Bahamian Botanicals: Traditional Uses and Phytochemical Benefits

University of The Bahamas

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Contents

[1]

[1]* means experimentally verified

Chapter 1

Love Vine

1.1 General Description

Love Vine, scientifically known as Cassytha filiformis, is commonly found throughout The Bahamas, the Caribbean, Southern United States, and tropical and subtropical regions of the world. It grows on plants in dry broadleaf evergreen formations, in woodland forests and shrublands, dunes, rocky shore, wetlands and human-altered environments. This plant is a yellowish-orange parasitic vine that covers other vegetation, attached via haustoria to branches and leaves. The highly reduced scale-like leaves are spirally arranged with flowers arranged in axillary in spikes. The vines are used medicinally by boiling to make a concentrated bush tea that is used as an aphrodisiac for "sex weakness", obstetric and gynecological concerns, and skin treatments for pain, itching and prickly heat. The chemicals found in this species that assists with its usage are saponin, flavonoid, tannin, phytate, cardiac glycosides, oxalate, haemaglutinin, tetrahydroisoquinoline alkaloids (laurotetainin, cassyfiline, cassythidine, cassythicine), alpha-caryophyllene, humulene and eremophilene

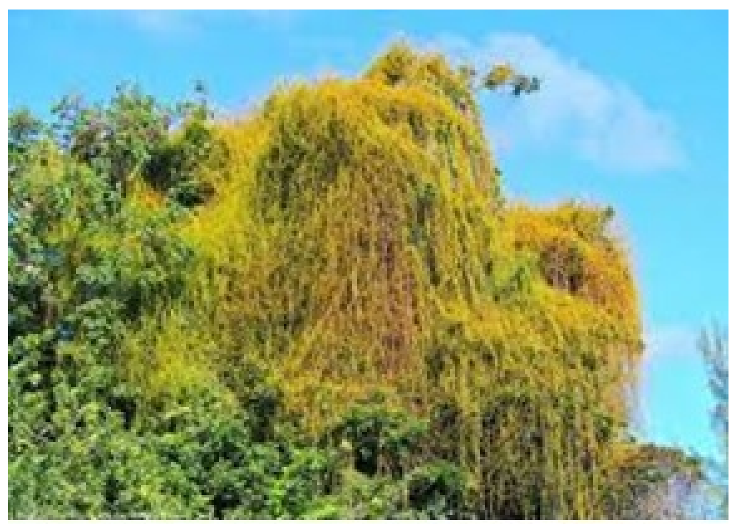


Table 1.1: Love Vine Whole Plant Benefits

Benefit	*Reference*
Cancer	Nelson, S. C. (2008). Cassytha filiformis.
Jellyfish Sting	Nelson, S. C. (2008). Cassytha filiformis.
Easing birthing and labour	Nelson, S. C. (2008). Cassytha filiformis.
Increase Diuretic Activity	Sakshy, S., Hullatti, K. K., Prasanna, S. M., Kuppast, I. J., and Paras, S. (2009). Comparative study of Cuscuta reflexa and Cassytha filiformis for diuretic activity. Pharmacognosy Research, 1(5).
Hepatoprotective (liver)	https://doi.org/10.1016/j.jopr.2013.01.011
Anti-bacterial	https://doi.org/10.1016/j.jopr.2013.01.011
treatment of ulcer, hemorrhoids, hepatitis, and cough and also has diuretic effect	https://doi.org/10.1016/j.jopr.2013.01.011
Sleep inducer	https://patents.google.com/patent/WO2018129138A1/en
Soap	Eldridge, J. (1975). Bush medicine in the Exumas and long island, Bahamas a field study. Economic Botany, 29(4), 307-332.
Lotion	Eldridge, J. (1975). Bush medicine in the Exumas and long island, Bahamas a field study. Economic Botany, 29(4), 307-332.

1.2 Phytochemical Benefits

1.2.1 Saponin

Table 1.2: Benefits of Saponin are shown in the table below

Benefit	*Reference*
Obesity	10.3390/molecules21101404
Insulin and glucose regulation	https://doi.org/10.1016/0963-9969(93)90069-U
reduce the availability of nutrients and cause growth inhibition (negative)	https://doi.org/10.1016/0963-9969(93)90069-U
Colon Cancer	10.3748/wjg.v16.i27.3371
Fungal Resistance	https://doi.org/10.1016/S1360-1385(96)80016-1
Soap	https://doi.org/10.1016/S1360-1385(96)80016-1;
Soap	https://www.newdirections.com.au/Articles/Saponins-Natures-Soap-and-So-Much-More
Skin Moisturizer	10.1080/09168451.2018.1547627
Skin Wound Healing	10.5142/jgr.2011.35.3.360
Hair Conditioning	https://doi.org/10.1111/j.1467-2494.1989.tb00510.x
Hair Growth	https://doi.org/10.7236/IJASC.2019.8.1.184

1.2.2 Flavonoid c-glycoside

Table 1.3: Benefits of flavonoid c-glycosides are shown in the table below

Benefit	*Reference*
Anticancer and Antitumor activity	https://doi.org/10.1016/j.tetlet.2019.151313
Anti-inflammatory activity	https://doi.org/10.1016/j.tet.2004.08.015
Anti-inflammatory activity	https://doi.org/10.1021/jo801432t
Memory ameliorating activity	https://doi.org/10.1016/j.pbb.2014.02.015
Memory ameliorating activity	https://doi.org/10.1016/j.pbb.2016.03.007
Antiviral activity	https://doi.org/10.1016/j.Antiviral.2008.04.004
Antiviral activity	10.1055/s-0031-1280128
Antiplatelet activity	https://doi.org/10.1021/np970011e
Antiplatelet activity	https://doi.org/10.1248/bpb.b18-00952
Anti aging cream	https://doi.org/10.1016/j.bmcl.2008.12.037
Anti aging cream	10.1039/9781849739986-00001
skin depigmentation	https://patents.google.com/patent/CN100484509C/en

1.2.3 Beta-Caryophyllene*

Table 1.4: Benefits of beta-Caryophyllene are shown in the table below

Benefit	*Reference*
Antibacterial activity	https://doi.org/10.1016/j.sajb.2021.07.046
Antibacterial activity (pneumonia - mice)	https://doi.org/10.1016/j.sjbs.2021.06.034
Antiviral activity (zika virus)	https://doi.org/10.1016/j.indcrop.2021.113281; https://doi.org/10.1016/j.actatropica.2020.105556
Anticonvulsant/epileptic seizure (mice)	https://doi.org/10.1016/j.eplepsyres.2021.106842
increased libido in women	https://doi.org/10.1016/j.esxm.2020.06.001
Osteoarthritis Treatment (mice)	https://doi.org/10.1016/j.neuropharm.2021.108908
general review	https://doi.org/10.1016/j.biopha.2021.111639
Alcohol addiction	10.1016/j.pbb.2014.06.025
Neuropathic pain	10.1016/j.euroneuro.2013.10.008
Neuropathic pain	10.1016/j.phymed.2013.08.006
Neuropathic pain	10.4236/pp.2012.34053
Nociception	10.1038/ncpneuro0113
Neuropathic pain	https://doi.org/10.3390/molecules25010106
Insulin resistance and dyslipidemia	10.1016/j.cbi.2018.10.010
Insulin resistance and associated neurobehavioral changes	10.1016/j.biopha.2018.11.039
Atherosclerosis	10.1016/j.taap.2017.06.016
Ulcerative colitis	10.1016/j.ajpath.2010.11.052
Immunomodulation	10.3390/ijms18040691
Peripheral neuropathy	10.1016/j.neuropharm.2017.07.015
Chemotherapy-induced cardiotoxicity	10.1016/j.cbi.2019.02.028
Nephroprotective	10.1016/j.freeradbiomed.2012.01.014
Parkinson's disease	10.3389/fnins.2016.00321
Parkinson's disease	10.3390/ph10030060
Alzheimer's disease	10.1159/000362689
Post-stroke cognitive deficits	10.3389/fphar.2017.00002
Cerebral ischemia	10.1016/j.ajpath.2012.11.024

[Cont'd] Benefits of beta-Caryophyllene are shown in the table below

Benefit	*Reference*
Cerebral ischemia	10.1186/s12944-018-0661-4
Depression and anxiety	10.1016/j.physbeh.2014.06.003
Depression	10.1016/j.bbr.2019.112439
Liver fibrosis	10.1016/j.ejphar.2014.08.021
Alcohol liver damage	10.1111/bph.13722
Nicotine addiction	10.1111/bph.14969
Arthritis	10.3390/biom9080326
Obesity and related complications	10.1016/j.bbrc.2013.05.108
Hyperglycemia	10.1016/j.bbrc.2013.11.136
Atherosclerosis	10.1016/j.taap.2017.06.016
Cancer	10.3390/cancers12041038
Parkinson's disease	10.1016/j.biopha.2018.03.168
Cerebral ischemia-reperfusion injury	10.1080/07391102.2019.1567384
Multiple sclerosis	10.1016/j.lfs.2018.12.059
Multiple sclerosis	10.1016/j.bcp.2018.12.001
Neuroinflammation	10.1007/s12031-014-0243-5
Glioma	10.1016/j.neuroscience.2014.08.043
Depression	10.1016/j.bbr.2019.112439
Hepatic steatosis	10.1002/mnfr.201600197
Osteoporosis	10.1002/iub.158
Mucositis	10.3390/BIOMEDICINES8060164
Antifungal	10.1023/A:1007178924408
Fragrance	https://doi.org/10.1016/j.fct.2008.06.030
skin creams, shampoos and lotions	https://www.naturemary.com/beta-caryophyllene-for-skin/

1.2.4 Phytate

Table 1.5: Benefits of Phytate are shown in the table below

Benefit	*Reference*
Anti-cancer	10.1093/jn/133.11.3778S
Anti-cancer (breast)	Shamsuddin, A. M., Yang, G. Y., and Vucenik, I. V. A. N. A. (1996). Novel Anti-cancer functions of IP6: growth inhibition and differentiation of human mammary cancer cell lines in vitro. Anticancer research, 16(6A), 3287-3292.
Anti-cancer (colon)	10.3390/molecules25245931
Anti-cancer (cervical)	10.1093/carcin/23.12.2031
coronary protection	Jariwalla RJ, Sabin R, Lawson S, Herman ZS. Lowering of serum cholesterol and triglycerides and
	modulation of divalent cations by dietary phytate. J Appl Nutr 1990; 42: 18–28.
Anti-diabetic	https://doi.org/10.1016/0963-9969(93)90069-U
kidney stone reduction	10.1080/003655900750016526
kidney stone reduction	10.1016/j.lfs.2003.11.030

1.2.5 Eremophilene*

Table 1.6: Benefits of Eremophilene are shown in the table below

Benefit	*Reference*
Anti-Bacterial	https://doi.org/10.3390/molecules23071679
Anti-Oxidants	Chemical composition and Antioxidant properties of Ferula-assa-foetida leaves essential oil

1.2.6 Humulene*

Table 1.7: Benefits of Humulene are shown in the table below

Benefit	*Reference*
Anti-inflammatory	https://doi.org/10.1111/j.1476-5381.2009.00177.x
Anti-cancer	https://doi.org/10.3892/or.2010.1087
Anti-cancer	https://doi.org/10.1211/jpp.59.12.0005
Anti-bacterial	https://doi.org/10.1139/cjm-2020-0004
Anti-tumor	10.1002/biof.552210127
Beer	https://doi.org/10.1094/ASBCJ-46-0104
Insect-repellant	DOI:10.1016/0031-9422(93)85098-C
Insect-repellant	https://doi.org/10.1016/j.ecoenv.2017.11.044
Hair loss	Galcerá, F. C. (2002). U.S. Patent No. 6,447,762. Washington, DC: U.S. Patent and Trademark Office.
Renal Health	https://doi.org/10.1016/j.cbi.2017.10.021
Perfumes and oils	https://shop.perfumersapprentice.com/p-8493-humulene-natural.aspx
soap	https://artofsoaps.com/terpenes-2021-guide/
Asthma	10.1111/j.1476-5381.2009.00177.x
Anti-cancer	10.1093/jn/133.11.3778S
Anti-cancer (breast)	Shamsuddin, A. M., Yang, G. Y., and Vucenik, I. V. A. N. A. (1996). Novel Anti-cancer functions of IP6: growth inhibition and differentiation of human mammary cancer cell lines in vitro. Anticancer research, 16(6A), 3287-3292.
Anti-cancer (colon)	10.3390/molecules25245931
Anti-cancer (cervical)	10.1093/carcin/23.12.2031
coronary protection	Jariwalla RJ, Sabin R, Lawson S, Herman ZS. Lowering of serum cholesterol and triglycerides and modulation of divalent cations by dietary phytate. J Appl Nutr 1990; 42: 18–28.
Anti-diabetic	https://doi.org/10.1016/0963-9969(93)90069-U
kidney stone reduction	10.1080/003655900750016526
kidney stone reduction	10.1016/j.lfs.2003.11.030

1.2.7 Tetrahydroisoquinoline Alkaloids

Table 1.8: Benefits of Tetrahydroisoquinoline Alkaloids are shown in the table below

Benefit	*Reference*
Laurotetainin	
Antitumor diuretic Antiviral analgesics Anti-inflammatory	Anarado, C. E., Anarado, C. J. O., Umedum, N. L., Chukwubueze, F. M., and Anarado, I. L. (2020). Phytochemical and Antimicrobial analysis of leaves of Bridelia micrantha, Cassytha filiformis, Euphorbia hirta and Securinega virosa. Journal of Pharmacognosy and Phytochemistry, 9(3), 581-587.
Anti-acetylcholinesterase (AChE) Anti-alpha-glucosidase Anti-leishmanial Anti-fungal	National Center of Advancing Translational Science. (n.d.). NCATS INXIGHT drugs - laurotetanine. Inxight Drugs. Retrieved January 21, 2022, from https://drugs.ncats.io/drug/SDW3N623LN
Antiplasmodial activity good Antioxidant activities	National Center of Advancing Translational Science. (n.d.). NCATS INXIGHT drugs - laurotetanine. Inxight Drugs. Retrieved January 21, 2022, from https://drugs.ncats.io/drug/SDW3N623LN
Anti-asthmatic effect (in rats)	http://dx.doi.org/10.4314/tjpr.v18i6.19
Cassyfiline	
Antitumor diuretic Antiviral analgesics Anti-inflammatory	Anarado, C. E., Anarado, C. J. O., Umedum, N. L., Chukwubueze, F. M., and Anarado, I. L. (2020). Phytochemical and Antimicrobial analysis of leaves of Bridelia micrantha, Cassytha filiformis, Euphorbia hirta and Securinega virosa. Journal of Pharmacognosy and Phytochemistry, 9(3), 581-587.
Astringent Chronic dysentery Kills vermin Hair tonic and shampoo Ulcer Cleaner	Kumar, A. (2003). Environment, pollution and management. APH Publishing.
Cassythidine	
Antitumor diuretic Antiviral analgesics Anti-inflammatory	Anarado, C. E., Anarado, C. J. O., Umedum, N. L., Chukwubueze, F. M., and Anarado, I. L. (2020). Phytochemical and Antimicrobial analysis of leaves of Bridelia micrantha, Cassytha filiformis, Euphorbia hirta and Securinega virosa. Journal of Pharmacognosy and Phytochemistry, 9(3), 581-587.
Astringent Chronic dysentery Kills vermin Hair tonic and shampoo Ulcer Cleaner	Kumar, A. (2003). Environment, pollution and management. APH Publishing.

Cont'd Benefits of Tetrahydroisoquinoline Alkaloids are shown in the table below

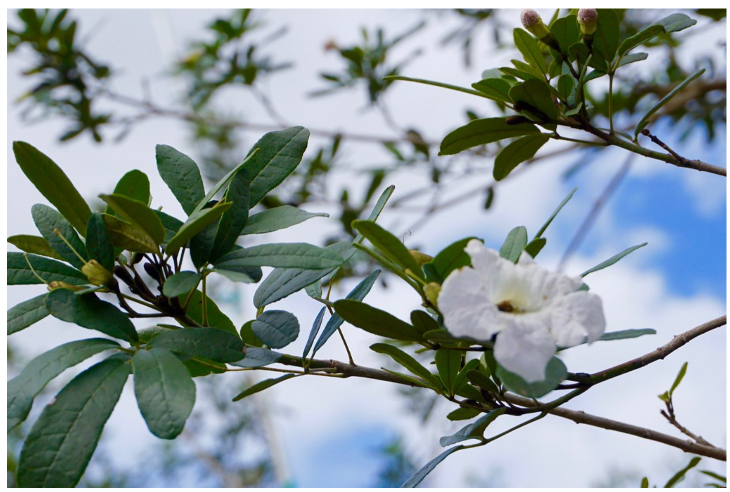
Benefit	*Reference*
Cassythicine	
Antitumor diuretic Antiviral analgesics Anti-inflammatory	Anarado, C. E., Anarado, C. J. O., Umedum, N. L., Chukwubueze, F. M., and Anarado, I. L. (2020). Phytochemical and Antimicrobial analysis of leaves of Bridelia micrantha, Cassytha filiformis, Euphorbia hirta and Securinega virosa. Journal of Pharmacognosy and Phytochemistry, 9(3), 581-587.
Astringent Chronic dysentery Kills vermin Hair tonic and shampoo Ulcer Cleaner	Kumar, A. (2003). Environment, pollution and management. APH Publishing.

Chapter 2

Five Finger

2.1 General Description

Five fingers, so named for its leaves that grows in batches of five is scientifically known as Tabebuia bahamensis. It is native to the Bahamas and is also known as Dwarf Bahamian trumpet tree. The leaf is used for teas and used to make a famous traditional Bahamian concoction called "Twenty-one Gun Salute" , so named because it is believed to be a love potion that is an aphrodisiac and sexual stimulant. It is also used topically in body creams or in shampoos due to its anti-infectious properties. The leaf contains ursolic acid which has demonstrated to be very effective as an antibacterial and antifungal agent.



2.2 Phytochemical Benefits

2.2.1 Ursolic Acid

Table 2.1: Benefits of Ursolic acid are shown in the table below

Benefit	*Reference*
Antibacterial activity against Staphylococcus aureus	https://doi.org/10.7275/R54X55RX
Antimicrobial	https://doi.org/10.1016/j.foodres.2017.10.028
Anticancer	https://doi.org/10.7275/R54X55RX
Anticancer	https://doi.org/10.1002/mnfr.200700389
Antiangiogenic	https://doi.org/10.1177/1534735410367647
protect against chemically induced liver injuries (hepatoprotection)	https://doi.org/10.1016/0378-8741(95)90032-2
hepatoprotection	https://doi.org/10.1016/j.jep.2005.05.024
Anti-inflammatory	https://doi.org/10.1016/0378-8741(95)90032-2
Anti-inflammatory	https://doi.org/10.1073/pnas.2000208117
Anti-inflammatory	https://doi.org/10.1002/mnfr.200700389
treatment of multiple sclerosis	https://doi.org/10.1073/pnas.2000208117
Antihyperlipidemic	https://doi.org/10.1016/0378-8741(95)90032-2
Antihyperlipidemic	https://doi.org/10.1016/j.foodres.2017.10.028
Antitumor-promotion effects	https://doi.org/10.1016/0378-8741(95)90032-2
Antitumor	https://doi.org/10.1016/j.jep.2005.05.024
Cosmetics and health products	https://doi.org/10.1016/0378-8741(95)90032-2
Antioxidant	https://doi.org/10.4196/kjpp.2018.22.3.235
Antioxidant	https://doi.org/10.1002/mnfr.200700389
Anti-apoptotic	https://doi.org/10.4196/kjpp.2018.22.3.235
Anti-carcinogenic	https://doi.org/10.4196/kjpp.2018.22.3.235
cardioprotective	https://doi.org/10.4196/kjpp.2018.22.3.235
cardioprotective	https://doi.org/10.1016/j.foodres.2017.10.028
Anti-diabetic	https://doi.org/10.4196/kjpp.2018.22.3.235
Anti-diabetic	https://doi.org/10.1073/pnas.2000208117
neuroprotective	https://doi.org/10.4196/kjpp.2018.22.3.235
Anti-skeletal muscle atrophy	https://doi.org/10.4196/kjpp.2018.22.3.235
thermogenic effects	https://doi.org/10.4196/kjpp.2018.22.3.235
cytotoxic	https://doi.org/10.1016/j.ejmech.2005.01.001

2.2.2 Lapachol

Table 2.2: Benefits of Lapachol are shown in the table below

Benefit	*Reference*
Antibacterial	doi: 10.11144/Javeriana.SC18-3.aapg
Antibacterial	DOI: 10.1055/s-2006-959504
Antiviral	doi: 10.11144/Javeriana.SC18-3.aapg
Antiviral	Oliveira, M. F., Lemos, T. L., MATTOS, M. C., Segundo, T. A., SAntiago, G. M., and Braz-Filho, R. (2002). New enamine derivatives of lapachol and biological activity. Anais da Academia Brasileira de Ciências, 74, 211-221.
Antiparasitic	doi: 10.11144/Javeriana.SC18-3.aapg
Antifungal	doi: 10.11144/Javeriana.SC18-3.aapg
Antifungal	DOI: 10.1055/s-2006-959504
Antimalarial agent	https://doi.org/10.1016/S1572-5995(05)80036-5
Antimalarial	Oliveira, M. F., Lemos, T. L., MATTOS, M. C., Segundo, T. A., SAntiago, G. M., and Braz-Filho, R. (2002). New enamine derivatives of lapachol and biological activity. Anais da Academia Brasileira de Ciências, 74, 211-221.
Anti-abscess	http://dx.doi.org/10.3998/ark.5550190.0008.204
Anti-cancer	https://dx.doi.org/10.3390/molecules25040893
Anti-cancer	https://doi.org/10.1007/s11101-013-9289-1
Anti-cancer	Oliveira, M. F., Lemos, T. L., MATTOS, M. C., Segundo, T. A., SAntiago, G. M., and Braz-Filho, R. (2002). New enamine derivatives of lapachol and biological activity. Anais da Academia Brasileira de Ciências, 74, 211-221.
Anti-ulcer	http://dx.doi.org/10.3998/ark.5550190.0008.204
Antileishmanial	http://dx.doi.org/10.3998/ark.5550190.0008.204
Antileishmanial	https://doi.org/10.1016/j.exppara.2019.02.013
Antileishmanial	https://doi.org/10.1590/S0074-02762004000700017
Anticarcinoma	http://dx.doi.org/10.3998/ark.5550190.0008.204
Anti-endemic	http://dx.doi.org/10.3998/ark.5550190.0008.204
Anti-inflammatory	http://dx.doi.org/10.3998/ark.5550190.0008.204
Anti-inflammatory	E R Almeida, A A Silva-Filho, E R Santos, C A C Lopes.(1990). Anti inflammatory Action of Lapachol Journal of Ethnopharmacology 29: 239-241 January
Anti-inflammatory (topical)	https://doi.org/10.1208/s12249-007-9002-z
Antiseptic	http://dx.doi.org/10.3998/ark.5550190.0008.204

[Cont'd] Benefits of Lapachol are shown in the table below

Benefit	*Reference*
Antitumor	http://dx.doi.org/10.3998/ark.5550190.0008.204
Antitumor	Rao, K. V., McBride, T. J., and Oleson, J. J. (1968). Recognition and evaluation of lapachol as an Antitumor agent. Cancer Research, 28(10), 1952-1954.
insectifugal	http://dx.doi.org/10.3998/ark.5550190.0008.204
pesticidal	http://dx.doi.org/10.3998/ark.5550190.0008.204
protisticidal	http://dx.doi.org/10.3998/ark.5550190.0008.204
respiradespressant	http://dx.doi.org/10.3998/ark.5550190.0008.204
schistosomicidal	http://dx.doi.org/10.3998/ark.5550190.0008.204
schistosomicidal	Oliveira, M. F., Lemos, T. L., MATTOS, M. C., Segundo, T. A., SAntiago, G. M., and Braz-Filho, R. (2002). New enamine derivatives of lapachol and biological activity. Anais da Academia Brasileira de Ciências, 74, 211-221.
termiticidal	http://dx.doi.org/10.3998/ark.5550190.0008.204
viricidal	http://dx.doi.org/10.3998/ark.5550190.0008.204
Antimicrobial	Oliveira, M. F., Lemos, T. L., MATTOS, M. C., Segundo, T. A., SAntiago, G. M., and Braz-Filho, R. (2002). New enamine derivatives of lapachol and biological activity. Anais da Academia Brasileira de Ciências, 74, 211-221.
molluscicidal and trypanocidal	DOI: 10.1055/s-2001-10877

Chapter 3

Sweet Margaret

3.1 General Description

The Sweet Margaret plant is also commonly known as wild guava, and scientifically known as Psidium longipes. This plant can be found throughout The Bahamas, as well as in Florida and Mexico. It grows on both sand and hardened limestone substrates in forests, woodlands, shrublands and pinelands. It is common along rocky coastlines as well as interior plant communities. The Sweet Margaret grows as a low shrub to a small tree up to 15 feet in height. The leaves are arranged oppositely with smooth margins and young stems and petioles often have a reddish colour. The leaves have a distinctive odour when crushed and the fruit is a berry that turns dark red to black with maturity. The leaves of the Sweet Margaret plant are traditionally used in teas to treat colds, diarrhea, stomachaches and as an aphrodisiac. Phytochemicals found in its leaves include limonene, eucalyptol, a-eudesmol, a-pinene and beta-eudesmol.

