

Honey: An Advanced Antimicrobial and Wound Healing Biomaterial for Tissue Engineering Applications

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Supplementary Tables

Table S1. Commercially available manuka honey and MGO levels available.

Manufacturer/Brand	MGO [mg/kg]	Reference
Comvita*	83+ to 829+ (UMF® 5+ to 20+)	[1]
Egmont Honey*	83+ to 829+ (UMF® 5+ to 20+) Limited editions of UMF27+	[2]
Manuka Doctor	30+ to 940+	[3]
Manuka Health	115+ to 950+	[4]
Manuka Pharm	40+ to 340+	[5]
New Zealand Manuka Group/Melora*	83+ to 829+ (UMF® 5+ to 20+)	[6]
Optima/ Pure Gold	85+ to 525+	[7]

* Manufacturers with UMF/dual grading system. UMF= Unique Manuka Factor – Grading system directly proportional to the amount of MGO, Leptosperin, dihydroxyacetone (DHA), and 5-hydroxymethylfurfural (HMF).

Table S2. Gram-positive and Gram-negative bacterial strains inhibited by different honey types, their corresponding minimum inhibitory concentration (MIC) values (lowest concentration of a chemical compound that prevents visible growth of a bacterium) and suggested mechanism of action.

GRAM-POSITIVE BACTERIA						
Strain inhibited	Honey Type	Honey/plant source (species)	Origin	MIC (% v/v)	Mechanism of action	Ref.
Coagulase-negative Staphylococci	Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	9.1*	Methylglyoxal	[8]
	Tualang	<i>Koompassia excelsa</i> , Multifloral by <i>Apis dorsata</i> bees	Malaysia	7.2*	Hydrogen peroxide	[8]
<i>Enterococcus faecalis</i>						
vancomycin-sensitive	Artificial	-	-	29.7	Osmolarity and acidity	[9]
	Chestnut	<i>Aesculus</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Honeydew	(<i>Abies Alba</i>)	Poland	15	High total amount of polyphenolic compounds (flavonoids)	[11]
	Lime tree	<i>Tilia</i>	Italy	50	Osmolarity, acidity and hydrogen peroxide	[10]
	Manuka (MGO 250+)	<i>Leptospermum scoparium</i>	New Zealand	15	Methylglyoxal, high amount of polyphenolic compounds (flavonoids)	[11]
	Manuka (MGO 696+)	<i>Leptospermum scoparium</i>	New Zealand	4.9	Methylglyoxal	[9]
	Multiflora	Pasture	New Zealand	9.7	Hydrogen peroxide	[9]
	Rhododendron	<i>Rhododendron</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
<i>Enterococcus faecalis</i>						
vancomycin-resistant	Artificial	-	-	29.5	Osmolarity and acidity	[9]
	Manuka (MGO 696+)	<i>Leptospermum scoparium</i>	New Zealand	3.8	Methylglyoxal	[9]
	Multiflora	Pasture	New Zealand	5.6	Hydrogen peroxide	[9]

<i>Enterococcus raffinosus</i> vancomycin-resistant	Artificial honey	-	-	29	Osmolarity and acidity	[9]
	Manuka (MGO 696+)	<i>Leptospermum scoparium</i>	New Zealand	4.9	Methylglyoxal	[9]
	Multiflora	Pasture	New Zealand	9	Hydrogen peroxide	[9]
<i>Staphylococcus aureus</i> (MSSA)	Agastache	<i>Agastache Rugosa</i>	Australia	6.3	Methyl syringate, phenyllactic acid and hydrogen peroxide	[12]
	Buckwheat	<i>Fagopyrum esculentum</i> Moench	Poland	3.1	Hydrogen peroxide, polyphenols and antioxidants	[13]
	Chestnut	<i>Aesculus</i>	Italy	6.3	Hydrogen peroxide, polyphenols and antioxidants	[13]
	Chestnut and pine	<i>Castanea</i> and <i>Pinus</i>	Greece	3.1	Hydrogen peroxide and antibacterial proteinaceous compounds	[14]
	Dandelium	<i>Taraxacum</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Honeydew	<i>(Abies Alba)</i>	Poland	3.1	Hydrogen peroxide, polyphenols and antioxidants	[13]
	Jarra	<i>Eucalyptus marginata</i>	Australia	12.5	Hydrogen peroxide	[12]
	Jelly bush	<i>Leptospermum polygalifolium</i>	Australia	12.5	Methylglyoxal	[12]
	Lime tree	<i>Tilia</i>	Poland	3.1	Hydrogen peroxide, polyphenols and antioxidants	[13]
	Lime tree	<i>Tilia</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Madrones	<i>Arbutus</i>	Greece	6.3	Hydrogen peroxide	[14]
	Manuka (medical grade)	<i>Leptospermum scoparium</i>	New Zealand	3.1	Methylglyoxal	[10]
	Manuka (MGO 250+)	<i>Leptospermum scoparium</i>	New Zealand	20	Methylglyoxal, high amount of polyphenolic compounds (flavonoids)	[11]
	Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	9.1*	Methylglyoxal	[8]

