 B		26.214	1.630
89	terpinen-4-o1	1177 A	0.236	t	
90	limonene-4-ol*	1178 B	t	0.013	t
91	methyl phenyl acetate*	1179 A	0.129	t	
92	octanoic acid	1180 A	0.010	0.019	
93	p-cymen-8-ol	1183 B	0.019		t
94	butyl hexanoate	1188 A	0.602	t	
95	α-terpineol	1189 A			0.134
96 07	methylchavicol*	1195 A		0.131	
97	ethyl octanoate	1196 A	0.105	t	t
98	trans-dihydrocarvone*	1200 A	0.250		
99	verbenone	1204 A	0.113 0.103	t	0.037
100	decanal	1205 A		t	
101	α-methylcinnamaldehyde*	1207 A 1229 A	0.134	t	0.011
102	cis-carveol		t		0.032
103 104	Z-3-hexenyl 2-methyl butanoate	1231 B 1237 A	t	t	
104	pulegone*	1237 A 1239 A	t	0.730	
	cuminaldehyde			t	1.032
106	carvone	1242 A		0.023	0.035
107 108	eucarvone	1245 B 1246 B		0.019	
108	trans-2,8-p-menthadiene-1-ol Isopentyl hexanoate*		0.019		t
		1250 A	0.133	t	
110 111	p-anisaldehyde* 2,6,6-trimamethyl-1-cyclohexene-1-	1251 A 1254 B		 0.111	0.174
111	acetaldehyde*	1234 B		0.111	
112	geraniol	1255 A	0.132	t	
113	Benzyl propanoate	1257 A	0.150		
114	γ-octalactone	1260 A		t	0.037
115	(E)-2-decanal	1261 A	0.103		t
116	(E)-cinnamaldehyde*	1266 B	0.100	t	0.024
117	citronellyl formate*	1275 A	t		0.042
118	Nonanoic acid	1280 A		t	
119	$\alpha$ -terpinene -7-al*	1282 B	t	0.890	
120	bornyl acetate*	1285 A		t	1.032
121	safrole	1287 A	0.234	0.013	0.025
122	thymol	1290 A		0.019	
123	ethyl nonanoate*	1294 A	0.029		t
124	carvaeol	1298 A	0.102	t	
125	undecanal	1306 A			0.134
126	trans- carvyl acetate	1337 B		0.151	
127	$\alpha$ -terpinyl acetate	1350 A	0.135	t	
128	citronellyl acetate	1354 A	t	t	0.032
129	eugenol	1356 A		0.095	