3.2 Phytochemical Benefits

3.2.1 Limonene

Table 3.1: Benefits of limonene are shown in the table below

Benefit	*Reference*
Antifungal	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antifungal	https://doi.org/10.1177/1934578X0800300728
Antilarval	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
chemoprotective	https://doi.org/10.1177/1934578X0800300728
Antioxidant	https://doi.org/10.1177/1934578X0800300728
Anti-inflammatory	https://doi.org/10.1177/1934578X0800300728
Anti-inflammatory	https://doi.org/10.1042/BSR20181253
Anti-inflammatory	https://doi.org/10.1007/s10753-016-0496-y
Antinociceptive	https://doi.org/10.1177/1934578X0800300728
Antinociceptive	https://doi.org/10.1007/s10753-016-0496-y
Anticancer	https://doi.org/10.1177/1934578X0800300728
Anticancer	https://doi.org/10.1042/BSR20181253
insecticidal	https://doi.org/10.1177/1934578X0800300728
Antitumor	https://doi.org/10.1042/BSR20181253

3.2.2 Eucalyptol*

Table 3.2: Benefits of Eucalyptol are shown in the table below

Benefit	*Reference*
Flavouring agent	DOI: 10.5530/rjps.2015.4.2
Fragrance	DOI: 10.5530/rjps.2015.4.2
Mouthwash and toothpaste	DOI: 10.5530/rjps.2015.4.2
Cosmetics: perfumes, soap, cream, lotion	DOI: 10.5530/rjps.2015.4.2
Antinociceptive properties (potential calmative and depressant)	DOI: 10.5530/rjps.2015.4.2
blood circulation	DOI: 10.5530/rjps.2015.4.2
Anti-inflammatory effects	DOI: 10.5530/rjps.2015.4.2
Anti-inflammatory	https://doi.org/10.3390/molecules26164933
Anti-inflammatory	https://doi.org/10.1080/10412905.2020.1716867
Anti-inflammatory (Bronchial asthma)	https://doi.org/10.1053/rmed.2003.1432
Secretolytic properties and myorelaxant effects	DOI: 10.5530/rjps.2015.4.2
Antifungal and Antibacterial	DOI: 10.5530/rjps.2015.4.2
Antimicrobial	https://doi.org/10.3390/molecules26164933
Antimicrobial	https://doi.org/10.3390/catal12010048
Antioxidant and lipoxygenase inhibitory actions Antioxidant	DOI: 10.5530/rjps.2015.4.2
Hepatoprotective effect	DOI: 10.5530/rjps.2015.4.2
Antitumorogenic effect (potential to treat coloreactal cancer) Anticancer	DOI: 10.5530/rjps.2015.4.2
bio-insecticidal efficacy	https://doi.org/10.1590/S0036-46652004000200008
Repellent	https://doi.org/10.3390/catal12010048
potential treatment to act as COVID-19 Mpro inhibitor	doi: 10.20944/preprints202003.0455.v1
Antiseptic	https://doi.org/10.3390/molecules26164933
Bronchodilatory effects (clears respiratory tract and nasal cavities from secretions)	https://doi.org/10.3390/molecules26164933
Bronchodilatory effects	https://doi.org/10.1080/10412905.2020.1716867
Antitussive	https://doi.org/10.3390/catal12010048

3.2.3 a-eudesmol

Table 3.3: Benefits of a-eudesmol l are shown in the table below

Benefit	*Reference*
Cytotoxic effects on cancer cells	Bhagat, M., Gupta, S., Jamwal, V. S., Sharma, S., Kattal, M., Dawa, S., ... and Bindu, K. (2016). Comparative study on chemical profiling and Antimicrobial properties of essential oils from different parts of Eucalyptus lanceolatus.
Calcium channel inhibitory activity (effective for treatment of cerebral apoplexy, Alzheimer's and migraine)	DOI: 10.1055/s-2001-16804
Antifungal	https://doi.org/10.1515/HF.2005.049
Acaricidal (Potential use as control agents against house dust and stored food mite)	https://doi.org/10.4315/0362-028X-72.8.1686
Antimicrobial	https://doi.org/10.1590/S0103-50532007000500002

3.2.4 b-eudesmol

Table 3.4: Benefits of b-eudesmol l are shown in the table below

Benefit	*Reference*
Anti-cancer activity	https://doi.org/10.1111/1440-1681.12354
Antiangiogenic activity; potential for use in chemotherapy	https://doi.org/10.1002/bmc.5021
Inhibit proliferation of tumour cells	https://doi.org/10.1080/10286020701394332
Anti-inflammatory	https://doi.org/10.3109/08923973.2010.491082
Hepatoprotective (in mice)	https://doi.org/10.1016/bs.apha.2017.03.004
Stimulates appetite	https://doi.org/10.1038/s41598-017-16150-6
Antihyperglycemic	https://doi.org/10.1248/yakushi.126.133

3.2.5 a-pinene

Table 3.5: Benefits of a-pinene are shown in the table below

Benefit	*Reference*
Anti-inflammatory effects	Bhagat, M., Gupta, S., Jamwal, V. S., Sharma, S., Kattal, M., Dawa, S., ... and Bindu, K. (2016). Comparative study on chemical profiling and Antimicrobial properties of essential oils from different parts of Eucalyptus lanceolatus.
Antimicrobial	https://doi.org/10.3390/molecules17066305
Antimicrobial	https://dx.doi.org/10.3390/biom9110738
Antimicrobial	https://doi.org/10.1080/10412905.1999.9701162
Antibacterial	https://doi.org/10.3390/molecules17066305
Antibacterial (hand sanitizer)	Wijayati, N., Widiyastuti, A., Mursiti, S., and Rakainsa, S. K. (2020, May). Formulation of Hand Sanitizer Gel of A-Pinene Isolated from Turpentine Oil and its Antibacterial Activity. In IOP Conference Series: Materials Science and Engineering (Vol. 846, No. 1, p. 012069). IOP Publishing.
Fungicidal	https://dx.doi.org/10.3390/biom9110738
Fungicidal	https://doi.org/10.3390/molecules17066305
Flavoring	https://dx.doi.org/10.3390/biom9110738
Flavoring	https://doi.org/10.3390/molecules17066305
Fragrances	https://dx.doi.org/10.3390/biom9110738
Antiviral	https://dx.doi.org/10.3390/biom9110738
Renal and Hepatic Drugs	https://dx.doi.org/10.3390/biom9110738
Inhibitory effects on breast cancer and leukemia	https://dx.doi.org/10.3390/biom9110738
Cytotoxic	https://doi.org/10.3390/molecules17066305
Polymer synthetization	https://dx.doi.org/10.3390/biom9110738
Anticoagulative/Antiplatelet	https://dx.doi.org/10.3390/biom9110738
Anti-tumour	https://dx.doi.org/10.3390/biom9110738
Antioxidant	https://dx.doi.org/10.3390/biom9110738
Gastroprotective activity	https://dx.doi.org/10.3390/biom9110738
Neuroprotective activity	https://dx.doi.org/10.3390/biom9110738
Bathtub, tile, and toilet surface cleaners	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 6654, alpha-Pinene. Retrieved January 20, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/alpha-Pinene.
Insect repellant	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 6654, alpha-Pinene. Retrieved January 20, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/alpha-Pinene.
Insecticide	https://doi.org/10.3390/molecules17066305

Chapter 4

Kamalame Bark and Leaves

4.1 General Description

The Kamalame plant is also commonly known as Gum elemi, Gamalamee, Gumbo limbo and Tourist tree, and is scientifically known as Bursera simarouba. This tree is found on all islands of The Bahamas, Florida, the Caribbean, and Central and South America. It grows in coppice formations and pine woodlands, on both limestone and sand substrate. The tree's peeling bark is a shiny dark red color, and its leaves are spirally arranged and pinnate with 7-11 leaflets. The bark of this tree secretes a natural resin that can be used to treat gout, stop blood flow from wounds, and as an antidote for poisonwood. The leaves are traditionally used in teas for rheumatism, in baths for back pains, to treat circulatory problems and bee and wasps stings, as well as in strengthening and aphrodisiac teas. Chemicals found in the bark include o-cymene, d-limonene, and (Z)-b-caryophyllene. Phytochemicals found in the leaves of Kamalemee include humulene, d-germacrene.

4.2 General Kamalame Bark Use

Table 4.1: Kamalame Bark Benefits

Benefit	*Reference*

4.3 Kamalame Bark Phytochemical Benefits

4.3.1 o-Cymene*

Table 4.2: Benefits of o-Cymene are shown in the table below

Benefit	*Reference*
Solvents	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 364
Synthetic-resin manufacture	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 365
Metal polishes	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 366
Organic synthesis	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 367
Antibacterial	https://doi.org/10.1016/j.jep.2005.07.024
Antibacterial	https://doi.org/10.1080/0972060X.2012.10644098
Antiviral	Kazemi Oskuee, Reza and Behravan, Javad and Ramezani, Mohammad (2011) Chemical composition, antimicrobial activity and antiviral activity of essential oil of Carum copticum from Iran. Avicenna Journal of Phytomedicine, 1 (2). pp. 83-90.
Antifungal	https://doi.org/10.1016/j.jep.2005.07.024
Anti-Candida	https://doi.org/10.1080/14786419.2017.1340291
Antioxidant	https://doi.org/10.1016/j.jep.2005.07.024
Antioxidant	Gweru, N., Gundidza, M., Magwa, M. L., Ramalivhana, N. J., Humphrey, G., Samie, A., and Mmbengwa, V. (2009). Phytochemical composition and biological activities of essential oil of Rhynchosia minima (L)(DC)(Fabaceae). African Journal of Biotechnology, 8(5).
Antioxidant	https://doi.org/10.1002/jsfa.10388

4.3.2 Beta-Caryophyllene*

Table 4.3: Benefits of beta-Caryophyllene are shown in the table below

Benefit	*Reference*
Antibacterial activity	https://doi.org/10.1016/j.sajb.2021.07.046
Antibacterial activity (pneumonia - mice)	https://doi.org/10.1016/j.sjbs.2021.06.034
Antiviral activity (zika virus)	https://doi.org/10.1016/j.indcrop.2021.113281; https://doi.org/10.1016/j.actatropica.2020.105556
Anticonvulsant/epileptic seizure (mice)	https://doi.org/10.1016/j.eplepsyres.2021.106842
increased libido in women	https://doi.org/10.1016/j.esxm.2020.06.001
Osteoarthritis Treatment (mice)	https://doi.org/10.1016/j.neuropharm.2021.108908
general review	https://doi.org/10.1016/j.biopha.2021.111639
Alcohol addiction	10.1016/j.pbb.2014.06.025
Neuropathic pain	10.1016/j.euroneuro.2013.10.008
Neuropathic pain	10.1016/j.phymed.2013.08.006
Neuropathic pain	10.4236/pp.2012.34053
Nociception	10.1038/ncpneuro0113
Neuropathic pain	https://doi.org/10.3390/molecules25010106
Insulin resistance and dyslipidemia	10.1016/j.cbi.2018.10.010
Insulin resistance and associated neurobehavioral changes	10.1016/j.biopha.2018.11.039
Atherosclerosis	10.1016/j.taap.2017.06.016
Ulcerative colitis	10.1016/j.ajpath.2010.11.052
Immunomodulation	10.3390/ijms18040691
Peripheral neuropathy	10.1016/j.neuropharm.2017.07.015
Chemotherapy-induced cardiotoxicity	10.1016/j.cbi.2019.02.028
Nephroprotective	10.1016/j.freeradbiomed.2012.01.014
Parkinson's disease	10.3389/fnins.2016.00321
Parkinson's disease	10.3390/ph10030060
Alzheimer's disease	10.1159/000362689
Post-stroke cognitive deficits	10.3389/fphar.2017.00002
Cerebral ischemia	10.1016/j.ajpath.2012.11.024

[Cont'd] Benefits of beta-Caryophyllene are shown in the table below

Benefit	*Reference*
Cerebral ischemia	10.1186/s12944-018-0661-4
Depression and anxiety	10.1016/j.physbeh.2014.06.003
Depression	10.1016/j.bbr.2019.112439
Liver fibrosis	10.1016/j.ejphar.2014.08.021
Alcohol liver damage	10.1111/bph.13722
Nicotine addiction	10.1111/bph.14969
Arthritis	10.3390/biom9080326
Obesity and related complications	10.1016/j.bbrc.2013.05.108
Hyperglycemia	10.1016/j.bbrc.2013.11.136
Atherosclerosis	10.1016/j.taap.2017.06.016
Cancer	10.3390/cancers12041038
Parkinson's disease	10.1016/j.biopha.2018.03.168
Cerebral ischemia-reperfusion injury	10.1080/07391102.2019.1567384
Multiple sclerosis	10.1016/j.lfs.2018.12.059
Multiple sclerosis	10.1016/j.bcp.2018.12.001
Neuroinflammation	10.1007/s12031-014-0243-5
Glioma	10.1016/j.neuroscience.2014.08.043
Depression	10.1016/j.bbr.2019.112439
Hepatic steatosis	10.1002/mnfr.201600197
Osteoporosis	10.1002/iub.158
Mucositis	10.3390/BIOMEDICINES8060164
Antifungal	10.1023/A:1007178924408
Fragrance	https://doi.org/10.1016/j.fct.2008.06.030
skin creams, shampoos and lotions	https://www.naturemary.com/beta-caryophyllene-for-skin/

4.3.3 D-Limonene*

Table 4.4: Benefits of D-Limonene are shown in the table below

Benefit	*Reference*
Dietary Supplement	National Center for Biotechnology Information (2022). PubChem Annotation Record for LIMONENE, Source: Hazardous Substances Data Bank (HSDB). Retrieved January 20, 2022
Fragrance for cosmetics	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 757
Fragrance for cosmetics	https://doi.org/10.1080/10937404.2013.769418
Fragrance	https://doi.org/10.1016/j.fct.2018.07.052
Food manufacturing	Burdock, G.A. (ed.). Fenaroli's Handbook of Flavor Ingredients. 6th ed.Boca Raton, FL 2010, p. 1090
Medicines	National Center for Biotechnology Information (2022). PubChem Annotation Record for LIMONENE, Source: Hazardous Substances Data Bank (HSDB). Retrieved January 20, 2022.
Flavoring to mask taste of alkaloids	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 757
Fragrance in perfumery	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 757
Aftershave lotions and bath products	USEPA/OPPTS; R.E.D Facts. Limonene (138-86-3). Reregistration Eligibility Decisions (REDs) Database. EPA-738-F-94-030. Sept 1994. Available from, as of Apr 24, 2015: https://www.epa.gov/pesticides/reregistration/status.htm
Botanical insecticide	USEPA/OPPTS; R.E.D Facts. Limonene (138-86-3). Reregistration Eligibility Decisions (REDs) Database. EPA-738-F-94-030. Sept 1994. Available from, as of Apr 24, 2015: https://www.epa.gov/pesticides/reregistration/status.htm
Insect repellant	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Herbicide	USEPA/OPPTS; R.E.D Facts. Limonene (138-86-3). Reregistration Eligibility Decisions (REDs) Database. EPA-738-F-94-030. Sept 1994. Available from, as of Apr 24, 2015: https://www.epa.gov/pesticides/reregistration/status.htm
Hand cleaners/soaps	USEPA/OPPTS; R.E.D Facts. Limonene (138-86-3). Reregistration Eligibility Decisions (REDs) Database. EPA-738-F-94-030. Sept 1994. Available from, as of Apr 24, 2015: https://www.epa.gov/pesticides/reregistration/status.htm

[Cont'd] Benefits of D-Limonene are shown in the table below

Benefit	*Reference*
Flavouring in beverages (fruit juices, soft drinks) and baked goods, ice cream and pudding	Burdock, G.A. (ed.). Fenaroli's Handbook of Flavor Ingredients. 6th ed.Boca Raton, FL 2010, p. 1090
Food flavoring	https://doi.org/10.1080/10937404.2013.769418
Food flavoring	https://doi.org/10.1016/j.fct.2018.07.052
Dissolves cholesterol-containing gallstones	Shepard, T.H. Catalog of Teratogenic Agents. 5th ed. Baltimore, MD: The Johns Hopkins University Press, 1986., p. 342
Dissolves cholesterol-containing gallstones	https://doi.org/10.1007/BF01071903
Relief of heartburn and gastroesophageal reflux	Sun J. D-Limonene: safety and clinical applications. Altern Med Rev. 2007 Sep;12(3):259-64. PMID: 18072821.
Chemopreventive activity	Sun J. D-Limonene: safety and clinical applications. Altern Med Rev. 2007 Sep;12(3):259-64. PMID: 18072821.
Hepatoprotective	doi:10.1016/S0367-326X(03)00028-5
Substitute for chlorinated hydrocarbons, CFCs and other organic solvents	https://doi.org/10.1093/annhyg/35.4.419
Bactericide, antioxidant and therapeutic activities	https://doi.org/10.1016/j.foodhyd.2015.01.031
Antimicrobial	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antiviral	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antifungal	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antilarval	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185

Kamalame Bark and Leaves

4.4 Kamalame Leaves Phytochemical Benefits

4.4.1 D-Germacrene*

Table 4.5: Benefits of D-Germacrene are shown in the table below

Benefit	*Reference*
Flavoring in beverages and food	Isobionics. (n.d.). Natural Germacrene-D. Isobionics Nootkatone. Retrieved January 20, 2022, from https://www.isobionics.com/index-Germacrene-D.html
Personal and skin care products	Isobionics. (n.d.). Natural Germacrene-D. Isobionics Nootkatone. Retrieved January 20, 2022, from https://www.isobionics.com/index-Germacrene-D.html
Antimicrobial	https://doi.org/10.1590/S0100-40422011000900013
Antimicrobial	https://doi.org/10.3390/molecules24173203
Antimicrobial	https://doi.org/10.1021/jf026203j
Antibacterial	https://doi.org/10.1590/S0100-40422011000900013
Disinfectant	https://doi.org/10.1590/S0100-40422011000900013
Attracts pollinators	https://doi.org/10.1590/S0100-40422011000900013
Antioxidant	https://doi.org/10.1155/2013/409826
Insect repellent	https://doi.org/10.1155/2013/409826
Insecticidal	https://doi.org/10.1016/j.indcrop.2015.03.025
Fragrance	https://doi.org/10.5650/jos.62.51

4.4.2 Humulene*

Table 4.6: Benefits of Humulene are shown in the table below

Benefit	*Reference*
anti-inflammatory	https://doi.org/10.1111/j.1476-5381.2009.00177.x
Anti-cancer	https://doi.org/10.3892/or.2010.1087
Anti-cancer	https://doi.org/10.1211/jpp.59.12.0005
Anti-bacterial	https://doi.org/10.1139/cjm-2020-0004
Anti-tumor	10.1002/biof.552210127
Beer	https://doi.org/10.1094/ASBCJ-46-0104
Insect-repellant	DOI:10.1016/0031-9422(93)85098-C
Insect-repellant	https://doi.org/10.1016/j.ecoenv.2017.11.044
Hair loss	Galcerá, F. C. (2002). U.S. Patent No. 6,447,762. Washington, DC: U.S. Patent and Trademark Office.
Renal Health	https://doi.org/10.1016/j.cbi.2017.10.021
Perfumes and oils	https://shop.perfumersapprentice.com/p-8493-humulene-natural.aspx
soap	https://artofsoaps.com/terpenes-2021-guide/
Asthma	10.1111/j.1476-5381.2009.00177.x
anti-cancer	10.1093/jn/133.11.3778S
anti-cancer (breast)	Shamsuddin, A. M., Yang, G. Y., and Vucenik, I. V. A. N. A. (1996). Novel anti-cancer functions of IP6: growth inhibition and differentiation of human mammary cancer cell lines in vitro. Anticancer research, 16(6A), 3287-3292.
anti-cancer (colon)	10.3390/molecules25245931
anti-cancer (cervical)	10.1093/carcin/23.12.2031
coronary protection	Jariwalla RJ, Sabin R, Lawson S, Herman ZS. Lowering of serum cholesterol and triglycerides and modulation of divalent cations by dietary phytate. J Appl Nutr 1990; 42: 18–28.
anti-diabetic	https://doi.org/10.1016/0963-9969(93)90069-U
kidney stone reduction	10.1080/003655900750016526
kidney stone reduction	10.1016/j.lfs.2003.11.030

Chapter 5

Lemongrass/Fever Grass

5.1 General Description

Lemongrass or fever grass as it is often referred to in the Caribbean is scientifically known as Cymbopogon flexuosus. It is used in teas and as a flavoring in drinks due to his lemon-like flavouring. It is also used as essential oils fragrance in soaps, cosmetics, detergents and as an insect repellent. Its essential oils are a good therapeutic candidate for treating inflammatory conditions of the skin. It may be used in body creams, soaps, lotion, deodorants etc. Phytochemicals found in lemongrass, particularly citral have been shown to have a number of health and medicinal benefits. In vitro studies have shown that citral has been effective against cancer cells. It has also shown to be an effective insecticide and possess antibacterial and Antifungal properties.

5.2 Phytochemical Benefits

5.2.1 Citral

Table 5.1: Benefits of citral are shown in the table below

Benefit	*Reference*
Antidiarrheal	Tangpu, V., & Yadav, A. K. (2006). Antidiarrheal activity & of Cymbopogon citratus and its main constituent, citral. Pharmacologyonline, 2, 290-298.
Antioxidant	Villalobos, M. C. (2010). Antioxidant activity and citral content of different tea preparations of the aboveground parts of lemongrass (Cymbopogon citratus Stapf.). Central Philippine University.
Antidiabetic	Najafian, M., Ebrahim-Habibi, A., Yaghmaei, P., Parivar, K., & Larijani, B. (2011). Citral as a potential Antihyperlipidemic medicine in diabetes: a study on streptozotocin-induced diabetic rats. Journal of Diabetes and Metabolic Disorders, 10, 3.
Antibacterial	Chhikara, N., Kour, R., Jaglan, S., Gupta, P., Gat, Y., & Panghal, A. (2018). Citrus medica: nutritional, phytochemical composition and health benefits–a review. Food& function, 9(4), 1978-1992.
Anti-inflammatory	Carbajal, D., Casaco, A., Arruzazabala, L., Gonzalez, R., & Tolon, Z. (1989). Pharmacological study of Cymbopogon citratus leaves. Journal of Ethnopharmacology, 25(1), 103-107.
Anticancer	Scolnik, M. D., Servadio, C., & Abramovici, A. (1994). Comparative study of experimentally induced benign and atypical hyperplasia in the ventral prostate of different sat strains. Journal of andrology, 15(4), 287-297.
Anticancer	Dudai, N., Weinstein, Y., Krup, M., Rabinski, T., & Ofir, R. (2005). Citral is a new inducer of caspase-3 in tumor cell lines. Planta medica, 71(05), 484-488.
Insecticide	Dudareva, N., Pichersky, E., & Gershenzon, J. (2004). Biochemistry of plant volatiles. Plant physiology, 135(4), 1893-1902.