Manuka (MGO 400+)	<i>Leptospermum scoparium</i>	New Zealand	15	Methylglyoxal, high amount of polyphenolic compounds (flavonoids)	[11]
Manuka (MGO 550+)	<i>Leptospermum scoparium</i>	New Zealand	6.3	Methylglyoxal	[14]
Manuka (MGO 971+)	<i>Leptospermum scoparium</i>	New Zealand	6.3	Methylglyoxal, phenyllactic acid and methyl syringate	[12]
Multiflora	-	Poland	1.6	Polyphenols and antioxidants	[13]
Multiflora	-	Kazakhstan	3.1	Hydrogen Peroxide, polyphenols and antioxidants	[13]
Multiflora	-	Italy	12.5	Osmolarity, acidity and hydrogen peroxide	[10]
Multiflora	Herbs	Greece	3.1	Hydrogen peroxide	[14]
Multiflora (A. mellifera)	Multifloral native forest, by Africanized A. mellifera bees	Brazil	10.6*	Phenolic content	[15]
Multiflora (T. angustula)	Typical native fores with B. dracunculifolia, by T. angustula bees	Brazil	12.8*	Phenolic content	[15]
Pine	<i>Pinus</i>	Greece	3.1	Hydrogen peroxide	[14]
Rhododendron	<i>Rhododendron</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
Sunflower	<i>Helianthus</i>	Greece	3.1	Hydrogen Peroxide and antibacterial proteinaceous compounds	[14]
Super manuka (MGO 400+)	<i>Leptospermum polygalifolium</i> <i>Leptospermum lanigerum</i>	Australia	12.5	Phenyllactic acid, hydrogen peroxide and methyl syringate	[12]
Tea tree	& <i>Leptospermum scoparium</i>	Australia	6.3	Hydrogen peroxide, phenyllactic acid and Methyl syringate	[12]
Thyme	<i>Thymus</i> <i>Koompassia excelsa</i> ,	Cyprus	6.3	Hydrogen peroxide	[14]
Tualang	Multifloral by <i>Apis dorsata</i> bees	Malaysia	12.7*	Hydrogen peroxide	[8]

<i>Staphylococcus aureus</i> Methicillin-resistant (MRSA)						
Agastache	<i>Agastache Rugosa</i>	Australia	9.1*	Methyl syringate, phenyllactic acid and hydrogen peroxide	[12]	
Artificial honey	-	-	>30	Osmolarity and acidity	[9]	
Chestnut	<i>Aesculus</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]	
Dandelium	<i>Taraxacum</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]	
Honeydews	-	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]	
Jarrah	<i>Eucalyptus marginata</i>	Australia	18.1*	Hydrogen peroxide	[12]	
Jelly bush	<i>Leptospermum polygalifolium</i>	Australia	2.3*	Methylglyoxal	[12]	
Lime tree	<i>Tilia</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]	
Manuka (medical grade)	<i>Leptospermum scoparium</i>	New Zealand	12.5	Methylglyoxal	[10]	
Manuka (MGO 1200+)	<i>Leptospermum scoparium</i>	New Zealand	12.5	Methylglyoxal	[16]	
Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	9.1*	Methylglyoxal	[8]	
Manuka (MGO 696+)	<i>Leptospermum scoparium</i>	New Zealand	3	Methylglyoxal	[9]	
Manuka (MGO 971+)	<i>Leptospermum scoparium</i>	New Zealand	4.5*	Methylglyoxal, phenyllactic acid and methyl syringate	[12]	
Multiflora	Pasture	New Zealand	3.1	Hydrogen peroxide	[9]	
Multiflora	-	Italy	12.5	Osmolarity, acidity and hydrogen peroxide	[10]	
Rhododendron	<i>Rhododendron</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]	
Super manuka (MGO 400+)	<i>Leptospermum polygalifolium</i>	Australia	9.1*	Phenyllactic acid, hydrogen peroxide and methyl syringate	[12]	
Tea tree	<i>Leptospermum lanigerum</i> & <i>Leptospermum scoparium</i>	Australia	2.3*	Hydrogen peroxide, phenyllactic acid and Methyl syringate	[12]	