Table 1. Continue           130         variable in the interval of the interva							
131       menth-1-ane-4.8-Diol*       137       B       3.079       4.570		Table 1. Continue					
132         α-copsene         137         B         0.97         2.281         4.757           133         butyl bezoate*         1377         A	130	γ-nonalactone	1360	А		t	0.210
133       buryl benzoate*       1377       A       t	131	menth-1-ene-4,8-Diol*	1371	В	3.079	4.570	
133       butyl benzoate*       1377       A       t        t         134       2-butyl-2-octenal*       1378       B       0.112           135       geranyl acetate       1380       A       0.123       0.042          136       octyl isobutanoate*       1394       A       0.100       0.012       t         137       p-elemene       1391       B       0.122         0.054         141       accedrene*       1407       B        0.054        0.054         142       caryophyllene       1418       A       6.183       3.390       10.897          143       a-guiaene       1442       A       1.183        0.032          144       2-pherylethylbutanoate       1440       A        0.030          144       2-pherylethylbutanoate       1445       B        0.031          147       9-egui/guinene       1472       B       -       1.031          147       9-egui/guinene       1477       B       -       0.043       3.032	132	α-copaene	1376	В	8.097	2.281	4.757
134       2-buryl-2-octenal*       1378       B       0.112           136       geranyl acetate       1380       A       0.123       0.042          136       geranyl acetate       1381       B       0.121           137       p-elemene       1397       A       0.100       0.012       t         139       ethyl decanoate       1397       A       0.164       0.440          139       ethyl decanoate       1397       A       0.164       0.440          140       a -guaiene       1418       A       1.18       3.390       10.897         142       caryophyllene       1414       A       t        0.032         144       z-phenylethyl butanoate       1445       B       -       0.032          144       a -guaiene       1447       B       -       0.032        -         147       9-epi-(E)-caryophyllen*       1465       B       -       1.012        -         147       9-epi-(E)-caryophyllen*       1477       B       t       0.013       -         150			1377	Α			t
136       decanoic acid       1380 A       0.123       0.042 $$ 136       geranyl acetate       1391 B       0.122 $$ $$ 137       p-clemene       1391 A       0.164       0.440 $$ 138       octyl isobtanoate*       1394 A       0.100       0.012       t         139       ethyl decanoate       1397 A       0.164       0.440 $$ $$ 140 $\alpha$ -gurjunene       1407 B $$ 0.054 $$ 0.054         144 $2$ -phorylethyl butanoate       1440 A       t $$ 0.032 $$ 144 $2$ -phorylethyl butanoate       1440 A       t $$ 0.033 $$ 147 $9$ -epic(E)-caryophyllene*       1445 B $$ t       0.030 $$ 148 $\gamma$ -gurjunene       1477 B       t       0.112 $$ $$ 148 $\gamma$ -gurjunene       1477 B       t       0.112 $$ $-$ 151       geracylophyllene*       1470 A       0.116 $$ $-$ 152       geralphone	134		1378	В	0.112		
136       geranyl acetate       138       A        0.121          137       p-elemene       1391       B       0.122           138       octyl isobutanoate*       1397       A       0.164       0.440          139       ethyl decanoate       1397       A       0.164       0.440          141 $a$ -guiginene       1418       A       1.83       3.30       10.897         142       caryophyllene       1418       A       I.183       3.300       10.897         142       caryophyllene*       1445       B        0.032          144       2-phenylethyl butanoate*       1445       B        0.033          145       de -lumulene       1445       B        0.032          144       2-phenylethyl butanoate*       1446       B       0.112           144       y-decalactone       1443       B       0.112            150       gerancrene D       1480       B        0.112        t			1380	Α	0.123	0.042	
137       p-elemene       139       H       0.12           138       octyl isobutanoate*       1397       A       0.164       0.404          140 $\alpha$ -gurjunene       1407       H        0.054        0.054         141 $\alpha$ -cedrene*       1407       H        0.053        0.054         142       caryophyllene       1418       A       0.112       0.093          144       2-phenylethyl butanoate       1440       A       t        0.032          144       2-phenylethyl butanoate       1445       A       1.183        0.030          147       9-epi-(E)-caryophyllene*       1465       B        0.043        -       0.043         150 $\gamma$ -muurolene       1472       B        1.0431        -       0.0431        -        1.0431        1.012        1.0431        1.0431        1.021        1.0431        1.0431        1.0215        1.0431       <	136	geranyl acetate	1383	А		0.121	
138       ctyl isobutaoate*       1394       A       0.100       0.012       t         139       ethyl decanoate       1397       A       0.164       0.440					0.122		
139       ch. 140 $\alpha$			1394	A		0.012	t
140       α-gurjunene       1407       B        0.054         141       α-cedrene*       1409       B       t       0.211         142       caryophyllene       1418       A       6.183       3.390       10.897         143       a-guaiene       1439       B       0.112       0.093          144       2-phenylethyl butanoate       1440       A       t        0.032         145       benzyl pentanoate*       1445       B        0.032         146       a-humulene       1454       A       2.183        5.819         147       9-epi-(E)-caryophyllene*       1472       B        0.12          147       y-quijunene       1477       B       0.311           150       y-muurolene       1477       B       -       0.798       3.032         153       gernacrene D       1480       B        -       0.798         154       valencene       1491       A       0.102       0.027         154       valencene       1493       B       2.12       -       1			1397	Α		0.440	
141       a-cardrene*       1409       B       t       0.211         142       caryophyllene       1418       A       6.183       3390       10.897         143       a-guaiene       1439       B       1.12       0.093          144       2-phenylethyl butanoate       1440       A       t        0.030          144       2-phenylethyl butanoate*       1445       B        0.030          144       9-epi-(E)-caryophyllene*       1465       B        0.030          148       y-gurjunene       1472       B        0.011           150       y-murolene       1477       B       -       0.031        1.0731         151       germacrene D       1480       B        -0.798       1.482       B       0.021       t       t       t       1.12       t       t       t       1.12       t       t       t       1.12       t       t       t       1.12       t       t       1.12       t       t       1.12       t       1.12       t       1.12       t							0.054
143 $a$ -guaiene       1439       B       0.112       0.093          144       2-phenylethyl butanoate       1440       A       t        0.030          145       benzyl pentanoate*       1445       B        0.030          146 $a$ -humulene       1454       A       2.183        5.819         147       9-epi-(E)-caryophyllene*       1465       B        0.112          148 $\gamma$ -gurjunene       1472       B        0.798         150       y-murolene       1477       B       1       0.011          151       germacrene D       1480       B        0.798         153       (E)-fonone       1484       B       0.602       0.828       3.032         156 $a$ -zingiberene*       1493       B       0.213       0.021       t       t         155 $a$ -sclinene       1493       B       0.213       0.021       t       t         156 $a$ -zingiberene*       1495       B       t       t       t       t       t       t			1409	В	t	0.211	
143 $a$ -gualene       1439       B       0.112       0.093          144 $2$ -phenylethyl butanoate*       1445       B        0.032         144 $b$ -expl-(E)-caryophyllene*       1455       B        0.032         147       9-epi-(E)-caryophyllene*       1455       B        0.112          148 $\gamma$ -decalactone       1470       A       0.116           150 $\gamma$ -murolene       1477       B        0.013          151       germacrene D       1480       B         0.798         152       GE-j6-ionone       1488       A       0.012       0.027       154       valencene       1491       A       0.112       t       t       t       1.56 $a$ -zingiberene*       1495       B       t       t        1.57 $\delta$ -decalactone       1490       A       0.102       0.027       t       t       t       t       1.52       0.57       5       edcalactone       1495       B       t       t<	142	caryophyllene	1418	А	6.183	3.390	10.897
144       2-phenyletyl butanoate       1440       A       t        0.032         145       benzyl pentanoate*       1445       B        0.030          146       a -humulene       1454       A       2.183        5.819         147       9-epi-(E)-caryophyllene*       1455       B        0.112          148       y-decalactone       1477       B       0.311          149       y-gurjunene       1477       B       0.311          151       germacrene D       14480       B        0.798         152       Ga-selinene       1484       B       0.602       0.828       3.032         153       (E)-β-ionone       1493       B       0.213       0.021       t         154       valencene       1493       B       0.213       0.021       t         155 $\sigma-selinene$ 1493       B       0.213       0.021       t         155 $\sigma-selinene^*$ 1497       B       -t       t       1.052         9       wirdifforene*       1498       A       0.368       0.098	143		1439	В	0.112	0.093	
145       benzyl pentanoate*       1445       B	144		1440	А	t		0.032
146 $\alpha$ -humulene       1454       A       2.183        5.819         147       9-epi-(E)-caryophyllene*       1465       B        0.112          148 $\gamma$ -decalactone       1470       A       0.116           149 $\gamma$ -gurjunene       1472       B        t       0.043         150 $\gamma$ -marcene D       1480       B         0.798         151       germacrene D       1484       B       0.602       0.828       3.032         153       (E)- $\beta$ -ionone       1484       A       t       0.102       0.027         154       valancene       1493       B       0.112       t       t       t         156 $\alpha$ -zingiberene*       1493       B       0.213       0.021       t       t         156 $\alpha$ -zingiberene*       1497       B        t       1.052         157 $\delta$ -decalactone       1497       B        t       1.052         158       viridlflorene*       1500       A        0.441          161	145		1445	В		0.030	
148 $\gamma$ -decalactone       1470       A       0.116	146		1454	А	2.183		5.819
148 $\gamma$ -decalactone       1470       A       0.116	147	9-epi-(E)-caryophyllene*	1465	В		0.112	
150γ-muurolene1477Bt0.311151germacrene D1480B0.798152β-selinene1484B0.6020.8283.032153(E)-β-ionone1484At0.1020.027154valencene1491A0.112tt155α-selinene1493B0.2130.021t156α-zingiberene*1495Btt157δ-decalactone1490At0.190158viridlforene*1497Bt1.052159ethyl undecanoate*1500A0.441161β-bisabolene*1500Bt162tridecanal*1511A0.220t1637-epi-α-selinene1517B0.015t1.070164β-sesquiphellandrene*1524Bt0.170165methyl dodecanoate1526A0.497168cadina-1/4-diene1532Bt0.098170germacrene B*1556B0.798171caryophyllene alcohol*1564Bt0.032172cB)-nerolidol1568At173y-undecalatone1573A-<	148		1470	А	0.116		