5.2.2 Nonanal

Table 5.2: Benefits of nonanal are shown in the table below

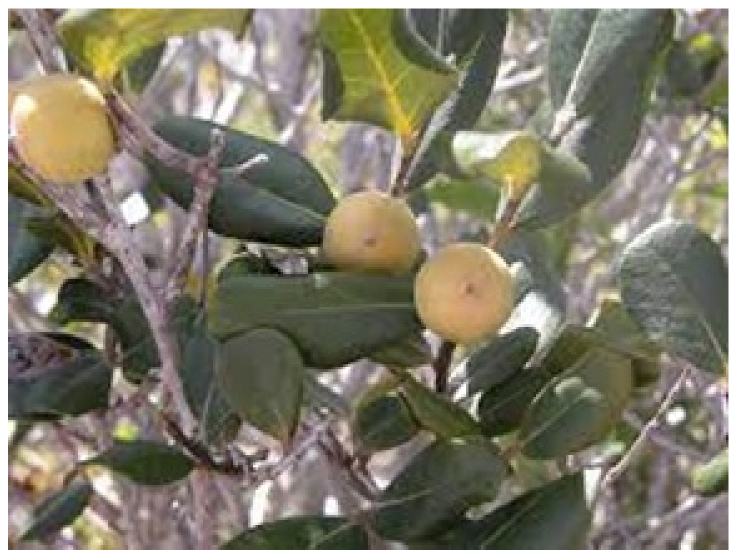
Benefit	*Reference*
Antidiarrhoeal	Zavala-Sanchez, M. A., Pérez-Gutiérrez, S., P? rez-González, C., Sánchez-Saldivar, D., & Arias-García, L. (2002). Antidiarrhoeal activity of nonanal, an aldehyde isolated from Artemisia ludoviciana. Pharmaceutical biology, 40(4), 263-268.
Antidiarrhoeal	Gohari, A. R., Saeidnia, S., Malmir, M., Yazdanpanah, M., & Ajani, Y. (2011). Sterols and flavonoids of Lomatopodium staurophyllum. Journal of Medicinal Plants, 10(39), 43-48.
Anti-fungal	Zhang, J. H., Sun, H. L., Chen, S. Y., Zeng, L. I., & Wang, T. T. (2017). Anti-fungal activity, mechanism studies on alpha-Phellandrene and Nonanal against Penicillium cyclopium. Botanical studies, 58, 1-9.
Anti-fungal	Li, Q., Zhu, X., Xie, Y., & Liang, J. (2021). Antifungal properties and mechanisms of three volatile aldehydes (octanal, nonanal and decanal) on Aspergillus flavus. Grain & Oil Science and Technology, 4(3), 131-140.
Anti-fungal	Zhang, J., Zeng, L., Sun, H., Chen, S., Wang, T., & Ma, S. (2017). Use of Nonanal-wax as Postharvest Fungicide of Tomato against Botrytis cinereal. J. Food Nutr. Res, 5, 458-466.

Chapter 6

Featherbed

6.1 General Description

The Featherbed tree is also commonly known as stiff cock and Boa wood and is scientifically known as Diospyros crassinervis. This tree can be found on the central and northern islands of The Bahamas, as well as Cuba and Hispaniola. It grows in coppice forests and shrublands. The leaves are arranged alternately, ovate, to 8 cm long, with a rounded apex and entire margin. The leaves are very chartaceous, dark green adaxially and light green to yellow abaxially. The fruit is a yellow berry that turns black with age. Featherbed leaves are traditionally used in The Bahamas in teas for "bedwetting" children, as an aphrodisiac for both sexes and for inducing vomiting. Phytochemicals that assist in its usage are limonene, (Z)-3-tetradecene and tannin.



6.2 Phytochemical Benefits

6.2.1 Tannin

Table 6.1: Benefits of Tannin are shown in the table below

Benefit	*Reference*
Tanning leather	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Leather processing	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Photography	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Dyes	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Dyes	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Clarifying wine and beer	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Astringents in medicine	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Astringents in medicine	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Antioxidant	DOI: 10.5772/intechopen.85984
Metal chelators	DOI: 10.5772/intechopen.85984
Influence reabsorption of metal	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Antiseptics	DOI: 10.5772/intechopen.85984
Anticarcinogenic	DOI: 10.5772/intechopen.85984
Anti-inflammatory	DOI: 10.5772/intechopen.85984
Antiviral	DOI: 10.5772/intechopen.85984
Antifungal	DOI: 10.5772/intechopen.85984
Antibacterial	DOI: 10.5772/intechopen.85984

Cont'd Benefits of Tannin are shown in the table below

Benefit	*Reference*
Antibacterial	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Reduce blood glucose levels	DOI: 10.5772/intechopen.85984
Prevent degenerative diseases like: Atherosclerosis Cardiovascular diseases Neurodegenerative diseasws	DOI: 10.5772/intechopen.85984
Food preservatives	DOI: 10.5772/intechopen.85984
Wood adhesives	https://dx.doi.org/10.3390/biom9080344
Fireproof and insulating foams	https://dx.doi.org/10.3390/biom9080344
Inhibit metal corrosion	https://dx.doi.org/10.3390/Fbiom9080344
Antitumor	https://dx.doi.org/10.3390/Fbiom9080344
Laxative	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Tannin gels	https://doi.org/10.3390/biom9100587

6.2.2 Limonene*

Table 6.2: Benefits of limonene are shown in the table below

Benefit	*Reference*
Antifungal	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antifungal	https://doi.org/10.1177/1934578X0800300728
Antilarval	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
chemoprotective	https://doi.org/10.1177/1934578X0800300728
Antioxidant	https://doi.org/10.1177/1934578X0800300728
Anti-inflammatory	https://doi.org/10.1177/1934578X0800300728
Anti-inflammatory	https://doi.org/10.1042/BSR20181253
Anti-inflammatory	https://doi.org/10.1007/s10753-016-0496-y
Antinociceptive	https://doi.org/10.1177/1934578X0800300728
Antinociceptive	https://doi.org/10.1007/s10753-016-0496-y
Anticancer	https://doi.org/10.1177/1934578X0800300728
Anticancer	https://doi.org/10.1042/BSR20181253
insecticidal	https://doi.org/10.1177/1934578X0800300728
Antitumor	https://doi.org/10.1042/BSR20181253

Chapter 7

Cerasee

7.1 General Description

Cerasee is a vine that is also commonly known as wild balsam apple, and scientifically known as Momordica charAntia. Cerasee is native to Africa and Asia but has spread throughout tropical and subtropical regions of the Western Hemisphere. It grows in human-altered environments like oil fields, yards, roadsides, and fence lines. Cerasee is a herbaceous, tendril-bearing vine that grows up to 16 ft in length. It has simple, alternate leaves across, with three to seven separated lobes. Each plant bears separate yellow male and female flowers. The fruit has a warty exterior that is oblong and has a hollow, orange berry at maturity with flat, red seeds. The vine is traditionally used in teas to treat colds and flu, obstetric and gynecological issues, gastrointestinal problems, and strengthening teas. Some of the main phytochemicals that contribute to this plant's Anti-inflammatory and Antimicrobial activities are momordicin, limonene, alkaloids and gentisic acid.

7.2 Phytochemical Benefits

7.2.1 Alkaloids

Table 7.1: Benefits of Alkaloids are shown in the table below

Benefit	*Reference*
Stimulant drugs	DOI: 10.5772/intechopen.85400
Stimulant	Awuchi, C. G. (2020). The Biochemistry, Toxicology, and Uses of the Pharmacologically Active Phytochemicals: Alkaloids, Terpenes, Polyphenols, and Glycosides. Journal of Food and Pharmaceutical Science, 2-2.
Psychotropic	Awuchi, C. G. (2020). The Biochemistry, Toxicology, and Uses of the Pharmacologically Active Phytochemicals: Alkaloids, Terpenes, Polyphenols, and Glycosides. Journal of Food and Pharmaceutical Science, 2-2.
Anti-inflammatory	DOI: 10.5772/intechopen.85400
Anticancer	DOI: 10.5772/intechopen.85400
Anticancer	Awuchi, C. G. (2020). The Biochemistry, Toxicology, and Uses of the Pharmacologically Active Phytochemicals: Alkaloids, Terpenes, Polyphenols, and Glycosides. Journal of Food and Pharmaceutical Science, 2-2.
Anticancer and Antiproliferative	https://doi.org/10.1016/j.ejphar.2019.172472
Analgesics	DOI: 10.5772/intechopen.85400
Analgesics	Awuchi, C. G. (2020). The Biochemistry, Toxicology, and Uses of the Pharmacologically Active Phytochemicals: Alkaloids, Terpenes, Polyphenols, and Glycosides. Journal of Food and Pharmaceutical Science, 2-2.
Local anesthetics and pain relief	DOI: 10.5772/intechopen.85400
Neuropharmacological	DOI: 10.5772/intechopen.85400
Antimicrobial	DOI: 10.5772/intechopen.85400
Antifungal	DOI: 10.5772/intechopen.85400
Supplements	DOI: 10.5772/intechopen.85400
Antiparasitic	DOI: 10.5772/intechopen.85400
Antiplasmodial	DOI: 10.5772/intechopen.85400
Anticorrosive	DOI: 10.5772/intechopen.85400
Antioxidative	DOI: 10.5772/intechopen.85400
Antibacterial	DOI: 10.5772/intechopen.85400
Antibacterial	Awuchi, C. G. (2020). The Biochemistry, Toxicology, and Uses of the Pharmacologically Active Phytochemicals: Alkaloids, Terpenes, Polyphenols, and Glycosides. Journal of Food and Pharmaceutical Science, 2-2.

Cont'd Benefits of Alkaloids are shown in the table below

Benefit	*Reference*
Anti-HIV	DOI: 10.5772/intechopen.85400
Insecticidal	DOI: 10.5772/intechopen.85400
Antimalarial	https://doi.org/10.2174/1568026613666131216105049
Antimalarial	Awuchi, C. G. (2020). The Biochemistry, Toxicology, and Uses of the Pharmacologically Active Phytochemicals: Alkaloids, Terpenes, Polyphenols, and Glycosides. Journal of Food and Pharmaceutical Science, 2-2.
Antiasthma	https://doi.org/10.2174/1568026613666131216105049
Antiasthma	Awuchi, C. G. (2020). The Biochemistry, Toxicology, and Uses of the Pharmacologically Active Phytochemicals: Alkaloids, Terpenes, Polyphenols, and Glycosides. Journal of Food and Pharmaceutical Science, 2-2.
Vasodilatory	Raymond S. Sinatra; Jonathan S. Jahr; J. Michael Watkins-Pitchford (2010). The Essence of Analgesia and Analgesics. Cambridge University Press. pp. 82–90. ISBN 978-1139491983.
Vasodilatory	Awuchi, C. G. (2020). The Biochemistry, Toxicology, and Uses of the Pharmacologically Active Phytochemicals: Alkaloids, Terpenes, Polyphenols, and Glycosides. Journal of Food and Pharmaceutical Science, 2-2.
Antiarrhythmic	Raymond S. Sinatra; Jonathan S. Jahr; J. Michael Watkins-Pitchford (2010). The Essence of Analgesia and Analgesics. Cambridge University Press. pp. 82–90. ISBN 978-1139491983.
Antiarrhythmic	Awuchi, C. G. (2020). The Biochemistry, Toxicology, and Uses of the Pharmacologically Active Phytochemicals: Alkaloids, Terpenes, Polyphenols, and Glycosides. Journal of Food and Pharmaceutical Science, 2-2.
Antihyperglycemic	Awuchi, C. G. (2020). The Biochemistry, Toxicology, and Uses of the Pharmacologically Active Phytochemicals: Alkaloids, Terpenes, Polyphenols, and Glycosides. Journal of Food and Pharmaceutical Science, 2-2.
Antidiabetic	https://doi.org/10.2174/1871530320666200821124817

7.2.2 Momordicin

Table 7.2: Benefits of Momordicin are shown in the table below

Benefit	*Reference*
Anthelmintic	https://doi.org/10.1016/j.jep.2004.08.009
Antidiabetic	https://dx.doi.org/10.1016/S2222-1808(13)60052-3
Antidiabetic	https://doi.org/10.7740/kjcs.2018.63.1.072
Antibacterial	doi:10.1016/j.jep.2004.08.009
Antitumor	Hu, D. M., Shen, F. B., Tan, X. L., Zheng, J. C., & Deng, N. H. (2019). Alpha-momordicin Regulates Hepatocyte Cytokine Expression. Sichuan da xue xue bao. Yi xue ban= Journal of Sichuan University. Medical science edition, 50(2), 193-196.
Treatment of gastrointestinal diseases	doi:10.1016/j.jep.2004.08.009
Potential bio chelator	DOI: 10.20959/wjpr20173-7939
Antifeedant	https://doi.org/10.1016/S1671-2927(08)60404-6
Antifeedant	Luo, J., Liu, H., Guo, Z., Wang, G., & Ling, B. (2016). Inhibition of cellular proliferation and induction of necrosis in Ofh cells of Ostrinina furnacalis (Lepidoptera: Pyralidae) by momordicin I and charAntin B. Acta Entomologica Sinica, 59(10), 1093-1102.
Antiproliferative	Luo, J., Liu, H., Guo, Z., Wang, G., & Ling, B. (2016). Inhibition of cellular proliferation and induction of necrosis in Ofh cells of Ostrinina furnacalis (Lepidoptera: Pyralidae) by momordicin I and charAntin B. Acta Entomologica Sinica, 59(10), 1093-1102.
Insecticidal	Cao, X., Zhu, C., Zhang, M., & Ling, B. (2015). Bioactivity of momordicin I against Ostrinia furnacalis (Lepidoptera: Pyralidae) and its effects on the metabolizing enzyme activities in larval bodies of the moth. Acta Entomologica Sinica, 58(6), 625-633.

7.2.3 CharAntin

Table 7.3: Benefits of CharAntin are shown in the table below

Benefit	*Reference*
Hypoglycemic activity	Desai, S., & Tatke, P. (2015). CharAntin: An important lead compound from Momordica charAntia for the treatment of diabetes. J Pharmacogn Phytochem, 3(6), 163-166.
Antidiabetic	https://doi.org/10.1016/j.seppur.2005.11.037
Antidiabetic	https://doi.org/10.1080/14786419.2019.1613400
Antidiabetic	https://doi.org/10.1016/j.fct.2014.04.008
Antihyperglycemic	Ahamad, Javed (2019) ANTIHYPERGLYCEMIC ACTIVITY OF CHARANTIN ISOLATED FROM FRUITS OF MOMORDICA CHARANTIA LINN. INTERNATIONAL RESEARCH JOURNAL OF PHARMACY, 10 (1). pp. 61-64.
Lowers blood pressure	Desai, S., & Tatke, P. (2015). CharAntin: An important lead compound from Momordica charAntia for the treatment of diabetes. J Pharmacogn Phytochem, 3(6), 163-166.
Anti-sialogogue	Desai, S., & Tatke, P. (2015). CharAntin: An important lead compound from Momordica charAntia for the treatment of diabetes. J Pharmacogn Phytochem, 3(6), 163-166.
Antimicrobial	Patel, S., Patel, T., Parmar, K., Bhatt, Y., Patel, Y., & Patel, N. M. (2010). Isolation, characterization and Antimicrobial activity of charAntin from Momordica charAntia linn. Fruit. Int J Drug Dev Res, 2(3), 629-34.
Antibacterial	Patel, S., Patel, T., Parmar, K., Bhatt, Y., Patel, Y., & Patel, N. M. (2010). Isolation, characterization and Antimicrobial activity of charAntin from Momordica charAntia linn. Fruit. Int J Drug Dev Res, 2(3), 629-34.
Antibacterial	https://doi.org/10.1021/acs.jafc.7b01948
Antioxidant	https://doi.org/10.1080/14786419.2019.1613400
Neuroprotective	Tamilanban, T., Chitra, V., & Chitra, K. (2018). In vitro neuroprotective effect of charAntin from Momordica charAntia against neurotoxin and endoplasmic reticulum stress-induced cell death in SH-SY5Y cells. Int J Green Pharm, 12, 5555-5560.
Anticancer	https://doi.org/10.1021/acs.jafc.7b01948

7.2.4 Catechin

Table 7.4: Benefits of Catechin shown in the table below

Benefit	*Reference*
Anticancer	https://doi.org/10.3390/molecules21101305
Anti-obesity	https://doi.org/10.3390/molecules21101305
Anti-obesity	https://doi.org/10.1038/oby.2008.505
Anti-Atherosclerosis	https://doi.org/10.1016/j.atherosclerosis.2008.12.007
Antidiabetic	https://doi.org/10.3390/molecules21101305
Antidiabetic	https://doi.org/10.1038/oby.2008.505
Hypoglycemic	https://doi.org/10.1007/s00044-011-9722-1
Anti-cardiovascular	https://doi.org/10.3390/molecules21101305
Anti-infectious	https://doi.org/10.3390/molecules21101305
Hepatoprotective	https://doi.org/10.3390/molecules21101305
Neuroprotective	https://doi.org/10.3390/molecules21101305
Antioxidant	https://doi.org/10.3390/molecules21101305
Antioxidant	https://doi.org/10.1002/ptr.1297
Antioxidant	Kríž, Z., Koča, J., Imberty, A., Charlot, A., & Auzély-Velty, R. (2003). Investigation of the complexation of (+)-catechin by b-cyclodextrin by a combination of NMR, microcalorimetry and molecular modeling techniques. Organic & biomolecular chemistry, 1(14), 2590-2595.
Anti-inflammatory	https://doi.org/10.3390/molecules21101305
Anti-microbial	https://doi.org/10.1186/s41702-020-0057-8
Anti-viral	https://doi.org/10.1186/s41702-020-0057-8
Anti-viral	https://doi.org/10.1002/ptr.1297
Anti-allergenic	https://doi.org/10.1186/s41702-020-0057-8
Antibacterial	https://doi.org/10.1002/ptr.1297
Antibacterial	https://doi.org/10.3390/molecules21020244
Cosmetics	https://doi.org/10.1186/s41702-020-0057-8
Cosmetics	Kríž, Z., Koča, J., Imberty, A., Charlot, A., & Auzély-Velty, R. (2003). Investigation of the complexation of (+)-catechin by b-cyclodextrin by a combination of NMR, microcalorimetry and molecular modeling techniques. Organic & biomolecular chemistry, 1(14), 2590-2595.
Treatment of chronic diseases (Inflammatory Bowel Disease)	https://dx.doi.org/10.3390/molecules22030484
Antifungal	https://doi.org/10.1111/jfbc.12779

7.2.5 Gallic Acid

Table 7.5: Benefits of Gallic Acid are shown in the table below

Benefit	*Reference*
Preservatives	https://doi.org/10.4155/ppa.15.14
Anticarcinogenic	https://doi.org/10.4155/ppa.15.14
Anticarcinogenic	https://doi.org/10.1016/j.etap.2013.02.011
Antimicrobial	https://doi.org/10.4155/ppa.15.14
Antimicrobial	http://dx.doi.org/10.4172/1920-4159.1000213
Antibacterial	https://doi.org/10.4155/ppa.15.14
Anticholesterolemic	https://doi.org/10.4155/ppa.15.14
Antimutagenic	https://doi.org/10.4155/ppa.15.14
Antimutagenic	Borde, V. U., Pangrikar, P. P., & Tekale, S. U. (2011). Gallic acid in Ayurvedic herbs and formulations. Recent Research in Science and Technology, 3(7).
Antiangiogenic	https://doi.org/10.4155/ppa.15.14
Anti-inflammatory	https://doi.org/10.4155/ppa.15.14
Anti-inflammatory	Borde, V. U., Pangrikar, P. P., & Tekale, S. U. (2011). Gallic acid in Ayurvedic herbs and formulations. Recent Research in Science and Technology, 3(7).
Antioxidant	https://doi.org/10.2174/1389200033489479
Antioxidant	https://doi.org/10.4155/ppa.15.14
Antioxidant	Borde, V. U., Pangrikar, P. P., & Tekale, S. U. (2011). Gallic acid in Ayurvedic herbs and formulations. Recent Research in Science and Technology, 3(7).
Cosmetics	https://doi.org/10.2174/1389200033489479
Inks, paints & colour developers	https://doi.org/10.2174/1389200033489479
Anticancer	https://doi.org/10.2174/1389200033489479
Anticancer	Borde, V. U., Pangrikar, P. P., & Tekale, S. U. (2011). Gallic acid in Ayurvedic herbs and formulations. Recent Research in Science and Technology, 3(7).
Apoptosis	https://doi.org/10.4155/ppa.15.14
Antifungal	Borde, V. U., Pangrikar, P. P., & Tekale, S. U. (2011). Gallic acid in Ayurvedic herbs and formulations. Recent Research in Science and Technology, 3(7).
Antiviral	Borde, V. U., Pangrikar, P. P., & Tekale, S. U. (2011). Gallic acid in Ayurvedic herbs and formulations. Recent Research in Science and Technology, 3(7).
Antibacterial	Borde, V. U., Pangrikar, P. P., & Tekale, S. U. (2011). Gallic acid in Ayurvedic herbs and formulations. Recent Research in Science and Technology, 3(7).