	Tualang	<i>Koompassia excelsa</i> , Multifloral by <i>Apis dorsata</i> bees	Malaysia	8.2*	Hydrogen peroxide	[8]
	Ulmo 90	<i>Eucryphia cordifolia</i>	Chile	6.3	Hydrogen peroxide	[16]
<i>Staphylococcus epidermidis</i>	Buckwheat	<i>Fagopyrum esculentum</i> Moench	Poland	3.1	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Chestnut	<i>Aesculus</i>	Italy	6.3	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Honeydew	-	Poland	6.3	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Lime tree	<i>Tilia</i>	Poland	3.1	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Multiflora	-	Poland	1.6	Polyphenols and antioxidants	[13]
	Multiflora	-	Kazakhstan	3.1	Hydrogen Peroxide, polyphenols and antioxidants	[13]
<i>Streptococcus agalactiae</i>	Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	12.7*	Methylglyoxal	[8]
	Tualang	<i>Koompassia excelsa</i> , Multifloral by <i>Apis dorsata</i> bees	Malaysia	10.9*	Hydrogen peroxide	[8]
<i>Streptococcus pyogenes</i>	Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	7.2*	Methylglyoxal	[8]
	Tualang	<i>Koompassia excelsa</i> , Multifloral by <i>Apis dorsata</i> bees	Malaysia	7.2*	Hydrogen peroxide	[8]

GRAM-NEGATIVE BACTERIA

Strain inhibited	Honey Type	Honey/plant source (species)	Origin	MIC (% v/v)	Mechanism of action	Ref.
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<i>Acinetobacter baumannii</i>	Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	9.1*	Methylglyoxal	[8]
	Tualang	<i>Koompassia excelsa</i> , Multifloral by <i>Apis dorsata</i> bees	Malaysia	7.2*	Hydrogen peroxide	[8]
<i>Enterobacter cloacae</i>	Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	16.3*	Methylglyoxal	[8]
	Tualang	<i>Koompassia excelsa</i> , Multifloral by <i>Apis dorsata</i> bees	Malaysia	18.1*	Hydrogen peroxide	[8]
<i>Escherichia coli</i>	Agastache	<i>Agastache Rugosa</i>	Australia	6.3	Methyl syringate, phenyllactic acid and hydrogen peroxide	[12]
	Buckwheat	<i>Fagopyrum esculentum</i> Moench	Poland	6.3	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Chestnut	<i>Aesculus</i>	Italy	12.5	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Chestnut	<i>Aesculus</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Dandelium	<i>Taraxacum</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Honeydew	-	Poland	12.5	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Honeydews	-	Italy	12.5	Osmolarity, acidity and hydrogen peroxide	[10]
	Jarrah	<i>Eucalyptus marginata</i>	Australia	25	Hydrogen peroxide	[12]
	Jelly bush	<i>Leptospermum polygalifolium</i>	Australia	6.3	Methylglyoxal	[12]
	Lime tree	<i>Tilia</i>	Poland	6.3	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Lime tree	<i>Tilia</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Manuka	<i>Leptospermum scoparium</i>	New Zealand	12.5	Methylglyoxal	[10]
	Manuka (MGO 1200+)	<i>Leptospermum scoparium</i>	New Zealand	12.5	Methylglyoxal	[16]
	Manuka (MGO 250+)	<i>Leptospermum scoparium</i>	New Zealand	25	Methylglyoxal, high amount of polyphenolic compounds (flavonoids)	[11]

	Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	20	Methylglyoxal	[8]
	Manuka (MGO 400+)	<i>Leptospermum scoparium</i>	New Zealand	20	Methylglyoxal, high amount of polyphenolic compounds (flavonoids)	[11]
	Manuka (MGO 971+)	<i>Leptospermum scoparium</i>	New Zealand	6.3	Methylglyoxal, phenyllactic acid and methyl syringate	[12]
	Multiflora	-	Poland	3.1	Polyphenols and antioxidants	[13]
	Multiflora	-	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Multiflora	-	Kazakhstan	12.5	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Rhododendron	<i>Rhododendron</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Super manuka (MGO 400+)	<i>Leptospermum polygalifolium</i>	Australia	25	Phenyllactic acid, hydrogen peroxide and methyl syringate	[12]
	Tea tree	<i>Leptospermum lanigerum</i> & <i>Leptospermum scoparium</i>	Tasmania, Australia	12.5	Hydrogen peroxide, phenyllactic acid and Methyl syringate	[12]
	Tualang	<i>Koompassia excelsa</i> , Multifloral by <i>Apis dorsata</i> bees	Malaysia	22.5	Hydrogen peroxide	[8]
	Ulmo 90	<i>Eucryphia cordifolia</i>	Chile	12.5	Hydrogen peroxide	[16]
<i>Proteus mirabilis</i>	Chestnut	<i>Aesculus</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Dandelium	<i>Taraxacum</i>	Italy	50	Osmolarity, acidity and hydrogen peroxide	[10]
	Honeydews	-	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Lime tree	<i>Tilia</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Manuka	<i>Leptospermum scoparium</i>	New Zealand	25	Methylglyoxal	[10]
	Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	16.3*	Methylglyoxal	[8]
	Multiflora	-	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Rhododendron	<i>Rhododendron</i>	Italy	50	Osmolarity, acidity and hydrogen peroxide	[10]

	Tualang	<i>Koompassia excelsa</i> , Multifloral by <i>Apis dorsata</i> bees	Malaysia	16.3*	Hydrogen peroxide	[8]
<i>Pseudomonas aeruginosa</i>	Agastache	<i>Agastache Rugosa</i>	Australia	4.5*	Methyl syringate, phenyllactic acid and hydrogen peroxide	[12]
	Buckwheat	<i>Fagopyrum esculentum</i> Moench	Poland	3.1	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Chestnut	<i>Aesculus</i>	Italy	12.5	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Chestnut	<i>Aesculus</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Dandelium	<i>Taraxacum</i>	Italy	50	Osmolarity, acidity and hydrogen peroxide	[10]
	Eucalyptus	<i>Eucalyptus</i>	Algeria	12	-	[17]
	Honeydew	(<i>Abies Alba</i>)	Poland	>25	High total amount of polyphenolic compounds (flavonoids)	[11]
	Honeydew	-	Poland	12.5	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Honeydews	-	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Jarra	<i>Eucalyptus marginata</i>	Australia	9.1*	Hydrogen peroxide	[12]
	Jelly bush	<i>Leptospermum polygalifolium</i>	Australia	9.1*	Methylglyoxal	[12]
	Lime tree	<i>Tilia</i>	Poland	6.25	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Lime tree	<i>Tilia</i>	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Manuka	<i>Leptospermum scoparium</i>	New Zealand	25	Methylglyoxal	[10]
	Manuka (MGO 1200+)	<i>Leptospermum scoparium</i>	New Zealand	12.5	Methylglyoxal	[16]
	Manuka (MGO 250+)	<i>Leptospermum scoparium</i>	New Zealand	>25	Methylglyoxal, high amount of polyphenolic compounds (flavonoids)	[11]
	Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	12.7*	Methylglyoxal	[8]
	Manuka (MGO 400+)	<i>Leptospermum scoparium</i>	New Zealand	>25	Methylglyoxal, high amount of polyphenolic compounds (flavonoids)	[11]

	Manuka (MGO 550+)	<i>Leptospermum scoparium</i>	New Zealand	12.5	Methylglyoxal	[14]
	Manuka (MGO 971+)	<i>Leptospermum scoparium</i>	New Zealand	18.1*	Methylglyoxal, phenyllactic acid and methyl syringate	[12]
	Multiflora	Herbs	Greece	6.3	Hydrogen peroxide	[14]
	Multiflora	-	Poland	3.1	Polyphenols and antioxidants	[13]
	Multiflora	-	Kazakhstan	6.3	Hydrogen Peroxide, polyphenols and antioxidants	[13]
	Multiflora	-	Italy	25	Osmolarity, acidity and hydrogen peroxide	[10]
	Orange blossom	<i>Citrus sinensis</i>	Algeria	18	-	[17]
	Origan and clover	<i>Trifolium</i>	Greece	6.3	Hydrogen Peroxide and antibacterial proteinaceous compounds	[14]
	Rhododendron	<i>Rhododendron</i>	Italy	50	Osmolarity, acidity and hydrogen peroxide	[10]
	Super manuka (MGO 400+)	<i>Leptospermum polygalifolium</i>	Australia	9.1*	Phenyllactic acid, hydrogen peroxide and methyl syringate	[12]
	Tea tree	<i>Leptospermum lanigerum</i> & <i>Leptospermum scoparium</i>	Tasmania, Australia	4.5*	Hydrogen peroxide, phenyllactic acid and Methyl syringate	[12]
	Tualang	Multifloral by <i>Apis dorsata</i> bees	Malaysia	12.7*	Hydrogen peroxide	[8]
	Ulmo 90	<i>Eucryphia cordifolia</i>	Chile	12.5	Hydrogen peroxide	[16]
<i>Salmonella</i> Enteritidis	Honeydew	(<i>Abies Alba</i>)	Poland	>25	High total amount of polyphenolic compounds (flavonoids)	[11]
	Manuka (MGO 250+)	<i>Leptospermum scoparium</i>	New Zealand	>25	Methylglyoxal, high amount of polyphenolic compounds (flavonoids)	[11]
	Manuka (MGO 400+)	<i>Leptospermum scoparium</i>	New Zealand	25	Methylglyoxal, high amount of polyphenolic compounds (flavonoids)	[11]
<i>Salmonella</i> Typhimurium	Honeydew	(<i>Abies Alba</i>)	Poland	>25	High total amount of polyphenolic compounds (flavonoids)	[11]