151       germacrene D       1480       B         0.798         152 $\beta$ -selinene       1484       B       0.602       0.828       3.032         153       (E)-p-ionone       1488       A       t       0.102       0.027         154       valencene       1491       A       0.112       t       t         156 $\alpha$ -zingiberene*       1493       B       0.213       0.021       t         156 $\alpha$ -zingiberne*       1497       B       -       t          157 $\delta$ -decalactone       1490       A       t       0.190          158       viridflorene*       1497       B        t       1.052         159       ethyl undecanoate*       1500       A        0.441          161 $\beta$ -bisabolene*       1517       B       0.015        t       1.052         162       tridecanal*       1517       B       0.015        t       0.121         163 $7$ -epi-a-selinene       1524       B        t       0.121         165       methyl dode	149	γ-gurjunene	1472	В		t	0.043
152       β-selinene       1484       B       0.602       0.828       3.032         153       (E)-β-ionone       1488       A       t       0.102       0.027         154       valencene       1493       B       0.213       0.021       t         155 $\alpha$ -selinene       1493       B       0.213       0.021       t         155 $\alpha$ -aringiberene*       1495       B       t       t          157 $\delta$ -decalactone       1490       A       t       0.190          158       viridlflorene*       1497       B        t       1.052         159       ethyl undecanoate*       1500       A        0.441          161       β-bisabolene*       1510       B       t         162         tridecanal*       1511       A        0.220        163       B         162         162       tridecanoate       1526       A         0.121       166       cis-calamene       1530       B         0.497 <td< td=""><td>150</td><td>γ-muurolene</td><td>1477</td><td>В</td><td>t</td><td>0.311</td><td></td></td<>	150	γ-muurolene	1477	В	t	0.311	
152 $\bar{\beta}$ -selinene1484B0.6020.8283.032153(E)- $\beta$ -ionone1488At0.1020.027154valencene1491A0.112tt155 $\alpha$ -selinene1493B0.2130.021t156 $\alpha$ -aingiberene*1495Btt157 $\delta$ -decalactone1490At0.190158viridlflorene*1497Bt1.052159ethyl undecanoate*1500A0.441161β-bisabolene*1500Bt162tridecanal*1511A0.2201637-epi-α-selinene1517B0.015t164β-sequiphellandrene*1524Bt0.170165methyl dodecanoate1526A0.497166c-cadinene1530B0.497168cadina-1,4-diene1532Btt0.007170germacrene B*1556B0.798171caryophyllene alcohol*1564Bt0.032172(E)-nerolidol1568At173γ-undecalactone1573A0.030172(E)-nerolidol1568At	151	germacrene D	1480	В			0.798
154valencene1491A0.112ttt155 $\alpha$ -selinene1493B0.2130.021t156 $\alpha$ -zingiberne*1495Btt157 $\delta$ -decalactone1490At0.190158viridflorene*1497Bt1.052159ethyl undecanoate*1498A0.3680.0980.327160pentadecane*1509Bt161 $\beta$ -bisabolene*1509Bt162tridecanat*1511A0.220163 $7$ -epi- $\alpha$ -selinene1517B0.015t164 $\beta$ -sesquiphellandrene*1524Bt0.170165methyl dodecanoate1529B0.674166cis-calamenene1530B0.497168cadina-1,4-diene1532Bt0.007170170germacrene B*1556B0.798171caryophyllene alcohol*1568At173 $\gamma$ -undecalactone1573A0.030173 $\gamma$ -undecalactone1573A0.120175caryophyllene oxide1581A2.8974.901174dodecanoate1593	152		1484	В	0.602	0.828	3.032
155 $\alpha$ -selinene1493B $0.213$ $0.021$ t156 $\alpha$ -zingiberene*1495Btt $$ 157 $\delta$ -decalactone1497Bt1.052158viridlflorene*1497Bt1.052159ethyl undecanoate*1498A0.3680.0980.327160pentadecane*1500A0.441161 $\beta$ -bisabolene*1500Bt162tridecanal*1511A0.2201637-epi- $\alpha$ -selinene1517B0.015t164 $\beta$ -sesquiphellandrene*1526A0.121166cis-calamenene1529B0.674167 $\delta$ -cadinene1530B0.497168cadina-1.4-diene1532Bt0.007170germacrene B*1556B0.798171caryophyllene alcohol*1564Bt0.032172(E)-nerolidol1568At173 $\gamma$ -undecalactone1573A0.030174dodecanoic acid1580A1173 $\gamma$ -undecalactone1573A0.120174dodecanoic acid1584At0.049	153	(E)-β-ionone	1488	А	t	0.102	0.027
156 $\alpha$ -zingiberene*1495Btt $$ 157 $\delta$ -decalactone1490At0.190 $$ 158viridiflorene*1497B $$ t1.052159ethyl undecanoate*1498A0.3680.0980.327160pentadecane*1509Bt $$ $$ 161 $\beta$ -bisabolene*1509Bt $$ $$ 162tridecanal*1511A $$ 0.220 $$ 1637-epi- $\alpha$ -selinene1517B0.015 $$ t164 $\beta$ -sesquiphellandrene*1524B $$ t0.121166cis-calamenene1529B0.674 $$ $$ 167 $\delta$ -cadinene1530B $$ $$ 0.497168cadina-l,4-diene1532Bt0.098 $$ 169 $\alpha$ -cadinene*1538Btt0.032 $$ 170germacrene B*1566B $$ $$ 0.798171caryophyllene alcohol*1568At $$ $$ 173 $\gamma$ -undecalactone1573A $$ 0.120174dodecanoate1588B $$ 0.120175caryophyllen oxide1581A2.8974.901 $$ 174dodecanoate1593B0.081 $$ $$ 175bethyl idgl	154	· · · ·	1491	А	0.112	t	t
157δ-decalactone1490At0.190158viridIflorene*1497Bt1.052159ethyl undecanoate*1498A0.3680.0980.327160pentadecane*1500A0.441161β-bisabolene*1509Bt162tridecanal*1511A0.2201637-epi-α-selinene1517B0.015t164β-sequiphellandrene*1524Bt0.170165methyl dodecanoate1526A0.121166cis-calamenene1530B0.497168cadina-1,4-diene1532Bt0.098176δ-cadinene*1538Btt0.077170germacrene B*1566B0.798171caryophyllene alcohol*1564Bt0.030173γ-undecalactone1573A0.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1584At0.0171762-phenylethyl tiglate*1584At0.0211762-phenylethyl tiglate*1584At0.021177butyl dodecanoate1597<	155	α-selinene	1493	В	0.213	0.021	t
157δ-decalactone1490At0.190158viridifforene*1497Bt1.052159ethyl undecanoate*1498A0.3680.0980.327160pentadecane*1500A0.441161β-bisabolene*1509Btt162tridecanal*1511A0.2201637-epi-α-selinene1517B0.015t164β-sequiphellandrene*1524Bt0.170165methyl dodecanoate1526A0.121166cis-calamenene1530B0.497168cadina-1,4-diene1532Bt0.098170germacrene B*1538Btt0.077170germacrene B*1564Bt0.032172(E)-nerolidol1568At173γ-undecalactone1573A0.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1584At0.0151762-phenylethyl tiglate*1584At0.0211762-phenylethyl tiglate*1584At0.021177butyl dodecanoate1597A <td>156</td> <td>α-zingiberene*</td> <td>1495</td> <td>В</td> <td>t</td> <td>t</td> <td></td>	156	α-zingiberene*	1495	В	t	t	
159ethyl undecanoate*1498A0.3680.0980.327160pentadecane*1500A0.441161β-bisabolene*1500Bt162tridecanal*1511A0.2201637-epi-α-selinene1517B0.015t164β-sesquiphellandrene*1524Bt0.170165methyl dodecanoate1526A0.121166cis-calamenene1529B0.674167δ- cadinene1530B0.497168cadina-1,4-diene1532Bt0.0077170germacrene B*1556B0.798171caryophyllene alcohol*1564Bt0.032172(E)-nerolidol1568At173γ-undecalactone1573A0.120175caryophyllene oxide1581A2.8974.901174dodecanoate1588B0.017175caryophyllene oxide1593B0.081176bumulene epoxide1593B0.081175caryophyllene oxide1593B0.021176bumulene epoxide1593B0.02	157		1490	Α	t	0.190	
160pentadecane*1500A0.441161β-bisabolene*1509Bt162tridecanal*1511A0.2201637-epi-α-selinene1517B0.015t164β-sesquiphellandrene*1524Bt0.170165methyl dodecanoate1526A0.121166cis-calamenene1529B0.674167δ- cadinene1530B0.497168cadina-1.4-diene1532Bt0.098169α-cadinene*1538Btt0.077170germacrene B*1564Bt0.032171caryophyllene alcohol*1564Bt0.032172(E)-nerolidol1568At173γ-undecalactone1573A0.030174dodecanoate1580A0.0150.120175caryophyllene oxide1584At0.049t177butyl decanoate1583B0.0171762-phenylethyl tiglate*1584At0.049t177butyl decanoate1597B2.374180humulene epoxide1593B0.081	158	viridlflorene*	1497	В		t	1.052
160pentadecane*1500A0.441161β-bisabolene*1509Bt162tridecanal*1511A0.2201637-epi-α-selinene1517B0.015t164β-sesquiphellandrene*1524Bt0.170165methyl dodecanoate1526A0.121166cis-calamenene1529B0.674167δ- cadinene1530Btt0.098168cadina-1,4-diene1532Bt0.098169α-cadinene*1538Btt0.032170germacrene B*1564Bt0.032171caryophyllene alcohol*1564Bt0.030172(E)-nerolidol1584At0.049t1174dodecanoic acid1581A2.8974.901175caryophyllene oxide1581At0.049t177butyl decanoate1593B0.0811762-phenylethyl tiglate*1584At0.049t177butyl decanoate1597A2.374178humulene epoxide1593B0.081 <tr< td=""><td>159</td><td>ethyl undecanoate*</td><td>1498</td><td>Α</td><td>0.368</td><td>0.098</td><td>0.327</td></tr<>	159	ethyl undecanoate*	1498	Α	0.368	0.098	0.327
161 $\hat{\beta}$ -bisabolene*1509Bt162tridecanal*1511A0.2201637-epi- $\alpha$ -selinene1517B0.015t164 $\beta$ -sesquiphellandrene*1524Bt0.170165methyl dodecanoate1526A0.121166cis-calamenene1529B0.6740.497168cadina-1,4-diene1532Bt0.098169 $\alpha$ -cadinene*1538Btt0.077170germacrene B*1556B0.798171caryophyllene alcohol*1564Bt0.030172(E)-nerolidol1568At173 $\gamma$ -undecalactone1573A0.030174dodecanoic acid1580A0.0150.120175caryophyllene oxide1584At0.049t177butyl decanoate1588B0.017178humulene epoxide1593B0.081179ethyl dodecanoate1597A2.374179ethyl dodecanoate1597A5.579181tetradecanal1611A0.535179ethyl dodecanoat	160		1500	А			
1637-epi-α-selinene1517B0.015t164β-sesquiphellandrene*1524Bt0.170165methyl dodecanoate1526A0.121166cis-calamenene1529B0.674167δ- cadinene1530B0.497168cadina-l,4-diene1532Bt0.098169α-cadinene*1538Btt0.077170germacrene B*1566B0.798171caryophyllene alcohol*1564Bt0.032172(E)-nerolidol1568At173γ-undecalactone1573A0.030174dodecanoic acid1580A0.0150.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1584At0.049t177butyl decanoate1593B0.081179ethyl dodecanoate1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182γ-eudesmol*1631At0.021178thumulene epoxide II16	161		1509	В	t		
164β-sesquiphellandrene*1524Bt0.170165methyl dodecanoate1526A0.121166cis-calamenene1529B0.674167δ- cadinene1530B0.497168cadina-1,4-diene1532Bt0.098169α-cadinene*1538Btt0.097170germacrene B*1556B0.798171caryophyllene alcohol*1564Bt0.030172(E)-nerolidol1568At173γ-undecalactone1573A0.030174dodecanoic acid1580A0.0150.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1588B0.017177butyl decanoate1593B0.081179ethyl dodecanoate1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182γ-eudesmol*1629Bt0.212183methyl tridecanoate*1631A10.021184τ-muurolol*1641 </td <td>162</td> <td>tridecanal*</td> <td>1511</td> <td>А</td> <td></td> <td>0.220</td> <td></td>	162	tridecanal*	1511	А		0.220	
165methyl dodecanoate1526A0.121166cis-calamenene1529B0.674167 $\delta$ - cadinene1530B0.497168cadina-1,4-diene1532Bt0.098169 $\alpha$ -cadinene*1538Btt0.077170germacrene B*1556B0.798171caryophyllene alcohol*1564Bt0.032172(E)-nerolidol1568At173 $\gamma$ -undecalactone1573A0.030174dodecanoic acid1580A0.0150.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1584At0.049t177butyl decanoate1593B0.081178humulene epoxide1597A2.374180humulene epoxide1597A2.374180humulene epoxide1611A0.535182 $\gamma$ -eudesmol*1629Bt0.212183methyl tridecanoate*1631At0.021184 $\tau$ -muurolol*1642B0.026tt185cubenol*	163	7-epi-α-selinene	1517	В	0.015		t
166cis-calamenene1529B $0.674$ 167 $\delta$ - cadinene1530B $0.497$ 168cadina-1,4-diene1532Bt $0.098$ 169 $\alpha$ -cadinene*1538Btt $0.077$ 170germacrene B*1556B $0.798$ 171caryophyllene alcohol*1564Bt $0.032$ 172(E)-nerolidol1568At173 $\gamma$ -undecalactone1573A $0.030$ 174dodecanoic acid1580A $0.015$ $0.120$ 175caryophyllene oxide1581A2.897 $4.901$ 1762-phenylethyl tiglate*1588B $0.017$ 177butyl decanoate1593B $0.081$ 179ethyl dodecanoate1597A $2.374$ 180humulene epoxide1593B $5.579$ 181tetradecanal1611A $0.535$ 182 $\gamma$ -eudesmol*1629Bt $0.221$ 183methyl tridecanoate*1631At $0.021$ 184 $\tau$ -muurolol*1642B $0.276$ $0.434$ 185cubenol*1643B $5.579$ 190	164	β-sesquiphellandrene*	1524	В		t	0.170