Cont'd Benefits of Gallic Acid are shown in the table below

Benefit	*Reference*
Treat albuminuria and diabetes	Borde, V. U., Pangrikar, P. P., & Tekale, S. U. (2011). Gallic acid in Ayurvedic herbs and formulations. Recent Research in Science and Technology, 3(7).
Hepatoprotective	http://dx.doi.org/10.4172/1920-4159.1000213
Antiproliferative	http://dx.doi.org/10.4172/1920-4159.1000213
Anti-melanogenic	https://doi.org/10.1248/bpb.30.1052

7.2.6 Flavonoid

Table 7.6: Benefits of Flavonoids are shown in the table below

Benefit	*Reference*
Bioactive ingredient for cosmetics	https://doi.org/10.3390/cosmetics7010012
Antioxidant	Haque, M. E., Alam, M. B., & Hossain, M. S. (2011). The efficacy of cucurbitane type triterpenoids, glycosides and phenolic compounds isolated from Momordica charAntia: a review. International Journal of Pharmaceutical Sciences and Research, 2(5), 1135.
Antioxidant	https://doi.org/10.3390/cosmetics7010012
Antioxidant	https://doi.org/10.1016/j.foodchem.2010.01.033
Antioxidant	http://dx.doi.org/10.5281/zenodo.545778
Cytotoxic	http://dx.doi.org/10.5281/zenodo.545778
Antiglycation	https://doi.org/10.3390/cosmetics7010012
Skin regeneration activities	https://doi.org/10.3390/cosmetics7010012
Melanogenesis inhibitory activities	https://doi.org/10.3390/cosmetics7010012
Anti-inflammatory	http://dx.doi.org/10.5281/zenodo.545778
Anti-allergic	http://dx.doi.org/10.5281/zenodo.545778
Antiviral	http://dx.doi.org/10.5281/zenodo.545778
Anticarcinogenic	http://dx.doi.org/10.5281/zenodo.545778
Antimutagenic	https://dx.doi.org/10.1017/jns.2016.41
Antibacterial	DOI: 10.5772/67864
Antibacterial	https://doi.org/10.1016/B978-0-12-813820-5.00026-X
Antiprotozoal	https://doi.org/10.1016/B978-0-12-813820-5.00026-X
Hepatoprotective	Haque, M. E., Alam, M. B., & Hossain, M. S. (2011). The efficacy of cucurbitane type triterpenoids, glycosides and phenolic compounds isolated from Momordica charAntia: a review. International Journal of Pharmaceutical Sciences and Research, 2(5), 1135.
Hypolipidemic	https://doi.org/10.1016/B978-0-12-813820-5.00026-X
Antiplatelet	https://doi.org/10.1016/B978-0-12-813820-5.00026-X
Antihypertensive	https://doi.org/10.1016/B978-0-12-813820-5.00026-X

7.2.7 Limonene*

Table 7.7: Benefits of limonene are shown in the table below

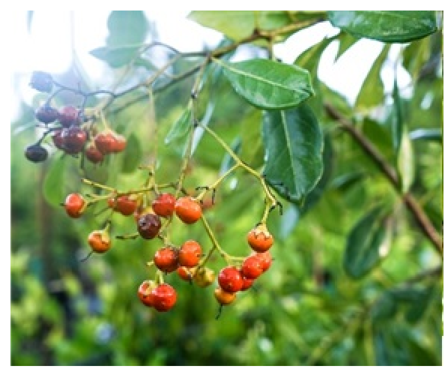
Benefit	*Reference*
Antifungal	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antifungal	https://doi.org/10.1177/1934578X0800300728
Antilarval	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
chemoprotective	https://doi.org/10.1177/1934578X0800300728
Antioxidant	https://doi.org/10.1177/1934578X0800300728
Anti-inflammatory	https://doi.org/10.1177/1934578X0800300728
Anti-inflammatory	https://doi.org/10.1042/BSR20181253
Anti-inflammatory	https://doi.org/10.1007/s10753-016-0496-y
Antinociceptive	https://doi.org/10.1177/1934578X0800300728
Antinociceptive	https://doi.org/10.1007/s10753-016-0496-y
Anticancer	https://doi.org/10.1177/1934578X0800300728
Anticancer	https://doi.org/10.1042/BSR20181253
insecticidal	https://doi.org/10.1177/1934578X0800300728
Antitumor	https://doi.org/10.1042/BSR20181253

Chapter 8

Strong Back

8.1 General Description

Strong back, also commonly called strong bark, is scientifically known as Bourreria ovata. This tree is found throughout the Caribbean in countries like The Bahamas, Cuba, Dominican Republic, Haiti, Puerto Rico, and Turks and Caicos, as well as Florida. It grows within the shrublands and coppice forests. This tree can grow up to 10m high, with petioles that are yellowish-green. The flowers are arranged in cymes and the leaves are nearly orbicular. The leaves of Strong back are used in teas to treat diarrhea, fevers, colds and flu, nerves, pain, skin infections and inflammations, weak bladders and in strengthening and aphrodisiac teas. Phytochemicals found in its leaves that assist with its usage are d-limonene, gentisic acid and phenolic acids.



8.2 Phytochemical Benefits

8.2.1 Phenolic Acid

Table 8.1: Benefits of Phenolic Acid are shown in the table below

Benefit	*Reference*
Antioxidant	https://doi.org/10.1016/B978-0-08-100596-5.22395-0
Antioxidant	https://doi.org/10.1016/j.enzmictec.2006.08.012
Antioxidant	https://doi.org/10.1016/j.jplph.2013.04.008
Antioxidant	https://doi.org/10.1021/jf900695s
Anti-inflammatory	GUTIÉRREZ-GRIJALVA, E. P., & CASTILLO, R. (2016). Review: Dietary phenolic compounds, health benefits and bio accessibility Review: dietary phenolic compounds, health benefits and bio accessibility. v. 66, n.
Anti-carcinogenic	GUTIÉRREZ-GRIJALVA, E. P., & CASTILLO, R. (2016). Review: Dietary phenolic compounds, health benefits and bioaccessibility Review: dietary phenolic compounds, health benefits and bioaccessibility. v. 66, n.
Decrease rate of chronic diseases	GUTIÉRREZ-GRIJALVA, E. P., & CASTILLO, R. (2016). Review: Dietary phenolic compounds, health benefits and bioaccessibility Review: dietary phenolic compounds, health benefits and bioaccessibility. v. 66, n.
Antimutagenic	https://doi.org/10.1007/978-3-642-22144-6_64
Antimicrobial	https://doi.org/10.1016/j.btre.2019.e00370
Anticancer	https://doi.org/10.1016/j.btre.2019.e00371
Antiallergic	https://doi.org/10.1016/j.btre.2019.e00372
Antiviral	https://doi.org/10.1016/j.btre.2019.e00373
Antithrombotic	https://doi.org/10.1016/j.btre.2019.e00374
Hepatoprotective	https://doi.org/10.1016/j.btre.2019.e00375
Food additive	https://doi.org/10.1016/j.btre.2019.e00376
Food preservative	https://doi.org/10.1016/j.enzmictec.2006.08.012
Skincare products	https://doi.org/10.1016/j.btre.2019.e00370
Anti-diabetic	https://doi.org/10.1016/j.btre.2019.e00371
Neuroprotective	https://doi.org/10.1016/j.btre.2019.e00372
Weed management of soil	https://doi.org/10.2134/jeq2001.3051631x

8.2.2 Gentisic Acid

Table 8.2: Benefits of Gentisic Acid are shown in the table below

Benefit	*Reference*
Anti-inflammatory	https://doi.org/10.1002/ptr.6573
Antigenotoxic	https://doi.org/10.1002/ptr.6573
Hepatoprotective	https://doi.org/10.1002/ptr.6573
Neuroprotective	https://doi.org/10.1002/ptr.6573
Neuroprotective (Anti-Parkinson's)	https://doi.org/10.1016/S2221-6189(14)60031-7
Antimicrobial	https://doi.org/10.1002/ptr.6573
Antioxidant	https://doi.org/10.1002/ptr.6573
Antioxidant	https://doi.org/10.1016/j.ejphar.2005.03.012
Antioxidant	https://doi.org/10.3109/10715762.2011.633518
Anti-atherogenic	https://doi.org/10.1016/j.ejphar.2005.03.012
Antitumor	https://doi.org/10.1016/j.jff.2020.103866
Therapeutic agent for cardiac hypertrophy and fibrosis	https://doi.org/10.1111/jcmm.13869
Metabolite of aspirin	https://doi.org/10.1002/ptr.6573
Metabolite of aspirin	https://doi.org/10.1074/jbc.M109.064618
Antirheumatic	National Center for Advancing Translational Sciences. (n.d.). NCATS INXIGHT drugs - gentisic acid. Inxight Drugs. Retrieved January 20, 2022, from https://drugs.ncats.io/substance/VP36V95O3T
Radioprotective	National Center for Advancing Translational Sciences. (n.d.). NCATS INXIGHT drugs - gentisic acid. Inxight Drugs. Retrieved January 20, 2022, from https://drugs.ncats.io/substance/VP36V95O3T
Radioprotective	https://doi.org/10.3109/10715762.2011.633518
Cosmetics; skin lightening agent	National Center for Advancing Translational Sciences. (n.d.). NCATS INXIGHT drugs - gentisic acid. Inxight Drugs. Retrieved January 20, 2022, from https://drugs.ncats.io/substance/VP36V95O3T
Cosmetics; skin lightening agent	https://doi.org/10.1016/S0928-0987(02)00255-5
Skin wound healing	10.7150/ijms.36484
Pesticide	https://doi.org/10.1074/jbc.M109.064618
Liquors	https://doi.org/10.1074/jbc.M109.064618

8.2.3 D-Limonene

Table 8.3: Benefits of D-Limonene are shown in the table below

Benefit	*Reference*
Dietary Supplement	National Center for Biotechnology Information (2022). PubChem Annotation Record for LIMONENE, Source: Hazardous Substances Data Bank (HSDB). Retrieved January 20, 2022
Fragrance for cosmetics	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 757
Fragrance for cosmetics	https://doi.org/10.1080/10937404.2013.769418
Fragrance	https://doi.org/10.1016/j.fct.2018.07.052
Food manufacturing	Burdock, G.A. (ed.). Fenaroli's Handbook of Flavor Ingredients. 6th ed.Boca Raton, FL 2010, p. 1090
Medicines	National Center for Biotechnology Information (2022). PubChem Annotation Record for LIMONENE, Source: Hazardous Substances Data Bank (HSDB). Retrieved January 20, 2022.
Flavoring to mask taste of alkaloids	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 757
Fragrance in perfumery	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 757
Aftershave lotions and bath products	USEPA/OPPTS; R.E.D Facts. Limonene (138-86-3). Reregistration Eligibility Decisions (REDs) Database. EPA-738-F-94-030. Sept 1994. Available from, as of Apr 24, 2015: https://www.epa.gov/pesticides/reregistration/status.htm
Botanical insecticide	USEPA/OPPTS; R.E.D Facts. Limonene (138-86-3). Reregistration Eligibility Decisions (REDs) Database. EPA-738-F-94-030. Sept 1994. Available from, as of Apr 24, 2015: https://www.epa.gov/pesticides/reregistration/status.htm
Insect repellant	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Herbicide	USEPA/OPPTS; R.E.D Facts. Limonene (138-86-3). Reregistration Eligibility Decisions (REDs) Database. EPA-738-F-94-030. Sept 1994. Available from, as of Apr 24, 2015: https://www.epa.gov/pesticides/reregistration/status.htm
Hand cleaners/soaps	USEPA/OPPTS; R.E.D Facts. Limonene (138-86-3). Reregistration Eligibility Decisions (REDs) Database. EPA-738-F-94-030. Sept 1994. Available from, as of Apr 24, 2015: https://www.epa.gov/pesticides/reregistration/status.htm
Flavouring in beverages (fruit juices, soft drinks) and baked goods, ice cream and pudding	Burdock, G.A. (ed.). Fenaroli's Handbook of Flavor Ingredients. 6th ed.Boca Raton, FL 2010, p. 1090

[Cont'd] Benefits of D-Limonene are shown in the table below

Benefit	*Reference*
Flavouring in beverages (fruit juices, soft drinks) and baked goods, ice cream and pudding	Burdock, G.A. (ed.). Fenaroli's Handbook of Flavor Ingredients. 6th ed.Boca Raton, FL 2010, p. 1090
Food flavoring	https://doi.org/10.1080/10937404.2013.769418
Food flavoring	https://doi.org/10.1016/j.fct.2018.07.052
Dissolves cholesterol-containing gallstones	Shepard, T.H. Catalog of Teratogenic Agents. 5th ed. Baltimore, MD: The Johns Hopkins University Press, 1986., p. 342
Dissolves cholesterol-containing gallstones	https://doi.org/10.1007/BF01071903
Relief of heartburn and gastroesophageal reflux	Sun J. D-Limonene: safety and clinical applications. Altern Med Rev. 2007 Sep;12(3):259-64. PMID: 18072821.
Chemopreventive activity	Sun J. D-Limonene: safety and clinical applications. Altern Med Rev. 2007 Sep;12(3):259-64. PMID: 18072821.
Hepatoprotective	doi:10.1016/S0367-326X(03)00028-5
Substitute for chlorinated hydrocarbons, CFCs and other organic solvents	https://doi.org/10.1093/annhyg/35.4.419
Bactericide, Antioxidant and therapeutic activities	https://doi.org/10.1016/j.foodhyd.2015.01.031
Antimicrobial	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antiviral	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antifungal	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antilarval	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185

Chapter 9

Cascarilla Bark and Leaves

9.1 General Description

Cascarilla, scientifically known as Croton eluteria, is a small tree that is found throughout The Bahamas, the Caribbean region, Mexico, and South America. It grows on a limestone substrate in coppice fields, most typically in shrublands. The Cascarilla tree can grow up to 20 feet in height with leaves that are scanty, alternate, and ovate-lanceolate, averaging 2 inches long. The flowers are small, with white petals, and the scented bark is fissured, pale yellowish-brown, and may be covered in lichen. Cascarilla is used medicinally in the Bahamas to treat issues of appetite, coughs, diarrhea, flu, indigestion, stomach pain, and to prevent vomiting. Tincture from the bark is also used as a tonic and stimulant, and a fever reducer. The bark and leaves can be used as an inhalant to clear sinuses and the leaves are used in bath water to refresh the body. The bark of C. eluteria is also used as a flavouring of the liquor Campari. Phytochemicals found in the bark of Cascarilla are a-pinene, b-myrcene, o-cymene, limonene, nonanal, cascarillins, lignins and tannins. The phytochemicals found in the leaves include a long list of aromatic terpenes and diterpene compounds, including pinene, vanillin, D-limonene, and thujene.

9.2 General Cascarilla Bark Use

Table 9.1: Cascarilla Bark Benefits

Benefit	*Reference*

9.3 Cascarilla Bark Phytochemical Benefits

9.3.1 Beta-myrcene*

Table 9.2: Benefits of Beta-myrcene are shown in the table below

Benefit	*Reference*
Flavoring in food & beverages	https://doi.org/10.3389/fnut.2021.699666
Flavoring in food & beverages	Burdock, G.A. (ed.). Fenaroli's Handbook of Flavor Ingredients. 6th ed.Boca Raton, FL 2010, p. 1447
Food additive	Bonamin, F., Moraes, T. M., dos Santos, R. C., Kushima, H., Faria, F. M., Silva, M. A., ... & Hiruma-Lima, C. A. (2014). The effect of a minor constituent of essential oil from Citrus aurantium.
Food additive	Paumgartten, F. J. R., Delgado, I. F., Alves, E. N., Nogueira, A. C. M. D. A., Presgrave, R. D. F., & Neubert, D. (1990). Single dose toxicity study of beta-myrcene, a natural analgesic substance.
Food preservative	https://doi.org/10.3390/foods10102354
Aroma agent in food & beverages	https://doi.org/10.3389/fnut.2021.699666
Anxiolytic	https://doi.org/10.3389/fnut.2021.699666
Antioxidant	https://doi.org/10.3389/fnut.2021.699666
Antioxidant	https://doi.org/10.1177/0748233710388452
Antioxidant	https://doi.org/10.3390/Antiox10010127
Anti-ageing	https://doi.org/10.3389/fnut.2021.699666
Anti-inflammatory	https://doi.org/10.3389/fnut.2021.699666
Anti-inflammatory	Tira-Picos, V., Nogueira, J., & Gbolade, A. (2010). Comparative analysis of leaf essential oil constituents of Piliostigma thonningii and Piliostigma reticulatum. International Journal of Green Pharmacy, 4(2), 67.
Analgesic	https://doi.org/10.3389/fnut.2021.699666
Sedative	https://doi.org/10.3389/fnut.2021.699666
Antidiabetic	https://doi.org/10.3389/fnut.2021.699666
Antimicrobial	https://doi.org/10.3390/foods10102354
Antibacterial	https://doi.org/10.3389/fnut.2021.699666
Antibacterial	https://doi.org/10.1248/cpb.54.936
Anticancer	https://doi.org/10.3389/fnut.2021.699666
Hepatoprotective	doi:10.1016/S0367-326X(03)00028-5
Cytotoxic	https://doi.org/10.3390/Antiox10010127

Cont'd Benefits of Beta-myrcene are shown in the table below

Benefit	*Reference*
Treats diarrhea, dysentery & hypertension	https://doi.org/10.1016/B978-0-12-821038-3.00038-0
Potential treatment for cardiac tissue after ischemic stroke (rats)	https://doi.org/10.1590/S0102-865020160070000005
Anti-ulcer	Tira-Picos, V., Nogueira, J., & Gbolade, A. (2010). Comparative analysis of leaf essential oil constituents of Piliostigma thonningii and Piliostigma reticulatum. International Journal of Green Pharmacy, 4(2), 67.
Anti-ulcer	Bonamin, F., Moraes, T. M., dos Santos, R. C., Kushima, H., Faria, F. M., Silva, M. A., ... & Hiruma-Lima, C. A. (2014). The effect of a minor constituent of essential oil from Citrus aurAntium.
Cosmetics	https://doi.org/10.3389/fnut.2021.699666
Cosmetics	Bonamin, F., Moraes, T. M., dos Santos, R. C., Kushima, H., Faria, F. M., Silva, M. A., ... & Hiruma-Lima, C. A. (2014). The effect of a minor constituent of essential oil from Citrus aurAntium.
Soaps	https://doi.org/10.3389/fnut.2021.699666
Detergents	https://doi.org/10.3389/fnut.2021.699666
Detergents	Otson R et al; pp. 335-421 in Gas Pollut Charact Cycl Nriagu Jo Ed. NY,NY: John Wiley & Sons, Inc (1992)
Perfumes	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley & Sons, Inc. New York, NY 2007., p. 868
Perfumes	Paumgartten, F. J. R., Delgado, I. F., Alves, E. N., Nogueira, A. C. M. D. A., Presgrave, R. D. F., & Neubert, D. (1990). Single dose toxicity study of beta-myrcene, a natural analgesic substance.
Insect repellent	Bordasch RP, Berryman AA; Can Entomol 109 (1): 95 (1977)

9.3.2 Cascarillins

Table 9.3: Benefits of Cascarillins are shown in the table below

Benefit	*Reference*
Improves digestion	https://doi.org/10.1021/jf034780h
Bitters	https://doi.org/10.1371/journal.pgen.1005530

9.3.3 Lignins

Table 9.4: Benefits of Lignins are shown in the table below

Benefit	*Reference*
Production of polymer materials	DOI: 10.5772/intechopen.72963
Source of renewable & biobased carbon	https://doi.org/10.1039/C7GC01479A
Renewable raw material	https://doi.org/10.1002/cssc.201000157
Batteries	https://doi.org/10.1016/j.jechem.2018.02.015
Dispersants, adhesives, & surfactants	https://doi.org/10.1016/j.indcrop.2019.111526
Flame retardant	DOI: 10.5772/intechopen.72963
Pesticide	https://doi.org/10.1002/cssc.201000157
Production of Vanillin	https://doi.org/10.1021/acssuschemeng.5b01344
Antimicrobial	https://doi.org/10.1016/j.eurpolymj.2019.01.007
Antibacterial	https://doi.org/10.3390/ijms18112367
Antioxidant	https://doi.org/10.3390/ijms18112367

9.3.4 Limonene*

Table 9.5: Benefits of limonene are shown in the table below

Benefit	*Reference*
Antifungal	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antifungal	https://doi.org/10.1177/1934578X0800300728
Antilarval	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
chemoprotective	https://doi.org/10.1177/1934578X0800300728
Antioxidant	https://doi.org/10.1177/1934578X0800300728
Anti-inflammatory	https://doi.org/10.1177/1934578X0800300728
Anti-inflammatory	https://doi.org/10.1042/BSR20181253
Anti-inflammatory	https://doi.org/10.1007/s10753-016-0496-y
Antinociceptive	https://doi.org/10.1177/1934578X0800300728
Antinociceptive	https://doi.org/10.1007/s10753-016-0496-y
Anticancer	https://doi.org/10.1177/1934578X0800300728
Anticancer	https://doi.org/10.1042/BSR20181253
insecticidal	https://doi.org/10.1177/1934578X0800300728
Antitumor	https://doi.org/10.1042/BSR20181253

9.3.5 a-pinene*

Table 9.6: Benefits of a-pinene are shown in the table below

Benefit	*Reference*
Anti-inflammatory effects	Bhagat, M., Gupta, S., Jamwal, V. S., Sharma, S., Kattal, M., Dawa, S., ... and Bindu, K. (2016). Comparative study on chemical profiling and Antimicrobial properties of essential oils from different parts of Eucalyptus lanceolatus.
Antimicrobial	https://doi.org/10.3390/molecules17066305
Antimicrobial	https://dx.doi.org/10.3390/biom9110738
Antimicrobial	https://doi.org/10.1080/10412905.1999.9701162
Antibacterial	https://doi.org/10.3390/molecules17066305
Antibacterial (hand sanitizer)	Wijayati, N., Widiyastuti, A., Mursiti, S., and Rakainsa, S. K. (2020, May). Formulation of Hand Sanitizer Gel of A-Pinene Isolated from Turpentine Oil and its Antibacterial Activity. In IOP Conference Series: Materials Science and Engineering (Vol. 846, No. 1, p. 012069). IOP Publishing.
Fungicidal	https://dx.doi.org/10.3390/biom9110738
Fungicidal	https://doi.org/10.3390/molecules17066305
Flavoring	https://dx.doi.org/10.3390/biom9110738
Flavoring	https://doi.org/10.3390/molecules17066305
Fragrances	https://dx.doi.org/10.3390/biom9110738
Antiviral	https://dx.doi.org/10.3390/biom9110738
Renal and Hepatic Drugs	https://dx.doi.org/10.3390/biom9110738
Inhibitory effects on breast cancer and leukemia	https://dx.doi.org/10.3390/biom9110738
Cytotoxic	https://doi.org/10.3390/molecules17066305
Polymer synthetization	https://dx.doi.org/10.3390/biom9110738
Anticoagulative/Antiplatelet	https://dx.doi.org/10.3390/biom9110738
Anti-tumour	https://dx.doi.org/10.3390/biom9110738
Antioxidant	https://dx.doi.org/10.3390/biom9110738
Gastroprotective activity	https://dx.doi.org/10.3390/biom9110738
Neuroprotective activity	https://dx.doi.org/10.3390/biom9110738
Bathtub, tile, and toilet surface cleaners	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 6654, alpha-Pinene. Retrieved January 20, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/alpha-Pinene.
Insect repellant	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 6654, alpha-Pinene. Retrieved January 20, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/alpha-Pinene.
Insecticide	https://doi.org/10.3390/molecules17066305

9.3.6 o-Cymene*

Table 9.7: Benefits of o-Cymene are shown in the table below

Benefit	*Reference*
Solvents	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 364
Synthetic-resin manufacture	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 365
Metal polishes	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 366
Organic synthesis	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 367
Antibacterial	https://doi.org/10.1016/j.jep.2005.07.024
Antibacterial	https://doi.org/10.1080/0972060X.2012.10644098
Antiviral	Kazemi Oskuee, Reza and Behravan, Javad and Ramezani, Mohammad (2011) Chemical composition, Antimicrobial activity and Antiviral activity of essential oil of Carum copticum from Iran. Avicenna Journal of Phytomedicine, 1 (2). pp. 83-90.
Antifungal	https://doi.org/10.1016/j.jep.2005.07.024
Anti-Candida	https://doi.org/10.1080/14786419.2017.1340291
Antioxidant	https://doi.org/10.1016/j.jep.2005.07.024
Antioxidant	Gweru, N., Gundidza, M., Magwa, M. L., Ramalivhana, N. J., Humphrey, G., Samie, A., and Mmbengwa, V. (2009). Phytochemical composition and biological activities of essential oil of Rhynchosia minima (L)(DC)(Fabaceae). African Journal of Biotechnology, 8(5).
Antioxidant	https://doi.org/10.1002/jsfa.10388