	Manuka (MGO 250+)	<i>Leptospermum scoparium</i>	New Zealand	25	Methylglyoxal, high amount of polyphenolic compounds (flavonoids)	[11]
	Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	12.7*	Methylglyoxal	[8]
	Manuka (MGO 400+)	<i>Leptospermum scoparium</i>	New Zealand	25	Methylglyoxal, high amount of polyphenolic compounds (flavonoids)	[11]
	Tualang	<i>Koompassia excelsa</i> , Multifloral by <i>Apis dorsata</i> bees	Malaysia	10.9*	Hydrogen peroxide	[8]
<i>Shigella flexner</i>	Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	18.1*	Methylglyoxal	[8]
	Tualang	<i>Koompassia excelsa</i> , Multifloral by <i>Apis dorsata</i> bees	Malaysia	18.1*	Hydrogen peroxide	[8]
<i>Stenotrophomonas maltophilia</i>	Manuka (MGO 263+)	<i>Leptospermum scoparium</i>	New Zealand	7.2*	Methylglyoxal	[8]
	Tualang	<i>Koompassia excelsa</i> , Multifloral by <i>Apis dorsata</i> bees	Malaysia	7.2*	Hydrogen peroxide	[8]

* MIC values converted from %w/v to %v/v using the honey density of 1.38g/mL (lowest reported density), to report the highest possible MIC.

Table S3. Fungal strains inhibited by different honey types, their corresponding MIC values and mechanism of action suggested by the authors.

FUNGAL STRAINS						
Strain inhibited	Honey Type	Honey source (species)	Origin	MIC (% v/v)	Mechanism of action	Ref.
<i>Aspergillus flavus</i>	Alfalfa	<i>Alfalfa</i>	Iran	25	High phenolic content: tannins, pectin substances, saponines, amines, triterpene glycosides, purines base, phytoestrogens, flavones, isoflavonoids	[18]
	Astragalus	<i>Astragalus</i>	Iran	35	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Chamaemelum	<i>Chamaemelum nobile</i>	Iran	55	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Citrus	<i>Citrus</i>	Iran	50	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Multiflora	Multifloral	Iran	35	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Thymus	<i>Thymus vulgaris</i>	Iran	35	High phenolic content: caravacrol, thymol and gamma terpinene	[18]
	Zizyphus	<i>Zizyphus</i>	Iran	55	Acidic pH, hydrogen peroxide and high osmolarity	[18]
<i>Aspergillus fumigatus</i>	Alfalfa	<i>Alfalfa</i>	Iran	25	High phenolic content: tannins, pectin substances, saponines, amines, triterpene glycosides, purines base, phytoestrogens, flavones, isoflavonoids	[18]
	Astragalus	<i>Astragalus</i>	Iran	40	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Chamaemelum	<i>Chamaemelum nobile</i>	Iran	55	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Citrus	<i>Citrus</i>	Iran	55	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Multiflora	Multifloral	Iran	35	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Thymus	<i>Thymus vulgaris</i>	Iran	35	High phenolic content: caravacrol, thymol and gamma terpinene	[18]
	Zizyphus	<i>Zizyphus</i>	Iran	60	Acidic pH, hydrogen peroxide and high osmolarity	[18]
<i>Aspergillus niger</i>	Acacia	<i>Acacia mangium</i> trees by <i>Apis mellifera</i>	Malaysia	15	-	[19]