167δ- cadinene1530B0.497168cadina-1,4-diene1532Bt0.098169 $\alpha$ -cadinene*1538Btt0.077170germacrene B*1556B0.798171caryophyllene alcohol*1564Bt0.032172(E)-nerolidol1568At173γ-undecalactone1573A0.030174dodecanoic acid1580A0.0150.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1588B0.017177butyl decanoate1593B0.081179ethyl dodecanoate1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182γ-eudesmol*1631At0.021183methyl tridecanoate*1631At0.021184τ-muurolol*1642B0.026tt185cubenol*1642B0.026tt186α-muurolol*1652Bt0.2210.213188α-cadinol1654B0.276 </td <td>165</td> <td>methyl dodecanoate</td> <td>1526</td> <td>Α</td> <td></td> <td></td> <td>0.121</td>	165	methyl dodecanoate	1526	Α			0.121
168cadina-1,4-diene1532Bt0.098169 $\alpha$ -cadinene*1538Btt0.077170germacrene B*1556B0.798171caryophyllene alcohol*1564Bt0.032172(E)-nerolidol1568At173 $\gamma$ -undecalactone1573A0.030174dodecanoic acid1580A0.0150.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1584At0.049t177butyl decanoate1593B0.081178humulene epoxide1593B0.081179ethyl dodecanoate1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182 $\gamma$ -eudesmol*1631At0.021183methyl tridecanoate*1631At0.021184 $\tau$ -muurolol*1642B0.026tt185cubenol*1643B5.579195bulnesol1664B5.579196bulnesol1664B<	166	cis-calamenene	1529	В	0.674		
169α-cadinene*1538Btt0.077170germacrene B*1556B0.798171caryophyllene alcohol*1564Bt0.032172(E)-nerolidol1568At173γ-undecalactone1573A0.030174dodecanoic acid1580A0.0150.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1584At0.049t177butyl decanoate1593B0.081178humulene epoxide1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182γ-eudesmol*1631At0.021183methyl tridecanoate*1631At0.021184t-muurolol*1642B0.026ttt185cubenol*1642B0.2760.434186 $\alpha$ -muurolol*1652Bt0.2210.213188 $\alpha$ -cadinol1654B0.2760.434189ar-turmerone*1664B5.579190bulnesol1666B <td>167</td> <td>δ- cadinene</td> <td>1530</td> <td>В</td> <td></td> <td></td> <td>0.497</td>	167	δ- cadinene	1530	В			0.497
170germacrene B*1556B0.798171caryophyllene alcohol*1564Bt0.032172(E)-nerolidol1568At173 $\gamma$ -undecalactone1573A0.030174dodecanoic acid1580A0.0150.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1584At0.049t177butyl decanoate1593B0.081178humulene epoxide1597A2.374180humulene epoxide1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182 $\gamma$ -eudesmol*1629Bt0.212183methyl tridecanoate*1631At0.021184 $\tau$ -muurolol*1641B0.0940.0650.327185cubenol*1642B0.2210.213186 $\alpha$ -muurolol*1652Bt0.2210.213188 $\alpha$ -cadinol1654B0.2760.434189ar-turmerone*1666B0.335190bulnesol1666 <td>168</td> <td>cadina-l,4-diene</td> <td>1532</td> <td>В</td> <td>t</td> <td>0.098</td> <td></td>	168	cadina-l,4-diene	1532	В	t	0.098	
171caryophyllene alcohol*1564Bt0.032172(E)-nerolidol1568At173γ-undecalactone1573A0.030174dodecanoic acid1580A0.0150.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1584At0.049t177butyl decanoate1588B0.017178humulene epoxide1593B0.081179ethyl dodecanoate1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182γ-eudesmol*1629Bt0.212183methyl tridecanoate*1631At0.021184t-muurolol*1641B0.0940.0650.327185cubenol*1642B0.226tt186α-muurolol*1652Bt0.2210.213188α-cadinol1654B0.2760.434189ar-turmerone*1664B5.579190bulnesol1664B5.579190bulnesol1664B	169	α-cadinene*	1538	В	t	t	0.077
172(E)-nerolidol1568At173 $\gamma$ -undecalactone1573A0.030174dodecanoic acid1580A0.0150.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1584At0.049t177butyl decanoate1593B0.081178humulene epoxide1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182 $\gamma$ -eudesmol*1629Bt0.212183methyl tridecanoate*1631At0.0650.327185cubenol*1643B0.548187selin-11-en-4- $\alpha$ -ol1652Bt0.221188 $\alpha$ -cadinol1654B0.2760.434189ar-turmerone*1664B5.579190bulnesol1666B0.335191(Z)-3-hexenyl salicylate*1670A0.0120.212192cadalene*1673Bt0.290193 $\gamma$ -dodecalactone1675A0.1980.0980.327194tridecanoic acid*<	170	germacrene B*	1556	В			0.798
173γ-undecalactone1573A0.030174dodecanoic acid1580A0.0150.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1584At0.049t177butyl decanoate1588B0.017178humulene epoxide1593B0.081179ethyl dodecanoate1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182γ-eudesmol*1629Bt0.212183methyl tridecanoate*1631At0.0650.327185cubenol*1642B0.026tt186α-muurolol*1652Bt0.2210.213188α-cadinol1654B0.2760.434189ar-turmerone*1664B5.579190bulnesol1666B0.335191(Z)-3-hexenyl salicylate*1670A0.0120.212192cadalene*1673Bt0.290193γ-dodecalactone1675A0.1980.0980.327194tridecanoic acid*1678	171	caryophyllene alcohol*	1564	В	t	0.032	
174dodecanoic acid1580A0.0150.120175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1584At0.049t177butyl decanoate1588B0.017178humulene epoxide1593B0.081179ethyl dodecanoate1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182γ-eudesmol*1629Bt0.212183methyl tridecanoate*1631At0.021184τ-muurolol*1641B0.0940.0650.327185cubenol*1642B0.026tt186α-muurolol*1652Bt0.2210.213188α-cadinol1654B0.2760.434189ar-turmerone*1664B5.579190bulnesol1666B0.335191(Z)-3-hexenyl salicylate*1673Bt0.290192cadalene*1673Bt0.290193γ-dodecalactone1675A0.1980.0980.327194tridecanoic acid*1678	172	(E)-nerolidol	1568	A	t		
175caryophyllene oxide1581A2.8974.9011762-phenylethyl tiglate*1584At0.049t177butyl decanoate1588B0.017178humulene epoxide1593B0.081179ethyl dodecanoate1597A2.374180humulene epoxide II1606B2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182γ-eudesmol*1629Bt0.212183methyl tridecanoate*1631At0.021184τ-muurolol*1641B0.0940.0650.327185cubenol*1642B0.026tt186α-muurolol*1652Bt0.2120.213188α-cadinol1654B0.2760.434189ar-turmerone*1664B5.579190bulnesol1666B0.335191(Z)-3-hexenyl salicylate*1670A0.0120.212192cadalene*1673Bt0.290193γ-dodecalactone1675A0.1980.0980.327194tridecanoic acid*1678		γ-undecalactone				0.030	
1762-phenylethyl tiglate*1584At0.049t177butyl decanoate1588B0.017178humulene epoxide1593B0.081179ethyl dodecanoate1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182 $\gamma$ -eudesmol*1629Bt0.212183methyl tridecanoate*1631At0.021184 $\tau$ -muurolol*1641B0.0940.0650.327185cubenol*1642B0.026tt186 $\alpha$ -muurolol*1652Bt0.2120.213188 $\alpha$ -cadinol1654B0.2760.434189ar-turmerone*1664B5.579190bulnesol1666B0.335191(Z)-3-hexenyl salicylate*1670A0.0120.212192cadalene*1673Bt0.290193 $\gamma$ -dodecalactone1675A0.1980.0980.327194tridecanoic acid*1678A0.106tt					0.015		0.120
177butyl decanoate1588B $0.017$ 178humulene epoxide1593B $0.081$ 179ethyl dodecanoate1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A $0.535$ 182 $\gamma$ -eudesmol*1629Bt $0.212$ 183methyl tridecanoate*1631At $0.021$ 184 $\tau$ -muurolol*1641B $0.094$ $0.065$ $0.327$ 185cubenol*1642B $0.026$ tt186 $\alpha$ -muurolol*1643B $0.548$ 187selin-11-en-4- $\alpha$ -ol1652Bt $0.221$ $0.213$ 188 $\alpha$ -cadinol1654B $0.276$ $0.434$ 189ar-turmerone*1664B5.579190bulnesol1666B $0.335$ 191(Z)-3-hexenyl salicylate*1670A0.012 $0.212$ 192cadalene*1673Bt $0.290$ 193 $\gamma$ -dodecalactone1675A $0.198$ $0.098$ $0.327$ 194tridecanoic acid*1678A $0.106$ tt					2.897		
178humulene epoxide1593B $0.081$ 179ethyl dodecanoate1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A $0.535$ 182 $\gamma$ -eudesmol*1629Bt $0.212$ 183methyl tridecanoate*1631At $0.021$ 184 $\tau$ -muurolol*1641B $0.094$ $0.065$ $0.327$ 185cubenol*1642B $0.026$ tt186 $\alpha$ -muurolol*1643B $0.548$ 187selin-11-en-4- $\alpha$ -ol1652Bt $0.221$ $0.213$ 188 $\alpha$ -cadinol1654B $0.276$ $0.434$ 189ar-turmerone*1666B $0.335$ 190bulnesol1666B $0.335$ 191(Z)-3-hexenyl salicylate*1670A $0.012$ $0.212$ 192cadalene*1673Bt $0.290$ 193 $\gamma$ -dodecalactone1675A $0.198$ $0.098$ $0.327$ 194tridecanoic acid*1678A $0.106$ tt					t	0.049	t
179ethyl dodecanoate1597A2.374180humulene epoxide II1606B5.579181tetradecanal1611A0.535182 $\gamma$ -eudesmol*1629Bt0.212183methyl tridecanoate*1631At0.021184 $\tau$ -muurolol*1641B0.0940.0650.327185cubenol*1642B0.026tt186 $\alpha$ -muurolol*1643B0.548187selin-11-en-4- $\alpha$ -ol1652Bt0.2210.213188 $\alpha$ -cadinol1654B0.2760.434189ar-turmerone*1666B0.335190bulnesol1666B0.335191(Z)-3-hexenyl salicylate*1673Bt0.290193 $\gamma$ -dodecalactone1675A0.1980.0980.327194tridecanoic acid*1678A0.106tt							
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181tetradecanal1611A $0.535$ 182 $\gamma$ -eudesmol*1629Bt $0.212$ 183methyl tridecanoate*1631At $0.021$ 184 $\tau$ -muurolol*1641B $0.094$ $0.065$ $0.327$ 185cubenol*1642B $0.026$ tt186 $\alpha$ -muurolol*1643B $0.548$ 187selin-11-en-4- $\alpha$ -ol1652Bt $0.221$ $0.213$ 188 $\alpha$ -cadinol1654B $0.276$ $0.434$ 189ar-turmerone*1664B $5.579$ 190bulnesol1666B $0.335$ 191(Z)-3-hexenyl salicylate*1670A $0.012$ $0.212$ 192cadalene*1673Bt $0.290$ 193 $\gamma$ -dodecalactone1675A $0.198$ $0.098$ $0.327$ 194tridecanoic acid*1678A $0.106$ tt							
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183methyl tridecanoate*1631At $0.021$ 184 $\tau$ -muurolol*1641B $0.094$ $0.065$ $0.327$ 185cubenol*1642B $0.026$ tt186 $\alpha$ -muurolol*1643B $0.548$ 187selin-11-en-4- $\alpha$ -ol1652Bt $0.221$ $0.213$ 188 $\alpha$ -cadinol1654B $0.276$ $0.434$ 189ar-turmerone*1664B $5.579$ 190bulnesol1666B $0.335$ 191(Z)-3-hexenyl salicylate*1670A $0.012$ $0.212$ 192cadalene*1673Bt $0.290$ 193 $\gamma$ -dodecalactone1675A $0.198$ $0.098$ $0.327$ 194tridecanoic acid*1678A $0.106$ tt							
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185cubenol*1642B $0.026$ tt186 $\alpha$ -muurolol*1643B $0.548$ 187selin-11-en-4- $\alpha$ -ol1652Bt $0.221$ $0.213$ 188 $\alpha$ -cadinol1654B $0.276$ $0.434$ 189ar-turmerone*1664B $5.579$ 190bulnesol1666B $0.335$ 191(Z)-3-hexenyl salicylate*1670A $0.012$ $0.212$ 192cadalene*1673Bt $0.290$ 193 $\gamma$ -dodecalactone1675A $0.198$ $0.098$ $0.327$ 194tridecanoic acid*1678A $0.106$ tt							
186α-muurolol*1643B0.548187selin-11-en-4-α-ol1652Bt0.2210.213188α-cadinol1654B0.2760.434189ar-turmerone*1664B5.579190bulnesol1666B0.335191(Z)-3-hexenyl salicylate*1670A0.0120.212192cadalene*1673Bt0.290193γ-dodecalactone1675A0.1980.0980.327194tridecanoic acid*1678A0.106tt							
187selin-11-en-4-α-ol1652Bt0.2210.213188α-cadinol1654B0.2760.434189ar-turmerone*1664B5.579190bulnesol1666B0.335191(Z)-3-hexenyl salicylate*1670A0.0120.212192cadalene*1673Bt0.290193γ-dodecalactone1675A0.1980.0980.327194tridecanoic acid*1678A0.106tt							
188α-cadinol1654B0.2760.434189ar-turmerone*1664B5.579190bulnesol1666B0.335191(Z)-3-hexenyl salicylate*1670A0.0120.212192cadalene*1673Bt0.290193 $\gamma$ -dodecalactone1675A0.1980.0980.327194tridecanoic acid*1678A0.106tt							
189ar-turmerone*1664B5.579190bulnesol1666B $0.335$ 191(Z)-3-hexenyl salicylate*1670A $0.012$ $0.212$ 192cadalene*1673Bt $0.290$ 193 $\gamma$ -dodecalactone1675A $0.198$ $0.098$ $0.327$ 194tridecanoic acid*1678A $0.106$ tt							
190bulnesol1666B $0.335$ 191(Z)-3-hexenyl salicylate*1670A0.0120.212192cadalene*1673Bt0.290193 $\gamma$ -dodecalactone1675A0.1980.0980.327194tridecanoic acid*1678A0.106tt							
191(Z)-3-hexenyl salicylate*1670A0.0120.212192cadalene*1673Bt0.290193γ-dodecalactone1675A0.1980.0980.327194tridecanoic acid*1678A0.106tt							
192cadalene*1673Bt0.290193γ-dodecalactone1675A0.1980.0980.327194tridecanoic acid*1678A0.106tt							
193γ-dodecalactone1675A0.1980.0980.327194tridecanoic acid*1678A0.106tt							
194 tridecanoic acid* 1678 A 0.106 t t							
195         propyl dodecanoate*         1685         B         0.108         0.025         t							
	195	propyl dodecanoate*	1685	В	0.108	0.025	t