9.3.7 Tannin

Table 9.8: Benefits of Tannin are shown in the table below

Benefit	*Reference*
Tanning leather	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Leather processing	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Photography	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Dyes	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Dyes	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Clarifying wine and beer	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Astringents in medicine	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Astringents in medicine	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Antioxidant	DOI: 10.5772/intechopen.85984
Metal chelators	DOI: 10.5772/intechopen.85984
Influence reabsorption of metal	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Antiseptics	DOI: 10.5772/intechopen.85984
Anticarcinogenic	DOI: 10.5772/intechopen.85984
Anti-inflammatory	DOI: 10.5772/intechopen.85984
Antiviral	DOI: 10.5772/intechopen.85984
Antifungal	DOI: 10.5772/intechopen.85984
Antibacterial	DOI: 10.5772/intechopen.85984
Antibacterial	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.

cont'd Benefits of Tannin are shown in the table below

Benefit	*Reference*
Reduce blood glucose levels	DOI: 10.5772/intechopen.85984
Prevent degenerative diseases like: Atherosclerosis Cardiovascular diseases Neurodegenerative diseasws	DOI: 10.5772/intechopen.85984
Food preservatives	DOI: 10.5772/intechopen.85984
Wood adhesives	https://dx.doi.org/10.3390/biom9080344
Fireproof and insulating foams	https://dx.doi.org/10.3390/biom9080344
Inhibit metal corrosion	https://dx.doi.org/10.3390/Fbiom9080344
Antitumor	https://dx.doi.org/10.3390/Fbiom9080344
Laxative	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Tannin gels	https://doi.org/10.3390/biom9100587

Cascarilla Leaves

9.4 General Cascarilla Leaves Use

9.5 Cascarilla Leaves Phytochemical Benefits

9.5.1 2-nonanone*

Table 9.9: Benefits of 2-nonanone are shown in the table below

Benefit	*Reference*
Flavoring (fruit, hot milk)	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 13187, 2-Nonanone. Retrieved January 21, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/2-Nonanone.
Food preservative	https://doi.org/10.1016/j.supflu.2015.04.031
Food preservative (Antimicrobial & Antifungal)	https://doi.org/10.1021/jf062809m
Milk odorant	https://doi.org/10.1017/S0022029900030806
Fragrance	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 13187, 2-Nonanone. Retrieved January 21, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/2-Nonanone.
Perfume	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 13187, 2-Nonanone. Retrieved January 21, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/2-Nonanone.
Antifungal	https://doi.org/10.1111/j.1365-2621.1997.tb15034.x
Antimicrobial	https://doi.org/10.1007/s11947-017-1926-z
Antibacterial	https://doi.org/10.1007/s00253-017-8350-1

9.5.2 a-Copaene*

Table 9.10: Benefits of a-Copaene are shown in the table below

Benefit	*Reference*
Attracts fruit flies	https://doi.org/10.1023/A:1005489411397
Attracts fruit flies	Takeoka, G., Flath, R. A., Mon, T. R., Buttery, R. G., Teranishi, R., Güntert, M., ... & Szejtli, J. (1990). Further applications of permethylated Beta-cyclodextrin capillary gas chromatographic columns. Journal of High Resolution Chromatography, 13(3), 202-206.
Antigenotoxic	https://doi.org/10.1007/s10616-013-9611-1
Antioxidant	https://doi.org/10.1007/s10616-013-9611-1
Antimicrobial	DOI: 10.1055/s-2006-957742

9.5.3 b-Bourbonenee*

Table 9.11: Benefits of b-Bourbonene are shown in the table below

Benefit	*Reference*
Flavouring	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 62566, (-)-beta-Bourbonene. Retrieved January 21, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/beta-Bourbonene.
Potentially Anticancer	https://doi.org/10.3892/ol.2018.9183
Antimicrobial	https://doi.org/10.1002/ffj.1409

9.5.4 Vanillin

Table 9.12: Benefits of Vanillin are shown in the table below

Benefit	*Reference*
Flavouring agent in baking & chocolate https://doi.org/10.1002/0471238961.2201140905191615.a01	
Flavoring O'Neil, M.J. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Cambridge, UK: Royal Society of Chemistry, 2013., p. 1843	
Perfumes	https://doi.org/10.1002/0471238961.2201140905191615.a01
Fragrance	O'Neil, M.J. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Cambridge, UK: Royal Society of Chemistry, 2013., p. 1843
Antiultraviolet protection	https://doi.org/10.1002/0471238961.2201140905191615.a01
Livestock fodder	https://doi.org/10.1002/0471238961.2201140905191615.a01
Flavoring in beverages	https://doi.org/10.1002/jsfa.9303
Metal plating	https://doi.org/10.1002/jsfa.9303
Herbicides	https://doi.org/10.1002/jsfa.9303
Ripening agents	https://doi.org/10.1002/jsfa.9303
Antifoaming agents	https://doi.org/10.1002/jsfa.9303
Deodorants, air fresheners, floor-polishing agents	https://doi.org/10.1002/jsfa.9303
Candles	Drugs.com. (n.d.). Vanillin (inactive ingredient). Drugs.com. Retrieved January 21, 2022, from https://www.drugs.com/inactive/vanillin-65.html
Soaps, body cleaners, toothpaste	National Center for Biotechnology Information (2022). PubChem Annotation Record for VANILLIN, Source: Hazardous Substances Data Bank (HSDB). Retrieved January 21, 2022 from https://pubchem.ncbi.nlm.nih.gov/source/hsdb/1027
Cosmetics	O'Neil, M.J. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Cambridge, UK: Royal Society of Chemistry, 2013., p. 1843
Shampoo	National Center for Biotechnology Information (2022). PubChem Annotation Record for VANILLIN, Source: Hazardous Substances Data Bank (HSDB). Retrieved January 21, 2022 from https://pubchem.ncbi.nlm.nih.gov/source/hsdb/1027
Lip products	National Center for Biotechnology Information (2022). PubChem Annotation Record for VANILLIN, Source: Hazardous Substances Data Bank (HSDB). Retrieved January 21, 2022 from https://pubchem.ncbi.nlm.nih.gov/source/hsdb/1027

Cont'd Benefits of Vanillin are shown in the table below

Benefit	*Reference*
Lip products	National Center for Biotechnology Information (2022). PubChem Annotation Record for VANILLIN, Source: Hazardous Substances Data Bank (HSDB). Retrieved January 21, 2022 from https://pubchem.ncbi.nlm.nih.gov/source/hsdb/1027
Antihypertensive	Vidal JP; Vanillin. Kirk-Othmer Encyclopedia of Chemical Technology (1999-2015). John Wiley & Sons, Inc. Online Posting Date: May 19, 2006
Antioxidant	https://doi.org/10.1016/j.ejphar.2011.07.001
Anti-inflammatory	https://doi.org/10.1016/j.ejphar.2011.07.001
Hepatoprotective	https://doi.org/10.1016/j.ejphar.2011.07.001
Anti-sickle cell anemia	https://doi.org/10.1016/j.fct.2010.08.023
Antimutagen	https://doi.org/10.1016/j.fct.2010.08.023
Antibacterial	https://doi.org/10.1016/j.fct.2010.08.023

9.5.5 Thujene

Table 9.13: Benefits of Thujene are shown in the table below

Benefit	*Reference*
Flavoring	Foreverest. (n.d.). Thujene (CAS 84625-32-1). Foreverest Resources. Retrieved January 21, 2022, from https://foreverest.cn/products/extractives-synthetic/thujene-2.html
Cosmetics	Foreverest. (n.d.). Thujene (CAS 84625-32-1). Foreverest Resources. Retrieved January 21, 2022, from https://foreverest.cn/products/extractives-synthetic/thujene-2.html
Fragrance	Foreverest. (n.d.). Thujene (CAS 84625-32-1). Foreverest Resources. Retrieved January 21, 2022, from https://foreverest.cn/products/extractives-synthetic/thujene-2.html
Antimalarial	Foreverest. (n.d.). Thujene (CAS 84625-32-1). Foreverest Resources. Retrieved January 21, 2022, from https://foreverest.cn/products/extractives-synthetic/thujene-2.html
Essential oils	Foreverest. (n.d.). Thujene (CAS 84625-32-1). Foreverest Resources. Retrieved January 21, 2022, from https://foreverest.cn/products/extractives-synthetic/thujene-2.html
Pain-relieving	Foreverest. (n.d.). Thujene (CAS 84625-32-1). Foreverest Resources. Retrieved January 21, 2022, from https://foreverest.cn/products/extractives-synthetic/thujene-2.html
Antioxidant	Foreverest. (n.d.). Thujene (CAS 84625-32-1). Foreverest Resources. Retrieved January 21, 2022, from https://foreverest.cn/products/extractives-synthetic/thujene-2.html
Antioxidant	Shabnum, S., & Wagay, M. G. (2011). Essential oil composition of Thymus vulgaris L. and their uses. J. Res. Dev, 11, 83-94.
Antimicrobial	Foreverest. (n.d.). Thujene (CAS 84625-32-1). Foreverest Resources. Retrieved January 21, 2022, from https://foreverest.cn/products/extractives-synthetic/thujene-2.html
Antifungal	https://doi.org/10.1080/0972060X.2008.10643643
Anti-inflammatory	Foreverest. (n.d.). Thujene (CAS 84625-32-1). Foreverest Resources. Retrieved January 21, 2022, from https://foreverest.cn/products/extractives-synthetic/thujene-2.html
Antibacterial	https://doi.org/10.1080/0972060X.2008.10643643
Herbicidal	Foreverest. (n.d.). Thujene (CAS 84625-32-1). Foreverest Resources. Retrieved January 21, 2022, from https://foreverest.cn/products/extractives-synthetic/thujene-2.html

9.5.6 o-Cymene*

Table 9.14: Benefits of o-Cymene are shown in the table below

Benefit	*Reference*
Solvents	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 364
Synthetic-resin manufacture	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 365
Metal polishes	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 366
Organic synthesis	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 367
Antibacterial	https://doi.org/10.1016/j.jep.2005.07.024
Antibacterial	https://doi.org/10.1080/0972060X.2012.10644098
Antiviral	Kazemi Oskuee, Reza and Behravan, Javad and Ramezani, Mohammad (2011) Chemical composition, Antimicrobial activity and Antiviral activity of essential oil of Carum copticum from Iran. Avicenna Journal of Phytomedicine, 1 (2). pp. 83-90.
Antifungal	https://doi.org/10.1016/j.jep.2005.07.024
Anti-Candida	https://doi.org/10.1080/14786419.2017.1340291
Antioxidant	https://doi.org/10.1016/j.jep.2005.07.024
Antioxidant	Gweru, N., Gundidza, M., Magwa, M. L., Ramalivhana, N. J., Humphrey, G., Samie, A., and Mmbengwa, V. (2009). Phytochemical composition and biological activities of essential oil of Rhynchosia minima (L)(DC)(Fabaceae). African Journal of Biotechnology, 8(5).
Antioxidant	https://doi.org/10.1002/jsfa.10388

9.5.7 D-Germacrene*

Table 9.15: Benefits of D-Germacrene are shown in the table below

Benefit	*Reference*
Flavoring in beverages and food	Isobionics. (n.d.). Natural Germacrene-D. Isobionics Nootkatone. Retrieved January 20, 2022, from https://www.isobionics.com/index-Germacrene-D.html
Personal and skin care products	Isobionics. (n.d.). Natural Germacrene-D. Isobionics Nootkatone. Retrieved January 20, 2022, from https://www.isobionics.com/index-Germacrene-D.html
Antimicrobial	https://doi.org/10.1590/S0100-40422011000900013
Antimicrobial	https://doi.org/10.3390/molecules24173203
Antimicrobial	https://doi.org/10.1021/jf026203j
Antibacterial	https://doi.org/10.1590/S0100-40422011000900013
Disinfectant	https://doi.org/10.1590/S0100-40422011000900013
Attracts pollinators	https://doi.org/10.1590/S0100-40422011000900013
Antioxidant	https://doi.org/10.1155/2013/409826
Insect repellent	https://doi.org/10.1155/2013/409826
Insecticidal	https://doi.org/10.1016/j.indcrop.2015.03.025
Fragrance	https://doi.org/10.5650/jos.62.51

9.5.8 a-pinene

Table 9.16: Benefits of a-pinene are shown in the table below

Benefit	*Reference*
Anti-inflammatory effects	Bhagat, M., Gupta, S., Jamwal, V. S., Sharma, S., Kattal, M., Dawa, S., ... and Bindu, K. (2016). Comparative study on chemical profiling and Antimicrobial properties of essential oils from different parts of Eucalyptus lanceolatus.
Antimicrobial	https://doi.org/10.3390/molecules17066305
Antimicrobial	https://dx.doi.org/10.3390/biom9110738
Antimicrobial	https://doi.org/10.1080/10412905.1999.9701162
Antibacterial	https://doi.org/10.3390/molecules17066305
Antibacterial (hand sanitizer)	Wijayati, N., Widiyastuti, A., Mursiti, S., and Rakainsa, S. K. (2020, May). Formulation of Hand Sanitizer Gel of A-Pinene Isolated from Turpentine Oil and its Antibacterial Activity. In IOP Conference Series: Materials Science and Engineering (Vol. 846, No. 1, p. 012069). IOP Publishing.
Fungicidal	https://dx.doi.org/10.3390/biom9110738
Fungicidal	https://doi.org/10.3390/molecules17066305
Flavoring	https://dx.doi.org/10.3390/biom9110738
Flavoring	https://doi.org/10.3390/molecules17066305
Fragrances	https://dx.doi.org/10.3390/biom9110738
Antiviral	https://dx.doi.org/10.3390/biom9110738
Renal and Hepatic Drugs	https://dx.doi.org/10.3390/biom9110738
Inhibitory effects on breast cancer and leukemia	https://dx.doi.org/10.3390/biom9110738
Cytotoxic	https://doi.org/10.3390/molecules17066305
Polymer synthetization	https://dx.doi.org/10.3390/biom9110738
Anticoagulative/Antiplatelet	https://dx.doi.org/10.3390/biom9110738
Anti-tumour	https://dx.doi.org/10.3390/biom9110738
Antioxidant	https://dx.doi.org/10.3390/biom9110738
Gastroprotective activity	https://dx.doi.org/10.3390/biom9110738
Neuroprotective activity	https://dx.doi.org/10.3390/biom9110738
Bathtub, tile, and toilet surface cleaners	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 6654, alpha-Pinene. Retrieved January 20, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/alpha-Pinene.
Insect repellant	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 6654, alpha-Pinene. Retrieved January 20, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/alpha-Pinene.
Insecticide	https://doi.org/10.3390/molecules17066305

9.5.9 D-Limonene

Table 9.17: Benefits of D-Limonene are shown in the table below

Benefit	*Reference*
Dietary Supplement	National Center for Biotechnology Information (2022). PubChem Annotation Record for LIMONENE, Source: Hazardous Substances Data Bank (HSDB). Retrieved January 20, 2022
Fragrance for cosmetics	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 757
Fragrance for cosmetics	https://doi.org/10.1080/10937404.2013.769418
Fragrance	https://doi.org/10.1016/j.fct.2018.07.052
Food manufacturing	Burdock, G.A. (ed.). Fenaroli's Handbook of Flavor Ingredients. 6th ed.Boca Raton, FL 2010, p. 1090
Medicines	National Center for Biotechnology Information (2022). PubChem Annotation Record for LIMONENE, Source: Hazardous Substances Data Bank (HSDB). Retrieved January 20, 2022.
Flavoring to mask taste of alkaloids	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 757
Fragrance in perfumery	Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley and Sons, Inc. New York, NY 2007., p. 757
Aftershave lotions and bath products	USEPA/OPPTS; R.E.D Facts. Limonene (138-86-3). Reregistration Eligibility Decisions (REDs) Database. EPA-738-F-94-030. Sept 1994. Available from, as of Apr 24, 2015: https://www.epa.gov/pesticides/reregistration/status.htm
Botanical insecticide	USEPA/OPPTS; R.E.D Facts. Limonene (138-86-3). Reregistration Eligibility Decisions (REDs) Database. EPA-738-F-94-030. Sept 1994. Available from, as of Apr 24, 2015: https://www.epa.gov/pesticides/reregistration/status.htm
Insect repellant	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Herbicide	USEPA/OPPTS; R.E.D Facts. Limonene (138-86-3). Reregistration Eligibility Decisions (REDs) Database. EPA-738-F-94-030. Sept 1994. Available from, as of Apr 24, 2015: https://www.epa.gov/pesticides/reregistration/status.htm
Hand cleaners/soaps	USEPA/OPPTS; R.E.D Facts. Limonene (138-86-3). Reregistration Eligibility Decisions (REDs) Database. EPA-738-F-94-030. Sept 1994. Available from, as of Apr 24, 2015: https://www.epa.gov/pesticides/reregistration/status.htm

[Cont'd] Benefits of D-Limonene are shown in the table below

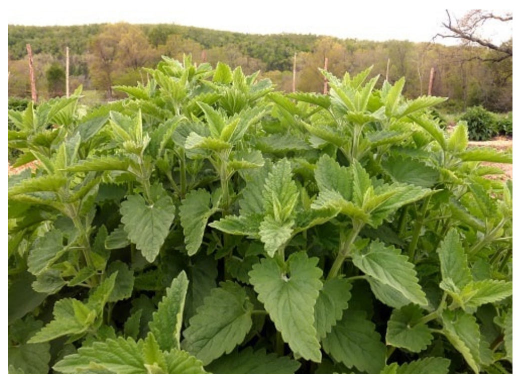
Benefit	*Reference*
Flavouring in beverages (fruit juices, soft drinks) and baked goods, ice cream and pudding	Burdock, G.A. (ed.). Fenaroli's Handbook of Flavor Ingredients. 6th ed.Boca Raton, FL 2010, p. 1090
Food flavoring	https://doi.org/10.1080/10937404.2013.769418
Food flavoring	https://doi.org/10.1016/j.fct.2018.07.052
Dissolves cholesterol-containing gallstones	Shepard, T.H. Catalog of Teratogenic Agents. 5th ed. Baltimore, MD: The Johns Hopkins University Press, 1986., p. 342
Dissolves cholesterol-containing gallstones	https://doi.org/10.1007/BF01071903
Relief of heartburn and gastroesophageal reflux	Sun J. D-Limonene: safety and clinical applications. Altern Med Rev. 2007 Sep;12(3):259-64. PMID: 18072821.
Chemopreventive activity	Sun J. D-Limonene: safety and clinical applications. Altern Med Rev. 2007 Sep;12(3):259-64. PMID: 18072821.
Hepatoprotective	doi:10.1016/S0367-326X(03)00028-5
Substitute for chlorinated hydrocarbons, CFCs and other organic solvents	https://doi.org/10.1093/annhyg/35.4.419
Bactericide, Antioxidant and therapeutic activities	https://doi.org/10.1016/j.foodhyd.2015.01.031
Antimicrobial	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antiviral	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antifungal	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antilarval	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185

Chapter 10

Mint Leaves

10.1 General Description

Mint or as it is also known as, mentha is often used in beverages such as teas, mojitos, lemonade, cocktails and rum. Non-beverage uses include in foodstuff such as chocolate, ice-cream, breath mints' and gum. It is also used as in toothpaste, mouthwash, Facial & body products, essential oils, waters baths and as an insect and bug repellant. Mint has traditional been used in teas because of its soothing affect on the stomach and its ability to manage gastrointestinal problems. However mint is also known for causing adverse affect on people with gastroesophageal reflux disease (GERD).



10.2 Phytochemical Benefits

10.2.1 Limonene*

Table 10.1: Benefits of limonene are shown in the table below

Benefit	*Reference*
Antifungal	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
Antifungal	https://doi.org/10.1177/1934578X0800300728
Antilarval	Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley and Sons. New York, N.Y. (2001)., p. V4 185
chemoprotective	https://doi.org/10.1177/1934578X0800300728
Antioxidant	https://doi.org/10.1177/1934578X0800300728
Anti-inflammatory	https://doi.org/10.1177/1934578X0800300728
Anti-inflammatory	https://doi.org/10.1042/BSR20181253
Anti-inflammatory	https://doi.org/10.1007/s10753-016-0496-y
Antinociceptive	https://doi.org/10.1177/1934578X0800300728
Antinociceptive	https://doi.org/10.1007/s10753-016-0496-y
Anticancer	https://doi.org/10.1177/1934578X0800300728
Anticancer	https://doi.org/10.1042/BSR20181253
insecticidal	https://doi.org/10.1177/1934578X0800300728
Antitumor	https://doi.org/10.1042/BSR20181253

10.2.2 Nonanal

Table 10.2: Benefits of nonanal are shown in the table below

Benefit	*Reference*
Antidiarrhoeal	Zavala-Sanchez, M. A., Pérez-Gutiérrez, S., P? rez-González, C., Sánchez-Saldivar, D., & Arias-García, L. (2002). Antidiarrhoeal activity of nonanal, an aldehyde isolated from Artemisia ludoviciana. Pharmaceutical biology, 40(4), 263-268.
Antidiarrhoeal	Gohari, A. R., Saeidnia, S., Malmir, M., Yazdanpanah, M., & Ajani, Y. (2011). Sterols and flavonoids of Lomatopodium staurophyllum. Journal of Medicinal Plants, 10(39), 43-48.
Anti-fungal	Zhang, J. H., Sun, H. L., Chen, S. Y., Zeng, L. I., & Wang, T. T. (2017). Anti-fungal activity, mechanism studies on alpha-Phellandrene and Nonanal against Penicillium cyclopium. Botanical studies, 58, 1-9.
Anti-fungal	Li, Q., Zhu, X., Xie, Y., & Liang, J. (2021). Antifungal properties and mechanisms of three volatile aldehydes (octanal, nonanal and decanal) on Aspergillus flavus. Grain & Oil Science and Technology, 4(3), 131-140.
Anti-fungal	Zhang, J., Zeng, L., Sun, H., Chen, S., Wang, T., & Ma, S. (2017). Use of Nonanal-wax as Postharvest Fungicide of Tomato against Botrytis cinereal. J. Food Nutr. Res, 5, 458-466.

10.2.3 Carvone*

Table 10.3: Benefits of carvone are shown in the table below

Benefit	*Reference*
parasitic	Silva, A. R., Scher, R., Santos, F. V., Ferreira, S. R., Cavalcanti, S. C., Correa, C. B., ... & Dolabella, S. S. (2017). Leishmanicidal activity and structure-activity relationships of essential oil constituents. Molecules, 22(5), 815.
Anticonvulsant	de Almeida, R. N., de Sousa, D. P., de Farias Nóbrega, F. F., de Sousa Claudino, F., Araújo, D. A. M., Leite, J. R., & Mattei, R. (2008). Anticonvulsant effect of a natural compound alpha, beta-epoxy-carvone and its action on the nerve excitability. Neuroscience letters, 443(1), 51-55.
Antioxidant	Obadiah, A., Kannan, R., Ramesh, P., Ramasubbu, A., & Kumar, S. V. (2012). Isolation of carvone and phellandrene from Murraya koenigii and study of their Antioxidant activity. Chemistry of Natural Compounds, 48, 149-150.
Antimicrobial	De Carvalho, C. C., & Da Fonseca, M. M. R. (2006). Carvone: Why and how should one bother to produce this terpene. Food chemistry, 95(3), 413-422.
Antimicrobial	Moro, I. J., Gondo, G. D. G. A., Pierri, E. G., Pietro, R. C. L. R., Soares, C. P., Sousa, D. P. D., & Santos, A. G. D. (2018). Evaluation of Antimicrobial, cytotoxic and chemopreventive activities of carvone and its derivatives. Brazilian journal of pharmaceutical sciences, 53.
Antidiabetic	Muruganathan, U., & Srinivasan, S. (2016). Beneficial effect of carvone, a dietary monoterpene ameliorates hyperglycemia by regulating the key enzymes activities of carbohydrate metabolism in streptozotocin-induced diabetic rats. Biomedicine & pharmacotherapy, 84, 1558-1567.
Antidiabetic	Bouyahya, A., Lagrouh, F., El Omari, N., Bourais, I., El Jemli, M., Marmouzi, I., ... & Bakri, Y. (2020). Essential oils of Mentha viridis rich phenolic compounds show important Antioxidant, Antidiabetic, dermatoprotective, Antidermatophyte and Antibacterial properties. Biocatalysis and Agricultural Biotechnology, 23, 101471.
Antifungal	Hartmans, K. J., Diepenhorst, P., Bakker, W., & Gorris, L. G. (1995). The use of carvone in agriculture: sprout suppression of potatoes and Antifungal activity against potato tuber and other plant diseases. Industrial Crops and Products, 4(1), 3-13.
Antifungal	Boonruang, K., Kerddonfag, N., Chinsirikul, W., Mitcham, E. J., & Chonhenchob, V. (2017). Antifungal effect of poly (lactic acid) films containing thymol and R-(-)-carvone against anthracnose pathogens isolated from avocado and citrus. Food Control, 78, 85-93.
Antibacterial	Mohib, K., & Vemuri, S. (2009). Antibacterial activity of carvone containing essential oils. Journal of Chemical and Pharmaceutical Sciences, 2(2), 126-127.