	Alfalfa	<i>Alfalfa</i>	Iran	30	High phenolic content: tannins, pectin substances, saponines, amines, triterpene glycosides, purines base, phytoestrogens, flavones, isoflavonoids	[18]
	Astragalus	<i>Astragalus</i>	Iran	35	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Chamaemelum	<i>Chamaemelum nobile</i>	Iran	55	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Citrus	<i>Citrus</i>	Iran	55	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Kelulut	Malaysian stingless bee	Malaysia	10	-	[19]
	Multiflora	Multifloral	Iran	40	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Thymus	<i>Thymus vulgaris</i>	Iran	35	High phenolic content: caravacrol, thymol and gamma terpinene	[18]
	Tualang	<i>Koompassia excelsa</i> , Multifloral by <i>Apis dorsata</i> bees	Malaysia	25	-	[19]
	Zizyphus	<i>Zizyphus</i>	Iran	55	Acidic pH, hydrogen peroxide and high osmolarity	[18]
<i>Candida albicans</i>	A. mellifera	Multifloral, <i>Apis mellifera</i> bee	Mexico	40	Flavonoids cause shrinkage of cell membrane, loss of polarization, and damages on the cell walls of <i>C. albicans</i> .	[20]
	Acacia	<i>Acacia mangium</i> trees by <i>Apis mellifera</i>	Malaysia	15	-	[19]
	Agastache	<i>Agastache Rugosa</i>	Australia	29*	Phenolic compounds: Phenol, 2,4-bis(1,1-dimethylethyl), estragole and nonanoic acid and ethyl ester	[21]
	Alfalfa	<i>Alfalfa</i>	Iran	24.5	High phenolic content: tannins, pectin substances, saponines, amines, triterpene glycosides, purines base, phytoestrogens, flavones, isoflavonoids	[18]

Artificial honey	7.5 g sucrose, 37.5 g maltose,	Laboratory	30.9*	Osmolarity	[22]
	167.5 g glucose, and 202.5 g fructose in 85 mL of sterile water				
Astragalus	<i>Astragalus</i>	Iran	32	Acidic pH, hydrogen peroxide and high osmolarity	[18]
Chamomile	<i>Chamaemelum nobile</i>	Iran	44	Acidic pH, hydrogen peroxide and high osmolarity	[18]
Citrus	<i>Citrus</i>	Iran	42	Acidic pH, hydrogen peroxide and high osmolarity	[18]
Comvita 18+	<i>Leptospermum</i>	New Zealand	28.9*	Methylglyoxal	[22]
Heather	<i>Erica</i>	Portugal	>43.5*	Phenolic compounds. Potential chemical markers: ellagic acid and myricetin-30-methylether	[23]
Jarrah	<i>Eucalyptus marginata</i>	Australia	29*	Hydrogen peroxide and volatile and phenolic compounds: isophorone and Nonanoic acid	[21]
Jarrah	<i>Eucalyptus marginata</i>	Australia	13.4*	Hydrogen peroxide	[22]
Jellybush	<i>Leptospermum polygalifolium</i>	Australia	29*	Volatile and phenolic compounds: linalool and nonanal	[21]
Jujube	<i>Zizyphus spina-christi</i>	Saudi Arabia	29*	Interference with cell membrane integrity, affects exopolysaccharide composition of biofilms	[24]
Kelulut	Malaysian stingless bee	Malaysia	10	-	[19]
M. beecheii	Multifloral, <i>Melipona beecheii</i> bee	Mexico	35	Flavonoids cause loss of polarization of growth, cellular lysis and cell walls damage of C. albicans.	[20]
Mad Honey (>2 mg/mL)	<i>Rhododendron</i>	Turkey	0.1*	Phenolic compounds: linalool, phenethyl alcohol and benzyl alcohol	[25]
Manuka	<i>Leptospermum scoparium</i>	New Zealand	29*	Acetanisole and Methyl 3,5-dimethoxy benzoate	[21]