	Table 1. Continue					
196	(Z)-11-pentadecenal *	1686	В	t		
197	ethyl tridecanoate*	1687	-		0.230	
198	2-pentadecanone*	1697			0.734	
199	pentadecanal	1711	В			0.012
200	(z,z)-farnesol*	1713	В		0.076	0.092
201	methyl tetradecanoate	1726	Α	t	0.033	
202	m-tetrabutyl phenol	1727	В	t		0.374
203	(E,Z)-farnesol*	1742	В		0.234	
204	isobutyl dodecanoate	1753		t		0.043
205	tetradecanoic acid	1780		1.168	1.384	t
206	(Z)-9-tetradecenoic acid*	1783			0.134	
207	butyl dodecanoate*	1786				0.043
208	ethyl tetradecanoate		А	0.692	1.260	1.232
209	hexadecanal*	-		t	0.234	
210	benzyl salicylate		A		t	0.012
211	pentadecanoic acid*	1878			t	0.021
212	1-hexadecanol		A	4.040	10.025	t
213	methyl linolenate		A	t		0.098
214	propyl tetradecanoate*	1896		0.211	t	
215 216	ethyl pentadecanoate*		A	t 2.213	0.030	
210	2-heptadecanone 2-Nonadecanone*	1900 1902		2.213	5.144 0.437	0.859
217	methyl hexdecanoate*	1902		0.145	0.457	
218	phytol*	1920		0.143 t	0.316	
21)	(Z)-9hexadecenoic acid*	1953		ι 	0.904	
220	butyl tetradecanoate*	1986		0.030		
222	hexadecanoic acid	1991		1.877	4.612	1.215
223	ethyl hexadecanoate		A	1.865	4.029	0.543
224	isopropyl hexadecanoate	1999	В	t		0.032
225	propyl hexadecanoate*	2091	В	0.065	t	
226	methyl linoleate	2093	Α	t	0.090	
227	methyl octadecanoate	2128	А			0.012
228	isobutyl hexadecanoate	2135	В	t	t	
229	oleic acid	2141	А		0.043	
230	ethyl linoleate*	2159	А	t		0.042
231	ethyl linolenate		А	0.021	t	
232	octadecanoic acid		А	t	0.290	
233	ethyl oleate		Α	t		0.036
234	butyl hexadecanoate*		В	0.012		0.023
235	ethyl octadecanoate	2193			t	0.740
236	isopentyl hexadecanoate	2260		0.013	t	
237	propyl octadecanoate*	2296		0.021		t
238	butyl octadecanoate	2388		t		
239	pentacosane*	2500		t	1.492	t
240	nonacosane*	2900	В	1.074	t	t
Tota	l identified compounds (%)			97.739	95.232	98.209