10.2.4 D-Germacrene*

Table 10.4: Benefits of D-Germacrene are shown in the table below

Benefit	*Reference*
Flavoring in beverages and food	Isobionics. (n.d.). Natural Germacrene-D. Isobionics Nootkatone. Retrieved January 20, 2022, from https://www.isobionics.com/index-Germacrene-D.html
Personal and skin care products	Isobionics. (n.d.). Natural Germacrene-D. Isobionics Nootkatone. Retrieved January 20, 2022, from https://www.isobionics.com/index-Germacrene-D.html
Antimicrobial	https://doi.org/10.1590/S0100-40422011000900013
Antimicrobial	https://doi.org/10.3390/molecules24173203
Antimicrobial	https://doi.org/10.1021/jf026203j
Antibacterial	https://doi.org/10.1590/S0100-40422011000900013
Disinfectant	https://doi.org/10.1590/S0100-40422011000900013
Attracts pollinators	https://doi.org/10.1590/S0100-40422011000900013
Antioxidant	https://doi.org/10.1155/2013/409826
Insect repellent	https://doi.org/10.1155/2013/409826
Insecticidal	https://doi.org/10.1016/j.indcrop.2015.03.025
Fragrance	https://doi.org/10.5650/jos.62.51

10.2.5 Beta-Caryophyllene*

Table 10.5: Benefits of beta-Caryophyllene are shown in the table below

Benefit	*Reference*
Antibacterial activity	https://doi.org/10.1016/j.sajb.2021.07.046
Antibacterial activity (pneumonia - mice)	https://doi.org/10.1016/j.sjbs.2021.06.034
Antiviral activity (zika virus)	https://doi.org/10.1016/j.indcrop.2021.113281; https://doi.org/10.1016/j.actatropica.2020.105556
Anticonvulsant/epileptic seizure (mice)	https://doi.org/10.1016/j.eplepsyres.2021.106842
increased libido in women	https://doi.org/10.1016/j.esxm.2020.06.001
Osteoarthritis Treatment (mice)	https://doi.org/10.1016/j.neuropharm.2021.108908
general review	https://doi.org/10.1016/j.biopha.2021.111639
Alcohol addiction	10.1016/j.pbb.2014.06.025
Neuropathic pain	10.1016/j.euroneuro.2013.10.008
Neuropathic pain	10.1016/j.phymed.2013.08.006
Neuropathic pain	10.4236/pp.2012.34053
Nociception	10.1038/ncpneuro0113
Neuropathic pain	https://doi.org/10.3390/molecules25010106
Insulin resistance and dyslipidemia	10.1016/j.cbi.2018.10.010
Insulin resistance and associated neurobehavioral changes	10.1016/j.biopha.2018.11.039
Atherosclerosis	10.1016/j.taap.2017.06.016
Ulcerative colitis	10.1016/j.ajpath.2010.11.052
Immunomodulation	10.3390/ijms18040691
Peripheral neuropathy	10.1016/j.neuropharm.2017.07.015
Chemotherapy-induced cardiotoxicity	10.1016/j.cbi.2019.02.028
Nephroprotective	10.1016/j.freeradbiomed.2012.01.014
Parkinson's disease	10.3389/fnins.2016.00321
Parkinson's disease	10.3390/ph10030060
Alzheimer's disease	10.1159/000362689
Post-stroke cognitive deficits	10.3389/fphar.2017.00002
Cerebral ischemia	10.1016/j.ajpath.2012.11.024

[Cont'd] Benefits of beta-Caryophyllene are shown in the table below

Benefit	*Reference*
Cerebral ischemia	10.1186/s12944-018-0661-4
Depression and anxiety	10.1016/j.physbeh.2014.06.003
Depression	10.1016/j.bbr.2019.112439
Liver fibrosis	10.1016/j.ejphar.2014.08.021
Alcohol liver damage	10.1111/bph.13722
Nicotine addiction	10.1111/bph.14969
Arthritis	10.3390/biom9080326
Obesity and related complications	10.1016/j.bbrc.2013.05.108
Hyperglycemia	10.1016/j.bbrc.2013.11.136
Atherosclerosis	10.1016/j.taap.2017.06.016
Cancer	10.3390/cancers12041038
Parkinson's disease	10.1016/j.biopha.2018.03.168
Cerebral ischemia-reperfusion injury	10.1080/07391102.2019.1567384
Multiple sclerosis	10.1016/j.lfs.2018.12.059
Multiple sclerosis	10.1016/j.bcp.2018.12.001
Neuroinflammation	10.1007/s12031-014-0243-5
Glioma	10.1016/j.neuroscience.2014.08.043
Depression	10.1016/j.bbr.2019.112439
Hepatic steatosis	10.1002/mnfr.201600197
Osteoporosis	10.1002/iub.158
Mucositis	10.3390/BIOMEDICINES8060164
Antifungal	10.1023/A:1007178924408
Fragrance	https://doi.org/10.1016/j.fct.2008.06.030
skin creams, shampoos and lotions	https://www.naturemary.com/beta-caryophyllene-for-skin/

10.2.6 Linalool

Table 10.6: Benefits of linalool are shown in the table below

Benefit	*Reference*
Antimicrobial, Antibacterial and Anti-oxidant	Van Zyl, R. L., Seatlholo, S. T., Van Vuuren, S. F., & Viljoen, A. M. (2006). The biological activities of 20 nature identical essential oil constituents. Journal of Essential Oil Research, 18(sup1), 129-133.
Anti-inflammatory	Peana, A. T., D'Aquila, P. S., Panin, F., Serra, G., Pippia, P., & Moretti, M. D. L. (2002). Anti-inflammatory activity of linalool and linalyl acetate constituents of essential oils. Phytomedicine, 9(8), 721-726.
Anti-inflammatory	Moretti, M. D., Peana, A. T., & Satta, M. (1997). A study on Anti-inflammatory and peripheral analgesic action of Salvia sclarea oil and its main components. Journal of Essential Oil Research, 9(2), 199-204.
Anti-inflammatory	Peana, A. T., & Moretti, M. D. (2002). Pharmacological activities and applications of Salvia sclarea and Salvia desoleana essential oils. Studies in natural products chemistry, 26, 391-423.
Antinociceptive	Peana, A. T., Marzocco, S., Popolo, A., & Pinto, A. (2006). Linalool inhibits in vitro NO formation: probable involvement in the Antinociceptive activity of this monoterpene compound. Life sciences, 78(7), 719-723.
Anti-oxidant	Van Zyl, R. L., Seatlholo, S. T., Van Vuuren, S. F., & Viljoen, A. M. (2006). The biological activities of 20 nature identical essential oil constituents. Journal of Essential Oil Research, 18(sup1), 129-133.
Anti-oxidant	Lin KH, Yeh SY, Lin MY, Shih MC, Yang KT, Hwang SY. (2007) Major chemotypes and Anti-oxidative activity of the leaf essential oils of Cinnamomum osmophloeum Kaneh. from a clonal orchard. Food Chemistry, 105, 133-139.
Anticancer	Cherng, J. M., Shieh, D. E., Chiang, W., Chang, M. Y., & Chiang, L. C. (2007). Chemopreventive effects of minor dietary constituents in common foods on human cancer cells. Bioscience, biotechnology, and biochemistry, 71(6), 1500-1504.
Anticancer	Silva, S. L. D., Figueiredo, P. M., & Yano, T. (2007). Cytotoxic evaluation of essential oil from Zanthoxylum rhoifolium Lam. leaves. Acta Amazonica, 37, 281-286.

[Cont'd] Benefits of linalool are shown in the table below

Benefit	*Reference*
insect repellant	Regnault-Roger, C., & Hamraoui, A. (1995). Fumigant toxic activity and reproductive inhibition induced by monoterpenes on Acanthoscelides obtectus (Say)(Coleoptera), a bruchid of kidney bean (Phaseolus vulgaris L.). Journal of Stored Products Research, 31(4), 291-299.
insect repellant	Stamopoulos, D. C., Damos, P., & Karagianidou, G. (2007). Bioactivity of five monoterpenoid vapours to Tribolium confusum (du Val)(Coleoptera: Tenebrionidae). Journal of stored products research, 43(4), 571-577.
effects on central nervous system	Elisabetsky, E., Coelho de Souza, G. P., Dos Santos, M. C., Siquieira, I. R., Amador, T. A., & Nunes, D. S. (1995). Sedative properties of linalool. Fitoterapia (Milano), 66(5), 407-414.
effects on central nervous system	Elisabetsky, E., Brum, L. S., & Souza, D. O. (1999). Anticonvulsant properties of linalool in glutamate-related seizure models. Phytomedicine, 6(2), 107-113.

10.2.7 Linalyl Acetate

Table 10.7: Benefits of linalyl acetate are shown in the table below

Benefit	*Reference*
Anti-inflammatory	Hsieh, Y. S., Shin, Y. K., Han, A. Y., Kwon, S., & Seol, G. H. (2019). Linalyl acetate prevents three related factors of vascular damage in COPD-like and hypertensive rats. Life sciences, 232, 116608.
Antibacterial	Shin, Y. K., Hsieh, Y. S., Han, A. Y., Kwon, S., Kang, P., & Seol, G. H. (2020). Sex-specific susceptibility to type 2 diabetes mellitus and preventive effect of linalyl acetate. Life Sciences, 260, 118432.
Antihypertensive	Kwon, S., Hsieh, Y. S., Shin, Y. K., Kang, P., & Seol, G. H. (2018). Linalyl acetate prevents olmesartan-induced intestinal hypermotility mediated by interference of the sympathetic inhibitory pathway in hypertensive rat. Biomedicine & Pharmacotherapy, 102, 362-368.
vascular disease prevention	Hsieh, Y. S., Shin, Y. K., Han, A. Y., Kwon, S., & Seol, G. H. (2019). Linalyl acetate prevents three related factors of vascular damage in COPD-like and hypertensive rats. Life sciences, 232, 116608.

10.2.8 Citronellol

Table 10.8: Benefits of citronellol are shown in the table below

Benefit	*Reference*
Anti-tumor	Zhuang, S. R., Chen, S. L., Tsai, J. H., Huang, C. C., Wu, T. C., Liu, W. S., ... & Wang, C. K. (2009). Effect of citronellol and the Chinese medical herb complex on cellular immunity of cancer patients receiving chemotherapy/radiotherapy. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives, 23(6), 785-790.
Anti-inflammatory	
Antihypertensive	Quintans-Júnior, L. J., Souza, T. T., Leite, B. S., Lessa, N. M. N., Bonjardim, L. R., Santos, M. R. V., ... & Antoniolli, A. R. (2008). Phytochemical screening and Anticonvulsant activity of Cymbopogon winterianus Jowitt (Poaceae) leaf essential oil in rodents. Phytomedicine, 15(8), 619-624.

10.2.9 Alpha-terpineol

Table 10.9: Benefits of alpha-terpineol are shown in the table below

Benefit	*Reference*
neuropathic pain reduction	Gouveia, D. N., Guimarães, A. G., Oliveira, M. A., Rabelo, T. K., Pina, L. T., Santos, W. B., ... & Quintans-Junior, L. J. (2022). Nanoencapsulated alpha-terpineol attenuates neuropathic pain induced by chemotherapy through calcium channel modulation. Polymer Bulletin, 1-18.
Antispasmodic	Magalhães, P. J., Criddle, D. N., Tavares, R. A., Melo, E. M., Mota, T. L., & Leal-Cardoso, J. H. (1998). Intestinal myorelaxant and Antispasmodic effects of the essential oil of Croton nepetaefolius and its constituents cineole, methyl-eugenol and terpineol. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives, 12(3), 172-177.
Antimicrobial	Park, S. N., Lim, Y. K., Freire, M. O., Cho, E., Jin, D., & Kook, J. K. (2012). Antimicrobial effect of linalool and alpha-terpineol against periodontopathic and cariogenic bacteria. Anaerobe, 18(3), 369-372.
Antifungal	Prakash, B., Singh, P., Goni, R., Raina, A. K. P., & Dubey, N. K. (2015). Efficacy of Angelica archangelica essential oil, phenyl ethyl alcohol and alpha-terpineol against isolated molds from walnut and their Antiaflatoxigenic and Antioxidant activity. Journal of food science and technology, 52, 2220-2228.
Antibacterial	Dorman, H. D., & Deans, S. G. (2000). Antimicrobial agents from plants: Antibacterial activity of plant volatile oils. Journal of applied microbiology, 88(2), 308-316.

Chapter 11

Almond Leaves

11.1 General Description

Almond leaves is from the tree commonly known as West Indian almond or Indian almond tree and is scientifically known as terminalia catappa. The leaf posseses a number of phytochemicals that have shown potential benefits to human health both clinically or under laboratory conditions. The leave and fruit is used to make several beverages such as teas, milk, wine and rum. Non-beverage uses of almond leaves and fruit include oils, candies and chocolate, ice cream, cookies, bread mixes, dessert fillings, soups and stews. The leaves contain several flavonoids (such as kaempferol or quercetin), several tannins (such as punicalin, punicalagin or tercatin), saponines and phytosterols. The leaves may also contain antioxidants, as well as anticlastogenic compounds.

11.2 Phytochemical Benefits

11.2.1 Nonanal*

Table 11.1: Benefits of nonanal are shown in the table below

Benefit	*Reference*
Antidiarrhoeal	Zavala-Sanchez, M. A., Pérez-Gutiérrez, S., P? rez-González, C., Sánchez-Saldivar, D., & Arias-García, L. (2002). Antidiarrhoeal activity of nonanal, an aldehyde isolated from Artemisia ludoviciana. Pharmaceutical biology, 40(4), 263-268.
Antidiarrhoeal	Gohari, A. R., Saeidnia, S., Malmir, M., Yazdanpanah, M., & Ajani, Y. (2011). Sterols and flavonoids of Lomatopodium staurophyllum. Journal of Medicinal Plants, 10(39), 43-48.
Anti-fungal	Zhang, J. H., Sun, H. L., Chen, S. Y., Zeng, L. I., & Wang, T. T. (2017). Anti-fungal activity, mechanism studies on alpha-Phellandrene and Nonanal against Penicillium cyclopium. Botanical studies, 58, 1-9.
Anti-fungal	Li, Q., Zhu, X., Xie, Y., & Liang, J. (2021). Antifungal properties and mechanisms of three volatile aldehydes (octanal, nonanal and decanal) on Aspergillus flavus. Grain & Oil Science and Technology, 4(3), 131-140.
Anti-fungal	Zhang, J., Zeng, L., Sun, H., Chen, S., Wang, T., & Ma, S. (2017). Use of Nonanal-wax as Postharvest Fungicide of Tomato against Botrytis cinereal. J. Food Nutr. Res, 5, 458-466.

11.2.2 Tannin

Table 11.2: Benefits of Tannin are shown in the table below

Benefit	*Reference*
Tanning leather	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Leather processing	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Photography	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Dyes	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Dyes	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Clarifying wine and beer	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Astringents in medicine	USDA. (n.d.). Tannins. Forest Service Shield. Retrieved January 20, 2022, from https://www.fs.fed.us/wildflowers/ethnobotany/tannins.shtml
Astringents in medicine	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Antioxidant	DOI: 10.5772/intechopen.85984
Metal chelators	DOI: 10.5772/intechopen.85984
Influence reabsorption of metal	Ramakrishnan, K., and Krishnan, M. R. V. (1994). Tannin–classification, analysis and applications. Ancient science of life, 13(3-4), 232.
Antiseptics	DOI: 10.5772/intechopen.85984
Anticarcinogenic	DOI: 10.5772/intechopen.85984
Anti-inflammatory	DOI: 10.5772/intechopen.85984
Antiviral	DOI: 10.5772/intechopen.85984
Antifungal	DOI: 10.5772/intechopen.85984
Antibacterial	DOI: 10.5772/intechopen.85984

11.2.3 Saponin

Table 11.3: Benefits of Saponin are shown in the table below

Benefit	*Reference*
Obesity	10.3390/molecules21101404
Insulin and glucose regulation	https://doi.org/10.1016/0963-9969(93)90069-U
reduce the availability of nutrients and cause growth inhibition (negative)	https://doi.org/10.1016/0963-9969(93)90069-U
Colon Cancer	10.3748/wjg.v16.i27.3371
Fungal Resistance	https://doi.org/10.1016/S1360-1385(96)80016-1
Soap	https://doi.org/10.1016/S1360-1385(96)80016-1;
Soap	https://www.newdirections.com.au/Articles/Saponins-Natures-Soap-and-So-Much-More
Skin Moisturizer	10.1080/09168451.2018.1547627
Skin Wound Healing	10.5142/jgr.2011.35.3.360
Hair Conditioning	https://doi.org/10.1111/j.1467-2494.1989.tb00510.x
Hair Growth	https://doi.org/10.7236/IJASC.2019.8.1.184

11.2.4 Quercetin

Table 11.4: Benefits of quercetin are shown in the table below

Benefit	*Reference*
Antioxidant	Zhang, M., Swarts, S. G., Yin, L., Liu, C., Tian, Y., Cao, Y., ... & Okunieff, P. (2011). Antioxidant properties of quercetin. In Oxygen transport to tissue XXXII (pp. 283-289). Springer US.
Antioxidant	Xu, D., Hu, M. J., Wang, Y. Q., & Cui, Y. L. (2019). Antioxidant activities of quercetin and its complexes for medicinal application. Molecules, 24(6), 1123.
Antioxidant and Anti-inflammatory	Lesjak, M., Beara, I., Simin, N., Pintać, D., Majkić, T., Bekvalac, K., ... & Mimica-Dukić, N. (2018). Antioxidant and anti-inflammatory activities of quercetin and its derivatives. Journal of Functional Foods, 40, 68-75.
Anticancer	Ezzati, M., Yousefi, B., Velaei, K., & Safa, A. (2020). A review on anti-cancer properties of Quercetin in breast cancer. Life sciences, 248, 117463.
Anticancer	Shafabakhsh, R., & Asemi, Z. (2019). Quercetin: a natural compound for ovarian cancer treatment. Journal of ovarian research, 12, 1-9.
Cardioprotective	Bhat, I. U. H., & Bhat, R. (2021). Quercetin: a bioactive compound imparting cardiovascular and neuroprotective benefits: scope for exploring fresh produce, their wastes, and by-products. Biology, 10(7), 586.
Antioxidant and Anti-inflammatory	Davis, J. M., Carlstedt, C. J., Chen, S., Carmichael, M. D., & Murphy, E. A. (2010). The dietary flavonoid quercetin increases VO2max and endurance capacity. International journal of sport nutrition and exercise metabolism, 20(1), 56-62.

11.2.5 Betacyanin

Table 11.5: Benefits of betacyanins are shown in the table below

Benefit	*Reference*
Antioxidant	Tenore, G. C., Novellino, E., & Basile, A. (2012). Nutraceutical potential and antioxidant benefits of red pitaya (Hylocereus polyrhizus) extracts. Journal of functional foods, 4(1), 129-136.
Antioxidants	Taira, J., Tsuchida, E., Katoh, M. C., Uehara, M., & Ogi, T. (2015). Antioxidant capacity of betacyanins as radical scavengers for peroxyl radical and nitric oxide. Food Chemistry, 166, 531-536.
Anticancer	Scarpa, E. S., Emanuelli, M., Frati, A., Pozzi, V., Antonini, E., Diamantini, G., ... & Ninfali, P. (2016). Betacyanins enhance vitexin-2-O-xyloside mediated inhibition of proliferation of T24 bladder cancer cells. Food & function, 7(12), 4772-4780.
Anticancer	Lee, E. J., An, D., Nguyen, C. T., Patil, B. S., Kim, J., & Yoo, K. S. (2014). Betalain and betaine composition of greenhouse-or field-produced beetroot (Beta vulgaris L.) and inhibition of HepG2 cell proliferation. Journal of agricultural and food chemistry, 62(6), 1324-1331.
Antiviral	Chang, Y. J., Pong, L. Y., Hassan, S. S., & Choo, W. S. (2020). Antiviral activity of betacyanins from red pitahaya (Hylocereus polyrhizus) and red spinach (Amaranthus dubius) against dengue virus type 2 (GenBank accession no. MH488959). Access Microbiology, 2(1).
Antibacterial	Yong, Y. Y., Dykes, G., Lee, S. M., & Choo, W. S. (2018). Effect of refrigerated storage on betacyanin composition, antibacterial activity of red pitahaya (Hylocereus polyrhizus) and cytotoxicity evaluation of betacyanin rich extract on normal human cell lines. LWT, 91, 491-497.

11.2.6 Anthocyanins

Table 11.6: Benefits of anthocyanins are shown in the table below

Benefit	*Reference*
Antioxidant and Anti-inflammatory & Miguel, M. G. (2011). Anthocyanins: Antioxidant and/or anti-inflammatory activities. Journal of Applied Pharmaceutical Science, (Issue), 07-15.	
Antioxidant	Zafra-Stone, S., Yasmin, T., Bagchi, M., Chatterjee, A., Vinson, J. A., & Bagchi, D. (2007). Berry anthocyanins as novel antioxidants in human health and disease prevention. Molecular nutrition & food research, 51(6), 675-683.
Antimicrobial	Cisowska, A., Wojnicz, D., & Hendrich, A. B. (2011). Anthocyanins as antimicrobial agents of natural plant origin. Natural product communications, 6(1), 1934578X1100600136.
Anti-inflammatory and Antimicrobial	Yoon, B. I., Bae, W. J., Choi, Y. S., Kim, S. J., Ha, U. S., Hong, S. H., ... & Kim, S. W. (2018). Anti-inflammatory and antimicrobial effects of anthocyanin extracted from black soybean on chronic bacterial prostatitis rat model. Chinese journal of integrative medicine, 24, 621-626.
Anticancer	de Arruda Nascimento, E., de Lima Coutinho, L., da Silva, C. J., de Lima, V. L. A. G., & dos Santos Aguiar, J. (2022). In vitro anticancer properties of anthocyanins: A systematic review. Biochimica et Biophysica Acta (BBA)-Reviews on Cancer, 188748.
Anticancer	Pallavi, R., Elakkiya, S., Tennety, S. S. R., & Devi, P. S. (2012). Anthocyanin analysis and its anticancer property from sugarcane (Saccharum officinarum L.) peel. IJRPC, 2(2), 338-45.
Antidiabetic	Les, F., Cásedas, G., Gómez, C., Moliner, C., Valero, M. S., & López, V. (2021). The role of anthocyanins as antidiabetic agents: From molecular mechanisms to in vivo and human studies. Journal of Physiology and Biochemistry, 77(1), 109-131.
Antibacterial	Sun, X. H., Zhou, T. T., Wei, C. H., Lan, W. Q., Zhao, Y., Pan, Y. J., & Wu, V. C. (2018). Antibacterial effect and mechanism of anthocyanin rich Chinese wild blueberry extract on various foodborne pathogens. Food Control, 94, 155-16

11.2.7 Coumarins

Table 11.7: Benefits of coumarins are shown in the table below

Benefit	*Reference*
Anticancer	Thakur, A., Singla, R., & Jaitak, V. (2015). Coumarins as anticancer agents: A review on synthetic strategies, mechanism of action and SAR studies. European journal of medicinal chemistry, 101, 476-495.
Antioxidant	Kostova, I., Bhatia, S., Grigorov, P., Balkansky, S., S Parmar, V., K Prasad, A., & Saso, L. (2011). Coumarins as antioxidants. Current medicinal chemistry, 18(25), 3929-3951.
Antibacterial	Souza, S. M. D., Monache, F. D., & Smânia Jr, A. (2005). Antibacterial activity of coumarins. Zeitschrift fuer Naturforschung C, 60(9-10), 693-700.
Antibacterial	Joao Matos, M., Vazquez-Rodriguez, S., Santana, L., Uriarte, E., Fuentes-Edfuf, C., Santos, Y., & Munoz-Crego, A. (2012). Looking for new targets: simple coumarins as antibacterial agents. Medicinal chemistry, 8(6), 1140-1145.
Antifungal	Prusty, J. S., & Kumar, A. (2020). Coumarins: antifungal effectiveness and future therapeutic scope. Molecular Diversity, 24, 1367-1383.
Antiviral	Hassan, M. Z., Osman, H., Ali, M. A., & Ahsan, M. J. (2016). Therapeutic potential of coumarins as antiviral agents. European journal of medicinal chemistry, 123, 236-255.
Anticoagulant	Akoudad, S., Darweesh, S. K., Leening, M. J., Koudstaal, P. J., Hofman, A., van der Lugt, A., ... & Vernooij, M. W. (2014). Use of coumarin anticoagulants and cerebral microbleeds in the general population. Stroke, 45(11), 3436-3439.