	Medihoney Barrier	Blend of <i>Leptospermum</i> and hydrogen peroxide honeys	-	27.7*	Methylglyoxal and hydrogen peroxide	[22]
	Multiflora	-	Iran	35	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Surgihoney RO™- low potency	-	-	1.2*	Hydrogen peroxide	[26]
	Surgihoney RO™- high potency	-	-	0.3*	Hydrogen peroxide	[26]
	Tea Tree	<i>Leptospermum lanigerum</i> & <i>Leptospermum scoparium</i>	Australia	29*	Hydrogen Peroxide and major volatile compounds: Acetanisole, and Methyl 3,5-dimethoxy benzoate	[21]
	Thymus	<i>Thymus vulgaris</i>	Iran	26	High phenolic content: caravacrol, thymol and gamma terpinene	[18]
	Tualang	Multifloral by <i>Apis dorsata</i> bees	Malaysia	25	-	[19]
	Zizyphus	<i>Zizyphus</i>	Iran	48	Acidic pH, hydrogen peroxide and high osmolarity	[18]
<i>Candida dubliniensis</i>	Alfalfa	<i>Alfalfa</i>	Iran	15	High phenolic content: tannins, pectin substances, saponines, amines, triterpene glycosides, purines base, phytoestrogens, flavones, isoflavonoids	[18]
	Artificial honey	-	-	24.9*	Osmolarity	[22]
	Astragalus	<i>Astragalus</i>	Iran	25	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Chamaemelum	<i>Chamaemelum nobile</i>	Iran	40	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Citrus	<i>Citrus</i>	Iran	35	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Comvita 18+	<i>Leptospermum</i>	New Zealand	24.2*	Methylglyoxal	[22]
	Jarrah	<i>Eucalyptus marginata</i>	Australia	11.2*	Hydrogen peroxide	[22]

	Medihoney Barrier	Blend of <i>Leptospermum</i> and hydrogen peroxide honeys	-	25.1*	Methylglyoxal and hydrogen peroxide	[22]
	Multiflora	Multifloral	Iran	30	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Thymus	<i>Thymus vulgaris</i>	Iran	20	High phenolic content: caravacrol, thymol and gamma terpinene	[18]
	Zizyphus	<i>Zizyphus</i>	Iran	45	Acidic pH, hydrogen peroxide and high osmolarity	[18]
<i>Candida glabrata</i>	Alfalfa	<i>Alfalfa</i>	Iran	23	High phenolic content: tannins, pectin substances, saponines, amines, triterpene glycosides, purines base, phytoestrogens, flavones, isoflavonoids	[18]
	Artificial honey	7.5 g sucrose, 37.5 g maltose, 167.5 g glucose, and 202.5 g fructose in 85 mL of sterile water	Laboratory	32.4*	Osmolarity	[22]
	Astragalus	<i>Astragalus</i>	Iran	30.5	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Chamaemelum	<i>Chamaemelum nobile</i>	Iran	47	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Citrus	<i>Citrus</i>	Iran	40	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Comvita 18+	<i>Leptospermum</i>	New Zealand	30.9*	Methylglyoxal	[22]
	Jarrah	<i>Eucalyptus marginata</i>	Australia	21.7*	Hydrogen peroxide	[22]
	Medihoney Barrier	Blend of <i>Leptospermum</i> and hydrogen peroxide honeys	-	31.2*	Methylglyoxal and hydrogen peroxide	[22]
	Multiflora	Multifloral	Iran	28.5	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Thymus	<i>Thymus vulgaris</i>	Iran	26	High phenolic content: caravacrol, thymol and gamma terpinene	[18]

	Zizyphus	<i>Zizyphus</i>	Iran	45	Acidic pH, hydrogen peroxide and high osmolarity	[18]
<i>Candida kefyr</i>	Alfalfa	<i>Alfalfa</i>	Iran	30	High phenolic content: tannins, pectin substances, saponines, amines, triterpene glycosides, purines base, phytoestrogens, flavones, isoflavonoids	[18]
	Astragalus	<i>Astragalus</i>	Iran	35	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Chamaemelum	<i>Chamaemelum nobile</i>	Iran	55	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Citrus	<i>Citrus</i>	Iran	55	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Multiflora	Multifloral	Iran	40	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Thymus	<i>Thymus vulgaris</i>	Iran	35	High phenolic content: caravacrol, thymol and gamma terpinene	[18]
	Zizyphus	<i>Zizyphus</i>	Iran	55	Acidic pH, hydrogen peroxide and high osmolarity	[18]
<i>Candida krusei</i>	Alfalfa	<i>Alfalfa</i>	Iran	23.5	High phenolic content: tannins, pectin substances, saponines, amines, triterpene glycosides, purines base, phytoestrogens, flavones, isoflavonoids	[18]
	Astragalus	<i>Astragalus</i>	Iran	32	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Chamaemelum	<i>Chamaemelum nobile</i>	Iran	49.5	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Citrus	<i>Citrus</i>	Iran	42	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Heather	<i>Erica</i>	Portugal	43.5*	Phenolic compounds. Potential chemical markers: ellagic acid and myricetin-30-methylether	[23]
	Multiflora	Multifloral	Iran	35	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Thymus	<i>Thymus vulgaris</i>	Iran	23.5	High phenolic content: caravacrol, thymol and gamma terpinene	[18]
	Zizyphus	<i>Zizyphus</i>	Iran	50	Acidic pH, hydrogen peroxide and high osmolarity	[18]
<i>Candida parapsilosis</i>	Alfalfa	<i>Alfalfa</i>	Iran	25	High phenolic content: tannins, pectin substances, saponines, amines, triterpene glycosides, purines base, phytoestrogens, flavones, isoflavonoids	[18]
	Astragalus	<i>Astragalus</i>	Iran	30	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Chamaemelum	<i>Chamaemelum nobile</i>	Iran	45	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Citrus	<i>Citrus</i>	Iran	40	Acidic pH, hydrogen peroxide and high osmolarity	[18]