**M.Z.**: *Mangifera indica* cultivar zebdeya; **M.H.**: *Mangifera indica* cultivar hindi; **M.C.**: *Mangifera indica* cultivar cobaneya. The reliability of the identification proposal is indicated by the following: **A**, mass spectrum and Kovat's index agreed with literature data (Adams; 2009); **B**, mass spectrum agreed with mass spectral NIST database, Mass Finder database (G1036A, and Wiley7 Mass Finder. \*: Reported for the first lime in mango, t: < 0.01%, --: not detected.

(0.220%), γ-eudesmol (0.212%), α-muurolol (0.548%), α-cadinol (0.434%), cadalene (0.290%), ethyl tridecanoate(0.230%), 2-pentadecanone (0.734%), (E,Z)-farnesol (0.234%), (Z)-9-tetradecenoic acid (0.134%), hexadecanal (0.234%), 2-Nonadecanone (0.437%), phytol (0.316%), (Z)-9-hexadecenoic acid (0.904%), octadecanoic acid (0.290%) and pentacosane (1.492%) in *M. indica* cultivar hindi while, 2,3-pentanedione (0.174%), 2-heptanone (1.062%), α-pinene (5.579%), 2-carene (0.121%), α-terpinene (0.216%), limonene (5.575%), acetophenone (0.121%), p-tolualdehyde (0.211%), p-cymenene (0.151%), ethyl heptanoate (0.133%), isophorone (0.234%), neo-allo-ocimene (2.267%), borneol (0.114%), α-terpineol (0.134%), γ-nonalactone (0.210%), germacrene D (0.798%), viridlflorene (1.052%), β-sesquiphellandrene (0.170%), methyl dodecanoate (0.121%), δ- cadinene (0.497%), germacrene B (0.798%), ethyl dodecanoate (2.374%), humulene epoxide II (5.579%), ar-turmerone (5.579%), m-tetrabutyl phenol (0.374%), ethyl hexadecanoate (0.543%) and ethyl octadecanoate (0.740%) %) in *M. indica* cultivar cobaneya. (Table 1, Figure 1)