11.2.8 Ursolic Acid

Table 11.8: Benefits of Ursolic acid are shown in the table below

Benefit	*Reference*
Antibacterial activity against Staphylococcus aureus	https://doi.org/10.7275/R54X55RX
Antimicrobial	https://doi.org/10.1016/j.foodres.2017.10.028
Anticancer	https://doi.org/10.7275/R54X55RX
Anticancer	https://doi.org/10.1002/mnfr.200700389
Antiangiogenic	https://doi.org/10.1177/1534735410367647
protect against chemically induced liver injuries (hepatoprotection)	https://doi.org/10.1016/0378-8741(95)90032-2
hepatoprotection	https://doi.org/10.1016/j.jep.2005.05.024
Antiinflammatory	https://doi.org/10.1016/0378-8741(95)90032-2
Antiinflammatory	https://doi.org/10.1073/pnas.2000208117
Antiinflammatory	https://doi.org/10.1002/mnfr.200700389
treatment of multiple sclerosis	https://doi.org/10.1073/pnas.2000208117
Antihyperlipidemic	https://doi.org/10.1016/0378-8741(95)90032-2
Antihyperlipidemic	https://doi.org/10.1016/j.foodres.2017.10.028
Antitumor-promotion effects	https://doi.org/10.1016/0378-8741(95)90032-2
Antitumor	https://doi.org/10.1016/j.jep.2005.05.024
Cosmetics and health products	https://doi.org/10.1016/0378-8741(95)90032-2
Antioxidant	https://doi.org/10.4196/kjpp.2018.22.3.235
Antioxidant	https://doi.org/10.1002/mnfr.200700389
Anti-apoptotic	https://doi.org/10.4196/kjpp.2018.22.3.235
Anti-carcinogenic	https://doi.org/10.4196/kjpp.2018.22.3.235
cardioprotective	https://doi.org/10.4196/kjpp.2018.22.3.235
cardioprotective	https://doi.org/10.1016/j.foodres.2017.10.028
Anti-diabetic	https://doi.org/10.4196/kjpp.2018.22.3.235
Anti-diabetic	https://doi.org/10.1073/pnas.2000208117
neuroprotective	https://doi.org/10.4196/kjpp.2018.22.3.235
Anti-skeletal muscle atrophy	https://doi.org/10.4196/kjpp.2018.22.3.235
thermogenic effects	https://doi.org/10.4196/kjpp.2018.22.3.235
cytotoxic	https://doi.org/10.1016/j.ejmech.2005.01.001

11.2.9 Chebulagic Acid

Table 11.9: Benefits of chebulagic acid are shown in the table below

Benefit	*Reference*
Antiviral	Lin, L. T., Chen, T. Y., Lin, S. C., Chung, C. Y., Lin, T. C., Wang, G. H., ... & Richardson, C. D. (2013). Broad-spectrum antiviral activity of chebulagic acid and punicalagin against viruses that use glycosaminoglycans for entry. BMC microbiology, 13(1), 1-15.
Antiviral	Yang, Y., Xiu, J., Liu, J., Zhang, L., Li, X., Xu, Y., ... & Zhang, L. (2013). Chebulagic acid, a hydrolyzable tannin, exhibited antiviral activity in vitro and in vivo against human enterovirus 71. International Journal of Molecular Sciences, 14(5), 9618-9627.
Neuroprotective	Kim, H. J., Kim, J., Kang, K. S., Lee, K. T., & Yang, H. O. (2014). Neuroprotective effect of chebulagic acid via autophagy induction in SH-SY5Y cells. Biomolecules & therapeutics, 22(4), 275.
Anti-hyperglycemic	Huang, Y. N., Zhao, D. D., Gao, B., Zhong, K., Zhu, R. X., Zhang, Y., ... & Gao, H. (2012). Anti-hyperglycemic effect of chebulagic acid from the fruits of Terminalia chebula Retz. International Journal of Molecular Sciences, 13(5), 6320-6333.
Anticancer	Ponnulakshmi, R., Shyamaladevi, B., Selvaraj, J., Valli, G., Purushothaman, V., Alsawalha, M., & Mohan, S. K. (2019). Effect of chebulagic acid on apoptotic regulators in prostate cancer cell line-PC-3. Drug Invention Today, 12(2).

11.2.10 Gentisic Acid

Table 11.10: Benefits of Gentisic Acid are shown in the table below

Benefit	*Reference*
Anti-inflammatory	https://doi.org/10.1002/ptr.6573
Antigenotoxic	https://doi.org/10.1002/ptr.6573
Hepatoprotective	https://doi.org/10.1002/ptr.6573
Neuroprotective	https://doi.org/10.1002/ptr.6573
Neuroprotective (Anti-Parkinson's)	https://doi.org/10.1016/S2221-6189(14)60031-7
Antimicrobial	https://doi.org/10.1002/ptr.6573
Antioxidant	https://doi.org/10.1002/ptr.6573
Antioxidant	https://doi.org/10.1016/j.ejphar.2005.03.012
Antioxidant	https://doi.org/10.3109/10715762.2011.633518
Anti-atherogenic	https://doi.org/10.1016/j.ejphar.2005.03.012
Antitumor	https://doi.org/10.1016/j.jff.2020.103866
Therapeutic agent for cardiac hypertrophy and fibrosis	https://doi.org/10.1111/jcmm.13869
Metabolite of aspirin	https://doi.org/10.1002/ptr.6573
Metabolite of aspirin	https://doi.org/10.1074/jbc.M109.064618
Antirheumatic	National Center for Advancing Translational Sciences. (n.d.). NCATS INXIGHT drugs - gentisic acid. Inxight Drugs. Retrieved January 20, 2022, from https://drugs.ncats.io/substance/VP36V95O3T
Radioprotective	National Center for Advancing Translational Sciences. (n.d.). NCATS INXIGHT drugs - gentisic acid. Inxight Drugs. Retrieved January 20, 2022, from https://drugs.ncats.io/substance/VP36V95O3T
Radioprotective	https://doi.org/10.3109/10715762.2011.633518
Cosmetics; skin lightening agent	National Center for Advancing Translational Sciences. (n.d.). NCATS INXIGHT drugs - gentisic acid. Inxight Drugs. Retrieved January 20, 2022, from https://drugs.ncats.io/substance/VP36V95O3T
Cosmetics; skin lightening agent	https://doi.org/10.1016/S0928-0987(02)00255-5
Skin wound healing	10.7150/ijms.36484
Pesticide	https://doi.org/10.1074/jbc.M109.064618
Liquors	https://doi.org/10.1074/jbc.M109.064618

11.2.11 Corilagin

Table 11.11: Benefits of corilagin are shown in the table below

Benefit	*Reference*
Anticancer	Gupta, A., Singh, A. K., Kumar, R., Ganguly, R., Rana, H. K., Pandey, P. K., ... & Pandey, A. K. (2019). Corilagin in cancer: a critical evaluation of anticancer activities and molecular mechanisms. Molecules, 24(18), 3399.
Anticancer	Hau, D. K. P., Zhu, G. Y., Leung, A. K. M., Wong, R. S. M., Cheng, G. Y. M., Bo-San Lai, P., ... & Fong, D. W. F. (2010). In vivo anti-tumour activity of corilagin on Hep3B hepatocellular carcinoma. Phytomedicine, 18(1), 11-15.
Anti-inflammatory	Zhao, L., Zhang, S. L., Tao, J. Y., Pang, R., Jin, F., Guo, Y. J., ... & Zheng, G. H. (2008). Preliminary exploration on anti-inflammatory mechanism of Corilagin (beta-1-O-galloyl-3, 6-(R)-hexahydroxydiphenoyl-D-glucose) in vitro. International immunopharmacology, 8(7), 1059-1064.
Anti-inflammatory and anti-oxidant	Jin, F., Cheng, D., Tao, J. Y., Zhang, S. L., Pang, R., Guo, Y. J., ... & Zhao, L. (2013). Anti-inflammatory and anti-oxidative effects of corilagin in a rat model of acute cholestasis. BMC gastroenterology, 13(1), 1-10.
Anti-oxidant	Kinoshita, S., Inoue, Y., Nakama, S., Ichiba, T., & Aniya, Y. (2007). Antioxidant and hepatoprotective actions of medicinal herb, Terminalia catappa L. from Okinawa Island and its tannin corilagin. Phytomedicine, 14(11), 755-762.
Anticancer	Jia, L., Jin, H., Zhou, J., Chen, L., Lu, Y., Ming, Y., & Yu, Y. (2013). A potential anti-tumor herbal medicine, Corilagin, inhibits ovarian cancer cell growth through blocking the TGF-beta signaling pathways. BMC complementary and alternative medicine, 13(1), 1-11.
Anti-tumor	Li, Xuan, Yuan Deng, Zhizhong Zheng, Wen Huang, Lianghua Chen, Qingxuan Tong, and Yanlin Ming. "Corilagin, a promising medicinal herbal agent." Biomedicine & Pharmacotherapy 99 (2018): 43-50.

11.2.12 Geraniin

Table 11.12: Benefits of geraniin are shown in the table below

Benefit	*Reference*
Antioxidant	Ito, H. (2011). Metabolites of the ellagitannin geraniin and their antioxidant activities. Planta medica, 77(11), 1110-1115.
Anti-hyperglycemic	Palanisamy, U. D., Ling, L. T., Manaharan, T., & Appleton, D. (2011). Rapid isolation of geraniin from Nephelium lappaceum rind waste and its anti-hyperglycemic activity. Food Chemistry, 127(1), 21-27.
Antiviral	Yang, Y., Zhang, L., Fan, X., Qin, C., & Liu, J. (2012). Antiviral effect of geraniin on human enterovirus 71 in vitro and in vivo. Bioorganic & medicinal chemistry letters, 22(6), 2209-2211.
Antioxidant and Anti-hypertensive	Lin, S. Y., Wang, C. C., Lu, Y. L., Wu, W. C., & Hou, W. C. (2008). Antioxidant, anti-semicarbazide-sensitive amine oxidase, and anti-hypertensive activities of geraniin isolated from Phyllanthus urinaria. Food and Chemical Toxicology, 46(7), 2485-2492.
Antihypertensive	Cheng, J. T., Chang, S. S., & Hsu, F. L. (1994). Antihypertensive action of geraniin in rats. Journal of pharmacy and pharmacology, 46(1), 46-49.
Antiviral	Abdul Ahmad, S. A., Palanisamy, U. D., Khoo, J. J., Dhanoa, A., & Syed Hassan, S. (2019). Efficacy of geraniin on dengue virus type-2 infected BALB/c mice. Virology journal, 16(1), 1-12.
Anti-bacterial	Boakye, Y. D., Agyare, C., & Hensel, A. (2016). Anti-infective properties and time-kill kinetics of Phyllanthus muellerianus and its major constituent, geraniin.
Anti-inflammatory	Boakye, Y. D., Agyare, C., Abotsi, W. K. M., Ayande, P. G., & Ossei, P. P. S. (2016). Anti-inflammatory activity of aqueous leaf extract of Phyllanthus muellerianus (Kuntze) Exell. and its major constituent, geraniin. Journal of ethnopharmacology, 187, 17-27.
kaempferol	

11.2.13 Kaempferol

Table 11.13: Benefits of kaempferol are shown in the table below

Benefit	*Reference*
Anticancer	Imran, M., Salehi, B., Sharifi-Rad, J., Aslam Gondal, T., Saeed, F., Imran, A., ... & Estevinho, L. M. (2019). Kaempferol: A key emphasis to its anticancer potential. Molecules, 24(12), 2277.
Anti-inflammation	Devi, K. P., Malar, D. S., Nabavi, S. F., Sureda, A., Xiao, J., Nabavi, S. M., & Daglia, M. (2015). Kaempferol and inflammation: From chemistry to medicine. Pharmacological research, 99, 1-10.
Anti-inflammation	Rho, H. S., Ghimeray, A. K., Yoo, D. S., Ahn, S. M., Kwon, S. S., Lee, K. H., ... & Cho, J. Y. (2011). Kaempferol and kaempferol rhamnosides with depigmenting and anti-inflammatory properties. Molecules, 16(4), 3338-3344.
Antiatherogenic	Tu, Y. C., Lian, T. W., Yen, J. H., Chen, Z. T., & Wu, M. J. (2007). Antiatherogenic effects of kaempferol and rhamnocitrin. Journal of agricultural and food chemistry, 55(24), 9969-9976.
Antitumor, Antioxidant and Anti-inflammatory	Wang, J., Fang, X., Ge, L., Cao, F., Zhao, L., Wang, Z., & Xiao, W. (2018). Antitumor, antioxidant and anti-inflammatory activities of kaempferol and its corresponding glycosides and the enzymatic preparation of kaempferol. PLoS One, 13(5), e0197563.
Antimicrobial and Antioxidant	Tatsimo, S. J. N., Tamokou, J. D. D., Havyarimana, L., Csupor, D., Forgo, P., Hohmann, J., ... & Tane, P. (2012). Antimicrobial and antioxidant activity of kaempferol rhamnoside derivatives from Bryophyllum pinnatum. BMC Research notes, 5(1), 1-6.
Antidiabetic	Yang, Y., Chen, Z., Zhao, X., Xie, H., Du, L., Gao, H., & Xie, C. (2022). Mechanisms of Kaempferol in the treatment of diabetes: A comprehensive and latest review. Frontiers in Endocrinology, 13, 990299.
Anti-bacterial	Escandón, R. A., Del Campo, M., López-Solis, R., Obreque-Slier, E., & Toledo, H. (2016). Antibacterial effect of kaempferol and epicatechin on Helicobacter pylori. European Food Research and Technology, 242, 1495-1502.

11.2.14 Punicalagin

Table 11.14: Benefits of punicalagin are shown in the table below

Benefit	*Reference*
Anti-oxidant	Aloqbi, A., Omar, U., Yousr, M., Grace, M., Lila, M. A., & Howell, N. (2016). Antioxidant activity of pomegranate juice and punicalagin. Natural Science, 8(06), 235.
Anti-inflammation	Lin, C. C., Hsu, Y. F., & Lin, T. C. (1999). Effects of punicalagin and punicalin on carrageenan-induced inflammation in rats. The American Journal of Chinese Medicine, 27(03n04), 371-376.
Anticancer	Berdowska, I., Matusiewicz, M., & Fecka, I. (2021). Punicalagin in Cancer Prevention—Via Signaling Pathways Targeting. Nutrients, 13(8), 2733.
Antimicrobial	Xu, Y., Shi, C., Wu, Q., Zheng, Z., Liu, P., Li, G., ... & Xia, X. (2017). Antimicrobial activity of punicalagin against Staphylococcus aureus and its effect on biofilm formation. Foodborne pathogens and disease, 14(5), 282-287.
Antifungal	Rongai, D., Pulcini, P., Di Lernia, G., Nota, P., Preka, P., & Milano, F. (2019). Punicalagin content and antifungal activity of different pomegranate (Punica ganatum L.) genotypes. Horticulturae, 5(3), 52.
Antimicrobial	Gosset-Erard, C., Zhao, M., Lordel-Madeleine, S., & Ennahar, S. (2021). Identification of punicalagin as the bioactive compound behind the antimicrobial activity of pomegranate (Punica granatum L.) peels. Food Chemistry, 352, 129396.
Antifungal	Foss, S. R., Nakamura, C. V., Ueda-Nakamura, T., Cortez, D. A., Endo, E. H., & Dias Filho, B. P. (2014). Antifungal activity of pomegranate peel extract and isolated compound punicalagin against dermatophytes. Annals of clinical microbiology and antimicrobials, 13(1), 1-6.
Anti-inflammation	Cao, Y., Chen, J., Ren, G., Zhang, Y., Tan, X., & Yang, L. (2019). Punicalagin prevents inflammation in LPS-induced RAW264. 7 macrophages by inhibiting FoxO3a/autophagy signaling pathway. Nutrients, 11(11), 2794.

11.2.15 Punicalin

Table 11.15: Benefits of punicalin are shown in the table below

Benefit	*Reference*
Anti-oxidant	Wang, Y., Zhang, H., Liang, H., & Yuan, Q. (2013). Purification, antioxidant activity and protein-precipitating capacity of punicalin from pomegranate husk. Food chemistry, 138(1), 437-443.
Anti-inflammation	Lin, C. C., Hsu, Y. F., & Lin, T. C. (1999). Effects of punicalagin and punicalin on carrageenan-induced inflammation in rats. The American Journal of Chinese Medicine, 27(03n04), 371-376.
Anti-oxidant	Lin, C. C., Hsu, Y. F., Lin, T. C., Hsu, F. L., & Hsu, H. Y. (1998). Antioxidant and hepatoprotective activity of punicalagin and punicalin on carbon tetrachloride-induced liver damage in rats. Journal of Pharmacy and Pharmacology, 50(7), 789-794
Anticancer	Li, T., Jiang, G., Hu, X., Yang, D., Tan, T., Gao, Z., ... & Guo, X. (2021). Punicalin Attenuates Breast Cancer-Associated Osteolysis by Inhibiting the NF-kB Signaling Pathway of Osteoclasts. Frontiers in Pharmacology, 12, 789552.

Chapter 12

Guava Leaves

12.1 General Description

Guava or as it is scientifically known, Psidium guajava, on smoothies, rum an a medium size tree that bears a sweet edible fruit with small seeds. The fruit can be used in Juices and cocktails and is used in a traditional Bahamian pastry, guava duff. The fruit contains many phytochemicals such as saponin, terpenes, quercetin and flavonoids. The leaf which can be used to make tea contains many bioactive compounds, which act as fungistatic and bacteriostatic agents as well as antiviral, antibacterial, antioxidant and anti-inflammatory properties. Its primary traditional uses include the alleviation of diarrhea and dehydration. Other reported uses include treatment of gastroenteritis, dysentery, stomach pain, diabetes mellitus, and wounds.

12.2 Phytochemical Benefits

12.2.1 Nonanal*

Table 12.1: Benefits of nonanal are shown in the table below

Benefit	*Reference*
Antidiarrhoeal	Zavala-Sanchez, M. A., Pérez-Gutiérrez, S., P? rez-González, C., Sánchez-Saldivar, D., & Arias-García, L. (2002). Antidiarrhoeal activity of nonanal, an aldehyde isolated from Artemisia ludoviciana. Pharmaceutical biology, 40(4), 263-268.
Antidiarrhoeal	Gohari, A. R., Saeidnia, S., Malmir, M., Yazdanpanah, M., & Ajani, Y. (2011). Sterols and flavonoids of Lomatopodium staurophyllum. Journal of Medicinal Plants, 10(39), 43-48.
Anti-fungal	Zhang, J. H., Sun, H. L., Chen, S. Y., Zeng, L. I., & Wang, T. T. (2017). Anti-fungal activity, mechanism studies on alpha-Phellandrene and Nonanal against Penicillium cyclopium. Botanical studies, 58, 1-9.
Anti-fungal	Li, Q., Zhu, X., Xie, Y., & Liang, J. (2021). Antifungal properties and mechanisms of three volatile aldehydes (octanal, nonanal and decanal) on Aspergillus flavus. Grain & Oil Science and Technology, 4(3), 131-140.
Anti-fungal	Zhang, J., Zeng, L., Sun, H., Chen, S., Wang, T., & Ma, S. (2017). Use of Nonanal-wax as Postharvest Fungicide of Tomato against Botrytis cinereal. J. Food Nutr. Res, 5, 458-466.