	Multiflora	Multifloral	Iran	35	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Thymus	<i>Thymus vulgaris</i>	Iran	25	High phenolic content: caravacrol, thymol and gamma terpinene	[18]
	Zizyphus	<i>Zizyphus</i>	Iran	50	Acidic pH, hydrogen peroxide and high osmolarity	[18]
<i>Candida neoformans</i>	Heather	<i>Erica</i>	Portugal	>43.5*	Phenolic compounds. Potential chemical markers: ellagic acid and myricetin-30-methylether	[23]
<i>Candida tropicalis</i>	Alfalfa	<i>Alfalfa</i>	Iran	25	High phenolic content: tannins, pectin substances, saponines, amines, triterpene glycosides, purines base, phytoestrogens, flavones, isoflavonoids	[18]
	Astragalus	<i>Astragalus</i>	Iran	30	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Chamaemelum	<i>Chamaemelum nobile</i>	Iran	46	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Citrus	<i>Citrus</i>	Iran	43	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Multiflora	Multifloral	Iran	35	Acidic pH, hydrogen peroxide and high osmolarity	[18]
	Thymus	<i>Thymus vulgaris</i>	Iran	26.5	High phenolic content: caravacrol, thymol and gamma terpinene	[18]
	Zizyphus	<i>Zizyphus</i>	Iran	46	Acidic pH, hydrogen peroxide and high osmolarity	[18]
<i>Trichophyton mentagrophytes</i>	Agastache	<i>Agastache Rugosa</i>	Australia	29*	Phenolic compounds: Phenol, 2,4-bis(1,1-dimethylethyl), estragole and nonanoic acid and ethyl ester	[21]
	Tea Tree	<i>Leptospermum lanigerum & Leptospermum scoparium</i>	Australia	29*	Hydrogen Peroxide and major volatile compounds: Acetanisole, and Methyl 3,5-dimethoxy benzoate	[21]
<i>Trichophyton rubrum</i>	Agastache	<i>Agastache Rugosa</i>	Australia	29*	Phenolic compounds: Phenol, 2,4-bis(1,1-dimethylethyl), estragole and nonanoic acid and ethyl ester	[21]
	Alfalfa	<i>Alfalfa</i>	Iran	20	High phenolic content: tannins, pectin substances, saponines, amines, triterpene glycosides, purines base, phytoestrogens, flavones, isoflavonoids	[18]
	Astragalus	<i>Astragalus</i>	Iran	31	Acidic pH, hydrogen peroxide and high osmolarity	[18]

Chamaemelum	<i>Chamaemelum nobile</i>	Iran	43	Acidic pH, hydrogen peroxide and high osmolarity	[18]
Citrus	<i>Citrus</i>	Iran	39	Acidic pH, hydrogen peroxide and high osmolarity	[18]
Manuka	<i>Leptospermum scoparium</i>	New Zealand	29*	Acetanisole, and Methyl 3,5-dimethoxy benzoate	[18]
Multiflora	Multifloral	Iran	25	Acidic pH, hydrogen peroxide and high osmolarity	[18]
Thymus	<i>Thymus vulgaris</i>	Iran	22	High phenolic content: carvacrol, thymol and gamma terpinene	[18]
Zizyphus	<i>Zizyphus</i>	Iran	44	Acidic pH, hydrogen peroxide and high osmolarity	[18]

* MIC values converted from %w/v to %v/v using the honey density of 1.38g/mL (lowest reported density), to report the highest possible MIC.

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