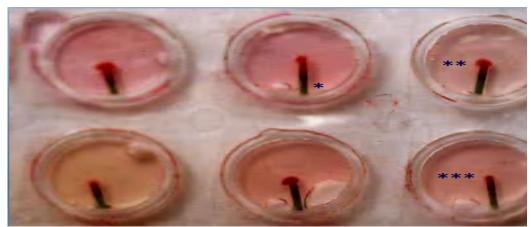
**Figure 1.** GC chromatograms of *Mangifera indica* cultivars (**M.Z.**: *Mangifera indica* cultivar zebdeya; **M.H.**: *Mangifera indica* cultivar hindi; **M.C.**: *Mangifera indica* cultivar cobaneya).

## 4.2. Immunostimulant activity:

Despite many published reports dealing with bioactivity of compounds isolated from *Mangifera* species little was known about its immunostimulant activity prior to our investigation.

Non-specific immune response using "Macrophage migration index" showed the lowest macrophage migration index with *Echinacea purpurea* followed by *M. indica* cultivar zebdeya in all concentrations tested, *M. indica* cultivar cobaneya at concentrations 500-2000  $\mu$ l/ml and *M. indica* cultivar hindi at concentrations 2000  $\mu$ l/ml only. So, peel essential oils of *M. indica* cultivar zebdeya and *M. indica* cultivar cobaneya showed appreciable non specific immunostimulant activity (low Macrophage migration index) comparable to the results displayed by *Echinacea purpurea*. (Table 2)

Conc. (µl/ml)	<i>M. indica</i> cultivar zebdeya	<i>M. indica</i> cultivar hindi	<i>M. indica</i> cultivar cobaneya	Echinacea purpurea
100	*0.079±0.012	0.131±0.063	0.152±0.098	*0.026±0.007
500	*0.072±0.016	$0.187 \pm 0.034$	*0.042±0.011	*0.025±0.011
1000	*0.070±0.043	0.128±0.033	*0.042±0.008	*0.019±0.012
1500	*0.061±0.011	0.106±0.043	*0.035±0.010	*0.018±0.013
2000	*0.049±0.013	*0.067±0.009	*0.053±0.012	*0.015±0.023



The results were presented as mean  $\pm$  S.E. Student T test was used for the statistical analysis of data. \*: Results with p < 0.01 were considered as statistically significant

**Figure 2:** Migration inhibition of albino mice spleen cells from capillaries in a multi-chamber disposable plate (Sterillin). Each well contains one replicate of each test which is randomly distributed. The inhibited migration is clearly shown. \*: Capillary tube containing macrophages. \*\*: Migration of macrophages from the Capillary tube to the surrounding culture media. \*\*\*: Complete inhibition of migration of macrophages from the capillary tube to the surrounding culture media.

Regarding the immune response using "phagocytic index", it was apparent that *M. indica* cultivar zebdeya and *M. indica* cultivar cobaneya had higher phagocytic indices up to 1.47and 1.06 respectively compared to *E. purpurea* that had a phagocytic index of 1.38 at concentration 2000  $\mu$ g/ml. (Table 3)

Table 3	Table 3. Phagocytic Index of essential oils of Mangifera indica cultivars							
Conc. (µl/ml)	<i>M. indica</i> cultivar zebdya	<i>M. indica</i> cultivar hindi	<i>M. indica</i> cultivar cobanya	Echinacea purpurea				
100	$0.59 \pm 0.09$	$0.22 \pm 0.05$	$0.62 \pm 0.05$	$0.46 \pm 0.05$				
500	*0.96±0.05	$0.28 \pm 0.03$	$0.30 \pm 0.01$	0.36±0.09				
1000	*1.35±0.08	$0.37 \pm 0.07$	$0.46 \pm 0.02$	$0.56\pm0.04$				
1500	*1.47±0.23	0.37±0.11	$0.47 \pm 0.05$	*0.92±0.08				
2000	*1.38±0.15	*0.77±0.08	*1.06±0.07	*1.38±0.23				

The results were presented as mean  $\pm$  S.E. Student T test was used for the statistical analysis of data. \*: Results with p < 0.01 were considered as statistically significant.

## 4.3. Anticancer activity:

The cytotoxicity of the essential oils were studied *invitro* against MCF-7, HCT-116 and Hep-G2 cancer cell lines at different concentration (0.5, 5.0, 10.0, 20  $\mu$ l/ml). The results obtained from MTT assay after 48 hrs of incubation showed significant effect on MCF-7, HCT-116 and Hep-G2 with IC<sub>50</sub> = 1.62-1.77, 2.95-5.56 and 2.76-3.14  $\mu$ l/ml for respectively. Interestingly, *M. indica* cultivars zebdeya, cobaneya and hindi expressed a valuable cytotoxic effect on MCF-7 breast carcinoma cell line as compared to standard antitumor drug doxorubicin as it led to inhibition in cell growth as concluded from IC<sub>50</sub> values 1.62-1.77 $\mu$ l/ml as shown in (Table 4).

 Table 4: IC<sub>50</sub> of essential oils Mangifera indica cultivars with different cell lines

Tumor cell line	Breast carcinoma cell line (MCF-7)	Colon carcinoma cell line (HCT-116)	Liver carcinoma cell line (HEP-G2)
Plant		IC <sub>50</sub> (μl/ml)	
M. Z.	1.62	3.53	2.76
М.Н.	1.77	2.95	3.14
M.C.	1.62	5.56	2.45

**M.Z.**: *Mangifera indica* cultivar zebdeya; **M.H.**: *Mangifera indica* cultivar hindi; **M.C.**: *Mangifera indica* cultivar cobaneya. Doxorubicin [IC<sub>50</sub> (0.42µg/ml for (**MCF-7**), 1.43µg/ml for (**HCT-116**) and 1.12µg/ml for (**HEP-G2**)]

### 4.4. Antimicrobial activity:

In the present study, based on previous reports we have found that among the essential oils *M. indica* cultivars showed wide range of antibacterial and antifungal activities. Generally, essential oils of the *M. indica* cultivars showed a moderate to high antibacterial activity with *M. indica* cultivar hindi being the most active showing broad spectrum activity against Gram-positive (18-21 mm) and Gram-negative bacteria (16-19 mm). These results comply with those reported by Abdalla, *et al.* (2007). It also showed significant antifungal activity against *Candida albicans* (16 mm); however, data revealed that all *tested cultivars* was ineffective and have no antifungal activity against *Aspergillus flavus*.

Table 5: Antimicrobial activity of essential oils of Mangifera indica cultivars

		Inhibition zone diameter (mm)						
	Gram	Sta	ndard	117		MG		
Microorganism	reaction	Gentamycin Amphotericin		M.Z.	M.H.	M.C.		
Bacillus subtilis (ATCC 6051)	$\mathbf{G}^{+}$	32		15	18	15		
Staphylococcus aureus (ATCC 12600)	$\mathbf{G}^{+}$	31		14	21	15		
Escherichia coli (ATCC 11775)	G	33		16	19	16		
Pseudomonas aeruginosa (ATCC 10145)	G	30		13	16	15		
Aspergillus flavus Link (ATCC 204304)	Fungus		16	≤6	≤6	≤6		
Candida albicans (ATCC 26555)	Fungus		18	12	16	14		

**M.Z.**: *Mangifera indica* cultivar zebdeya; **M.H.**: *Mangifera indica* cultivar hindi; **M.C.**: *Mangifera indica* cultivar cobaneya. Results are average of three replicate tests. The antimicrobial activity was done against six microorganisms by agar disc diffusion method.

**Table 6:** Minimal Inhibitory Concentration (MIC) of essential oils Mangifera indica cultivars against bacterial and fungal strains.

Tested microorganisms	M.Z.	М.Н.	M.C.	
		MIC (µl/ml)	1	
Bacillus subtilis (ATCC 6051)	116	85	166	
Staphylococcus aureus (ATCC 12600)	195	74	121	
Escherichia coli (ATCC 11775)	123	58	172	
Pseudomonas aeruginosa (ATCC 10145)	140	89	159	
Aspergillus flavus Link (ATCC 204304)	ND	ND	ND	
Candida albicans (ATCC 26555)	142	78	142	

**M.Z.**: *Mangifera indica* cultivar zebdeya; **M.H.**: *Mangifera indica* cultivar hindi; **M.C.**: *Mangifera indica* cultivar cobaneya. ND; Not done, as essential oil (s) has no antimicrobial activity on this microorganism.

The **MIC** of the three *M. indica* cultivars essential oils (Table 6) revealed that although essential oils didn't show antimicrobial activities against *Aspergillus flavus* the peel essential oils demonstrated a variability in the inhibitory concentrations of each essential oil for the given microorganisms. The essential oils of peels showed activities in the range (concentrations) from 116 to 142  $\mu$ l/ml for *M. indica* cultivar zebdeya, 58 to 89  $\mu$ l/ml for *M. indica* cultivar hindi and from 121 to 172  $\mu$ l/ml for *M. indica* cultivar cobaneya.

The lowest variation (58  $\mu$ l/ml) was observed for essential oil of *M. indica* cultivar hindi on *Escherichia* coli that may be attributed to their higher oxygenated content of their essential oils. These results are in agreement with Toshida *et al.*, (2000) who documented a MIC varying from 122 to198  $\mu$ l/ml upon testing different concentrations of *M. indica* cultivars on both Gram-negative and Gram-positive bacteria.

#### **Conclusion and future aspects**

The use of plant essential oils from common waste products is an inexpensive, easily scaled up and environmentally benign. It is especially suited for making eco-friendly chemotherapeutic agents that must be free of toxic contaminants as required in therapeutic applications.

It is known that the by-products of some vegetables and fruits represent an important source of sugars, minerals, organic acid, dietary fiber and phenolics that have a wide range of action, which includes antitumor, antiviral, antibacterial, cardioprotective and antimutagenic activities. Thus new aspects concerning the use of the wastes therapeutically are very attractive. The present investigation focused on the possibility of using mango peel waste as a source of low-cost natural immunostimulant, anticancer and antimicrobial. *M. indica* peel, usually a waste product which is thrown into the environment has a very good immunostimulant, anticancer potentiality as well as the demonstration of broad spectrum of antibacterial activity by *M. indica* peels may help to discover new chemical classes of antibiotic substances that could serve as selective agents for infectious disease chemotherapy and control. This investigation has opened up the possibility of the use of this plant in drug development for human consumption possibly for the treatment of various infections caused by microbes. These are novel, natural and economic sources of antimicrobics, which can be used in the prevention of diseases caused by pathogenic microbes.

Our results suggest that with the aid of plant wastes, conditional chemotherapeutic agents may have even broader range of applications in the future. Thus, a study of the exact mechanism by which essential oils inhibit signaling cascades responsible for the development and progression of the disease would be a tremendous breakthrough in the field of aromatherapy and make these agents an effective alternative in tumor and angiogenesis-related diseases.

In conclusion, *M. indica* cultivars essential oils can be used as an inexpensive source for the treatment of many infectious diseases caused by the bacteria and immune stimulation especially for cancer patient with special focus on breast cancer. Further research on the use of other botanicals can be rewarding to pursue in hunt for new herbal therapeutic agent. Therefore, this study will definitely open up as a scope for future utilization of the waste for therapeutic purpose.

#### Acknowledgements

The authors would like to thank Pharmacognosy department, Cairo University for providing all the facilities and equipment for the research and Assoc. Prof. Dr. Abeer Khairy Abdulall; Department of Microbiology and immunology, Faculty of Pharmacy, Al-Azhar University, Egypt, for help in conduction of the microbiology and immunostimulant assays. The authors indebt to National cancer institute, cancer biology department, pharmacology unit, Cairo University, Cairo, Egypt for great help in conduction of the anticancer activity.

#### **Conflict of interest**

No declarations of interests.

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