12.2.2 Beta-Caryophyllene*

Table 12.2: Benefits of beta-Caryophyllene are shown in the table below

Benefit	*Reference*
Antibacterial activity	https://doi.org/10.1016/j.sajb.2021.07.046
Antibacterial activity (pneumonia - mice)	https://doi.org/10.1016/j.sjbs.2021.06.034
Antiviral activity (zika virus)	https://doi.org/10.1016/j.indcrop.2021.113281; https://doi.org/10.1016/j.actatropica.2020.105556
Anticonvulsant/ epileptic seizure (mice)	https://doi.org/10.1016/j.eplepsyres.2021.106842
increased libido in women	https://doi.org/10.1016/j.esxm.2020.06.001
Osteoarthritis Treatment (mice)	https://doi.org/10.1016/j.neuropharm.2021.108908
general review	https://doi.org/10.1016/j.biopha.2021.111639
Alcohol addiction	10.1016/j.pbb.2014.06.025
Neuropathic pain	10.1016/j.euroneuro.2013.10.008
Neuropathic pain	10.1016/j.phymed.2013.08.006
Neuropathic pain	10.4236/pp.2012.34053
Nociception	10.1038/ncpneuro0113
Neuropathic pain	https://doi.org/10.3390/molecules25010106
Insulin resistance and dyslipidemia	10.1016/j.cbi.2018.10.010
Insulin resistance and associated neurobehavioral changes	10.1016/j.biopha.2018.11.039
Atherosclerosis	10.1016/j.taap.2017.06.016
Ulcerative colitis	10.1016/j.ajpath.2010.11.052
Immunomodulation	10.3390/ijms18040691
Peripheral neuropathy	10.1016/j.neuropharm.2017.07.015
Chemotherapy-induced cardiotoxicity	10.1016/j.cbi.2019.02.028
Nephroprotective	10.1016/j.freeradbiomed.2012.01.014
Parkinson's disease	10.3389/fnins.2016.00321
Parkinson's disease	10.3390/ph10030060
Alzheimer's disease	10.1159/000362689
Post-stroke cognitive deficits	10.3389/fphar.2017.00002
Cerebral ischemia	10.1016/j.ajpath.2012.11.024

[Cont'd] Benefits of beta-Caryophyllene are shown in the table below

Benefit	*Reference*
Cerebral ischemia	10.1186/s12944-018-0661-4
Depression and anxiety	10.1016/j.physbeh.2014.06.003
Depression	10.1016/j.bbr.2019.112439
Liver fibrosis	10.1016/j.ejphar.2014.08.021
Alcohol liver damage	10.1111/bph.13722
Nicotine addiction	10.1111/bph.14969
Arthritis	10.3390/biom9080326
Obesity and related complications	10.1016/j.bbrc.2013.05.108
Hyperglycemia	10.1016/j.bbrc.2013.11.136
Atherosclerosis	10.1016/j.taap.2017.06.016
Cancer	10.3390/cancers12041038
Parkinson's disease	10.1016/j.biopha.2018.03.168
Cerebral ischemia-reperfusion injury	10.1080/07391102.2019.1567384
Multiple sclerosis	10.1016/j.lfs.2018.12.059
Multiple sclerosis	10.1016/j.bcp.2018.12.001
Neuroinflammation	10.1007/s12031-014-0243-5
Glioma	10.1016/j.neuroscience.2014.08.043
Depression	10.1016/j.bbr.2019.112439
Hepatic steatosis	10.1002/mnfr.201600197
Osteoporosis	10.1002/iub.158
Mucositis	10.3390/BIOMEDICINES8060164
Antifungal	10.1023/A:1007178924408
Fragrance	https://doi.org/10.1016/j.fct.2008.06.030
skin creams, shampoos and lotions	https://www.naturemary.com/beta-caryophyllene-for-skin/

12.2.3 Acoradien

Table 12.3: Benefits of Acoradien are shown in the table below

Benefit	*Reference*
Antimicrobial	Adamczak, A., Ożarowski, M., & Karpiński, T. M. (2020). Curcumin, a natural antimicrobial agent with strain-specific activity. Pharmaceuticals, 13(7), 153.
Antifungal	Haile, K., Kebede, T., & Dekebo, A. (2012). A comparative study of volatile components of propolis (bee glue) collected from Haramaya University and Assela beekeeping centers, Ethiopia. Bulletin of the Chemical Society of Ethiopia, 26(3), 353-360.
Antimicrobial	Srivastava, D. L. (1995). Phytochemical study of some Scottish liverworts (Doctoral dissertation, University of Glasgow (United Kingdom)).
Antioxidant	Xuan, T. D., Yulianto, R., Andriana, Y., & Khanh, T. D. (2018). Chemical profile, antioxidant activities and allelopathic potential of liquid waste from germinated brown rice. Allelopath. J, 45, 1-12.
Antifungal	El-Tarawy, M. A., Hegazi, M. A., & Mahmoud, E. (2017). Effect of Bio, Organic and Chemical Fertilization on Growth, Productivity and Oil Constituents of Caraway (Carum carvi, L.). Journal of Plant Production, 8(10), 993-997.
Antiseptics	Mohiuddin, M., Chowdhury, M. J., Alam, M. K., & Hossain, M. K. (2012). Chemical composition of essential oil of four flavouring plants used by the tribal people of Bandarban hill district in Bangladesh. Int J Med Aromat Plants, 2, 106-13.
Antioxidant	Wu, C. Z. (2018). XL Jia*, HB Wang1, 2, JH Ye, FQ Wang, L. Lu, YL Hu, MZ Zheng, Q. Zhang2, and. Allelopathy Journal, 45, 1.
Antimicrobial	Tavakoli, H. R., Mashak, Z., Moradi, B., & Sodagari, H. R. (2015). Antimicrobial activities of the combined use of Cuminum cyminum L. essential oil, nisin and storage temperature against Salmonella Typhimurium and Staphylococcus aureus in vitro. Jundishapur journal of microbiology, 8(4).

12.2.4 a-Curcumene

Table 12.4: Benefits of a-Curcumene are shown in the table below

Benefit	*Reference*
Anticancer	Shin, Yujin & Lee, & Yongkyu. (2013). Cytotoxic Activity from Curcuma zedoaria Through Mitochondrial Activation on Ovarian Cancer Cells. Toxicological research. 29. 257-61. 10.5487/TR.2013.29.4.257.
Antimicrobial	López, E. , Balcázar, M. , Mendoza, J. , Ortiz, A. , Melo, M. , Parrales, R. and Delgado, T. (2017) Antimicrobial Activity of Essential Oil of Zingiber officinale Roscoe (Zingiberaceae). American Journal of Plant Sciences, 8, 1511-1524. doi: 10.4236/ajps.2017.87104.
Antibacterial	McEnroe, F. J., & Fenical, W. (1978). Structures and synthesis of some new antibacterial sesquiterpenoids from the gorgonian coral Pseudopterogorgia rigida. Tetrahedron, 34(11), 1661-1664.

12.2.5 b-Curcumene

Table 12.5: Benefits of b-Curcumene are shown in the table below

Benefit	*Reference*
Anticancer	Theanphong, O., Jenjittikul, T., & Mingvanish, W. (2019). Essential oils composition of nine Curcuma species from Thailand chemotaxonomic approach. Gardens' Bulletin (Singapore), 71(2), 499-518.
Antibacterial	Formisano, C., Senatore, F., Bellone, G., Bruno, M., Grassia, A., Raio, & Rigano, D., . Chemical composition and biological activity of essential oil from flowerheads of Centaurea polymorpha Lag., asteraceae, growing wild in Spain. Polish Journal of Chemistry, 80, 4,
Antibacterial	Zwaving, J. H., & Bos, R. (1992). Analysis of the essential oils of five Curcuma species. Flavour and Fragrance Journal, 7(1), 19-22.
Antifungal	Theanphong, . Essential oils composition of nine Curcuma species from Thailand: a chemotaxonomic approach. Gardens' Bulletin, Singapore
Antibacterial	Subarnas, & Apoteker, S., . The Role of Curcuma Species as Functional Food Ingredients. In Proceedings of the Korean Society of Food Science and Nutrition Conference, pp. 99-101. The Korean Society of Food Science and Nutrition.
Antibacterial	Samant, L. R., . Curcuma amada Roxb.: a phytopharmacological review. Journal of Pharmacy Research, 5
Antifungal	Formisano, C., Senatore, F., Bellone, G., Bruno, M., Grassia, A., Raio, A., & Rigano, D. (2006). Chemical composition and biological activity of essential oil from flowerheads of Centaurea polymorpha Lag.(asteraceae) growing wild in Spain. Polish Journal of Chemistry, 80(4)

12.2.6 a-pinene

Table 12.6: Benefits of a-pinene are shown in the table below

Benefit	*Reference*
Anti-inflammatory effects	Bhagat, M., Gupta, S., Jamwal, V. S., Sharma, S., Kattal, M., Dawa, S., ... and Bindu, K. (2016). Comparative study on chemical profiling and Antimicrobial properties of essential oils from different parts of Eucalyptus lanceolatus.
Antimicrobial	https://doi.org/10.3390/molecules17066305
Antimicrobial	https://dx.doi.org/10.3390/biom9110738
Antimicrobial	https://doi.org/10.1080/10412905.1999.9701162
Antibacterial	https://doi.org/10.3390/molecules17066305
Antibacterial (hand sanitizer)	Wijayati, N., Widiyastuti, A., Mursiti, S., and Rakainsa, S. K. (2020, May). Formulation of Hand Sanitizer Gel of A-Pinene Isolated from Turpentine Oil and its Antibacterial Activity. In IOP Conference Series: Materials Science and Engineering (Vol. 846, No. 1, p. 012069). IOP Publishing.
Fungicidal	https://dx.doi.org/10.3390/biom9110738
Fungicidal	https://doi.org/10.3390/molecules17066305
Flavoring	https://dx.doi.org/10.3390/biom9110738
Flavoring	https://doi.org/10.3390/molecules17066305
Fragrances	https://dx.doi.org/10.3390/biom9110738
Antiviral	https://dx.doi.org/10.3390/biom9110738
Renal and Hepatic Drugs	https://dx.doi.org/10.3390/biom9110738
Inhibitory effects on breast cancer and leukemia	https://dx.doi.org/10.3390/biom9110738
Cytotoxic	https://doi.org/10.3390/molecules17066305
Polymer synthetization	https://dx.doi.org/10.3390/biom9110738
Anticoagulative/Antiplatelet	https://dx.doi.org/10.3390/biom9110738
Anti-tumour	https://dx.doi.org/10.3390/biom9110738
Antioxidant	https://dx.doi.org/10.3390/biom9110738
Gastroprotective activity	https://dx.doi.org/10.3390/biom9110738
Neuroprotective activity	https://dx.doi.org/10.3390/biom9110738
Bathtub, tile, and toilet surface cleaners	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 6654, alpha-Pinene. Retrieved January 20, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/alpha-Pinene.
Insect repellant	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 6654, alpha-Pinene. Retrieved January 20, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/alpha-Pinene.
Insecticide	https://doi.org/10.3390/molecules17066305

12.2.7 Eucalyptol*

Table 12.7: Benefits of Eucalyptol are shown in the table below

Benefit	*Reference*
Flavouring agent	DOI: 10.5530/rjps.2015.4.2
Fragrance	DOI: 10.5530/rjps.2015.4.2
Mouthwash and toothpaste	DOI: 10.5530/rjps.2015.4.2
Cosmetics: perfumes, soap, cream, lotion	DOI: 10.5530/rjps.2015.4.2
Antinociceptive properties (potential calmative and depressant)	DOI: 10.5530/rjps.2015.4.2
blood circulation	DOI: 10.5530/rjps.2015.4.2
Anti-inflammatory effects	DOI: 10.5530/rjps.2015.4.2
Anti-inflammatory	https://doi.org/10.3390/molecules26164933
Anti-inflammatory	https://doi.org/10.1080/10412905.2020.1716867
Anti-inflammatory (Bronchial asthma)	https://doi.org/10.1053/rmed.2003.1432
Secretolytic properties and myorelaxant effects	DOI: 10.5530/rjps.2015.4.2
Antifungal and Antibacterial	DOI: 10.5530/rjps.2015.4.2
Antimicrobial	https://doi.org/10.3390/molecules26164933
Antimicrobial	https://doi.org/10.3390/catal12010048
Antioxidant and lipoxygenase inhibitory actions Antioxidant	DOI: 10.5530/rjps.2015.4.2
Hepatoprotective effect	DOI: 10.5530/rjps.2015.4.2
Antitumorogenic effect (potential to treat coloreactal cancer) Anticancer	DOI: 10.5530/rjps.2015.4.2
bio-insecticidal efficacy	https://doi.org/10.1590/S0036-46652004000200008
Repellent	https://doi.org/10.3390/catal12010048
potential treatment to act as COVID-19 Mpro inhibitor	doi: 10.20944/preprints202003.0455.v1
Antiseptic	https://doi.org/10.3390/molecules26164933
Bronchodilatory effects (clears respiratory tract and nasal cavities from secretions)	https://doi.org/10.3390/molecules26164933
Bronchodilatory effects	https://doi.org/10.1080/10412905.2020.1716867
Antitussive	https://doi.org/10.3390/catal12010048

Chapter 13

Cocoplum Leaves

13.1 General Description

Cocoplum, also called Pork-fat apple is scientifically known as Chrysobalanus icaco is native to the Caribbean and Africa. It is especially adapted to coastal regions and can thrive in relatively high saline environments. It is often used as a hedge for landscaping because of its robust nature. The tree bears small edible fruit with a relatively large seed. The fruit can be used in jams and the leaves can be used in juices and teas. It can also be externally applied as a skin rub. The seed can be used for its oil. scientific investigations that have provided evidence of hypoglycemic, antioxidant, antifungal, anticarcinogenic, and other pharmacological properties of the leaf extract.

13.2 Phytochemical Benefits

13.2.1 Nonanal

Table 13.1: Benefits of nonanal are shown in the table below

Benefit	*Reference*
Antidiarrhoeal	Zavala-Sanchez, M. A., Pérez-Gutiérrez, S., P? rez-González, C., Sánchez-Saldivar, D., & Arias-García, L. (2002). Antidiarrhoeal activity of nonanal, an aldehyde isolated from Artemisia ludoviciana. Pharmaceutical biology, 40(4), 263-268.
Antidiarrhoeal	Gohari, A. R., Saeidnia, S., Malmir, M., Yazdanpanah, M., & Ajani, Y. (2011). Sterols and flavonoids of Lomatopodium staurophyllum. Journal of Medicinal Plants, 10(39), 43-48.
Anti-fungal	Zhang, J. H., Sun, H. L., Chen, S. Y., Zeng, L. I., & Wang, T. T. (2017). Anti-fungal activity, mechanism studies on alpha-Phellandrene and Nonanal against Penicillium cyclopium. Botanical studies, 58, 1-9.
Anti-fungal	Li, Q., Zhu, X., Xie, Y., & Liang, J. (2021). Antifungal properties and mechanisms of three volatile aldehydes (octanal, nonanal and decanal) on Aspergillus flavus. Grain & Oil Science and Technology, 4(3), 131-140.
Anti-fungal	Zhang, J., Zeng, L., Sun, H., Chen, S., Wang, T., & Ma, S. (2017). Use of Nonanal-wax as Postharvest Fungicide of Tomato against Botrytis cinereal. J. Food Nutr. Res, 5, 458-466.

13.2.2 Quercetin

Table 13.2: Benefits of quercetin are shown in the table below

Benefit	*Reference*
Antioxidant	Zhang, M., Swarts, S. G., Yin, L., Liu, C., Tian, Y., Cao, Y., ... & Okunieff, P. (2011). Antioxidant properties of quercetin. In Oxygen transport to tissue XXXII (pp. 283-289). Springer US.
Antioxidant	Xu, D., Hu, M. J., Wang, Y. Q., & Cui, Y. L. (2019). Antioxidant activities of quercetin and its complexes for medicinal application. Molecules, 24(6), 1123.
Antioxidant and Anti-inflammatory	Lesjak, M., Beara, I., Simin, N., Pintać, D., Majkić, T., Bekvalac, K., ... & Mimica-Dukić, N. (2018). Antioxidant and anti-inflammatory activities of quercetin and its derivatives. Journal of Functional Foods, 40, 68-75.
Anticancer	Ezzati, M., Yousefi, B., Velaei, K., & Safa, A. (2020). A review on anti-cancer properties of Quercetin in breast cancer. Life sciences, 248, 117463.
Anticancer	Shafabakhsh, R., & Asemi, Z. (2019). Quercetin: a natural compound for ovarian cancer treatment. Journal of ovarian research, 12, 1-9.
Cardioprotective	Bhat, I. U. H., & Bhat, R. (2021). Quercetin: a bioactive compound imparting cardiovascular and neuroprotective benefits: scope for exploring fresh produce, their wastes, and by-products. Biology, 10(7), 586.
Antioxidant and Anti-inflammatory	Davis, J. M., Carlstedt, C. J., Chen, S., Carmichael, M. D., & Murphy, E. A. (2010). The dietary flavonoid quercetin increases VO2max and endurance capacity. International journal of sport nutrition and exercise metabolism, 20(1), 56-62.

13.2.3 Kaempferol

Table 13.3: Benefits of kaempferol are shown in the table below

Benefit	*Reference*
Anticancer	Imran, M., Salehi, B., Sharifi-Rad, J., Aslam Gondal, T., Saeed, F., Imran, A., ... & Estevinho, L. M. (2019). Kaempferol: A key emphasis to its anticancer potential. Molecules, 24(12), 2277.
Anti-inflammation	Devi, K. P., Malar, D. S., Nabavi, S. F., Sureda, A., Xiao, J., Nabavi, S. M., & Daglia, M. (2015). Kaempferol and inflammation: From chemistry to medicine. Pharmacological research, 99, 1-10.
Anti-inflammation	Rho, H. S., Ghimeray, A. K., Yoo, D. S., Ahn, S. M., Kwon, S. S., Lee, K. H., ... & Cho, J. Y. (2011). Kaempferol and kaempferol rhamnosides with depigmenting and anti-inflammatory properties. Molecules, 16(4), 3338-3344.
Antiatherogenic	Tu, Y. C., Lian, T. W., Yen, J. H., Chen, Z. T., & Wu, M. J. (2007). Antiatherogenic effects of kaempferol and rhamnocitrin. Journal of agricultural and food chemistry, 55(24), 9969-9976.
Antitumor, Antioxidant and Anti-inflammatory	Wang, J., Fang, X., Ge, L., Cao, F., Zhao, L., Wang, Z., & Xiao, W. (2018). Antitumor, antioxidant and anti-inflammatory activities of kaempferol and its corresponding glycosides and the enzymatic preparation of kaempferol. PLoS One, 13(5), e0197563.
Antimicrobial and Antioxidant	Tatsimo, S. J. N., Tamokou, J. D. D., Havyarimana, L., Csupor, D., Forgo, P., Hohmann, J., ... & Tane, P. (2012). Antimicrobial and antioxidant activity of kaempferol rhamnoside derivatives from Bryophyllum pinnatum. BMC Research notes, 5(1), 1-6.
Antidiabetic	Yang, Y., Chen, Z., Zhao, X., Xie, H., Du, L., Gao, H., & Xie, C. (2022). Mechanisms of Kaempferol in the treatment of diabetes: A comprehensive and latest review. Frontiers in Endocrinology, 13, 990299.
Anti-bacterial	Escandón, R. A., Del Campo, M., López-Solis, R., Obreque-Slier, E., & Toledo, H. (2016). Antibacterial effect of kaempferol and epicatechin on Helicobacter pylori. European Food Research and Technology, 242, 1495-1502.

13.2.4 oleanolic acid

Table 13.4: Benefits of oleanolic acid are shown in the table below

Benefit	*Reference*
anticancer	Shanmugam, M. K., Dai, X., Kumar, A. P., Tan, B. K., Sethi, G., & Bishayee, A. (2014). Oleanolic acid and its synthetic derivatives for the prevention and therapy of cancer: preclinical and clinical evidence. Cancer letters, 346(2), 206-216.
anticancer	Žiberna, L., Šamec, D., Mocan, A., Nabavi, S. F., Bishayee, A., Farooqi, A. A., ... & Nabavi, S. M. (2017). Oleanolic acid alters multiple cell signaling pathways: implication in cancer prevention and therapy. International journal of molecular sciences, 18(3), 643.
antibacterial	Wolska, K. I., Grudniak, A. M., Fiecek, B., Kraczkiewicz-Dowjat, A., & Kurek, A. (2010). Antibacterial activity of oleanolic and ursolic acids and their derivatives. Central European Journal of Biology, 5, 543-553.
antibacterial	Jesus, J. A., Lago, J. H. G., Laurenti, M. D., Yamamoto, E. S., & Passero, L. F. D. (2015). Antimicrobial activity of oleanolic and ursolic acids: an update. Evidence-Based Complementary and Alternative Medicine, 2015.
Anti-inflammatory	Lee, W., Yang, E. J., Ku, S. K., Song, K. S., & Bae, J. S. (2013). Anti-inflammatory effects of oleanolic acid on LPS-induced inflammation in vitro and in vivo. Inflammation, 36, 94-102.
Anti-inflammatory	Kashyap, D., Sharma, A., S Tuli, H., Punia, S., & K Sharma, A. (2016). Ursolic acid and oleanolic acid: pentacyclic terpenoids with promising anti-inflammatory activities. Recent patents on inflammation & allergy drug discovery, 10(1), 21-33.
Anti-fungal	Anisimov, M. M., Shcheglov, V. V., Strigina, L. I., Chetyrina, N. S., Uvarova, N. I., Oshitok, G. I., ... & Saltykova, I. A. (1979). Chemical structure and antifungal activity of a number of triterpenoids. Biology Bulletin of the Academy of Sciences of the USSR, 6(4), 464-468.
Anti-HIV	Mengoni, F., Lichtner, M., Battinelli, L., Marzi, M., Mastroianni, C. M., Vullo, V., & Mazzanti, G. (2002). In vitro anti-HIV activity of oleanolic acid on infected human mononuclear cells. Planta medica, 68(02), 111-114.
Anti-HIV	Kashiwada, Y., Wang, H. K., Nagao, T., Kitanaka, S., Yasuda, I., Fujioka, T., ... & Lee, K. H. (1998). Anti-AIDS agents. 30. Anti-HIV activity of oleanolic acid, pomolic acid, and structurally related triterpenoids. Journal of Natural Products, 61(9), 1090-1095.
Antiviral	Khwaza, V., Oyedeji, O. O., & Aderibigbe, B. A. (2018). Antiviral activities of oleanolic acid and its analogues. Molecules, 23(9), 2300.
Anti-viral	Kong, L., Li, S., Liao, Q., Zhang, Y., Sun, R., Zhu, X., ... & Zhu, Y. (2013). Oleanolic acid and ursolic acid:

13.2.5 Myricetin

Table 13.5: Benefits of myricetin are shown in the table below

Benefit	*Reference*
Anti-oxidant	Yao, Y., Lin, G., Xie, Y., Ma, P., Li, G., Meng, Q., & Wu, T. (2014). Preformulation studies of myricetin: a natural antioxidant flavonoid. Die Pharmazie-An International Journal of Pharmaceutical Sciences, 69(1), 19-26.
Anti-oxidant	Pekkarinen, S. S., Heinonen, I. M., & Hopia, A. I. (1999). Flavonoids quercetin, myricetin, kaempferol and (+)-catechin as antioxidants in methyl linoleate. Journal of the Science of Food and Agriculture, 79(4), 499-506.
Anti-inflammatory	Wang, S. J., Tong, Y., Lu, S., Yang, R., Liao, X., Xu, Y. F., & Li, X. (2010). Anti-inflammatory activity of myricetin isolated from Myrica rubra Sieb. et Zucc. leaves. Planta medica, 76(14), 1492-1496.
Anticancer	Sun, F., Zheng, X. Y., Ye, J., Wu, T. T., Wang, J. L., & Chen, W. (2012). Potential anticancer activity of myricetin in human T24 bladder cancer cells both in vitro and in vivo. Nutrition and cancer, 64(4), 599-606.
Anticancer	Ha, T. K., Jung, I., Kim, M. E., Bae, S. K., & Lee, J. S. (2017). Anti-cancer activity of myricetin against human papillary thyroid cancer cells involves mitochondrial dysfunction–mediated apoptosis. Biomedicine & Pharmacotherapy, 91, 378-384
Cardiovascular Effects	Zhang, N., Feng, H., Liao, H. H., Chen, S., Yang, Z., Deng, W., & Tang, Q. Z. (2018). Myricetin attenuated LPS induced cardiac injury in vivo and in vitro. Phytotherapy Research, 32(3), 459-470.
Comprehensive Review	Imran, M., Saeed, F., Hussain, G., Imran, A., Mehmood, Z., Gondal, T. A., ... & Islam, S. (2021). Myricetin: A comprehensive review on its biological potentials. Food Science & Nutrition, 9(10), 5854-5868.

13.2.6 Betulinic acid

Table 13.6: Benefits of betulinic acid are shown in the table below

Benefit	*Reference*
Anticancer	Fulda, S. (2008). Betulinic acid for cancer treatment and prevention. International journal of molecular sciences, 9(6), 1096-1107.
Anticancer and Anti-HIV	Cichewicz, R. H., & Kouzi, S. A. (2004). Chemistry, biological activity, and chemotherapeutic potential of betulinic acid for the prevention and treatment of cancer and HIV infection. Medicinal research reviews, 24(1), 90-114.
Antioxidant	Adesanwo, J. K., Makinde, O. O., & Obafemi, C. A. (2013). Phytochemical analysis and antioxidant activity of methanol extract and betulinic acid isolated from the roots of Tetracera potatoria. Journal of Pharmacy research, 6(9), 903-907.
Antioxidant	Sousa, J. L., Gonçalves, C., Ferreira, R. M., Cardoso, S. M., Freire, C. S., Silvestre, A. J., & Silva, A. M. (2021). Functionalization of betulinic acid with polyphenolic fragments for the development of new amphiphilic antioxidants. Antioxidants, 10(2), 148.
Anti-inflammatory	Tsai, J. C., Peng, W. H., Chiu, T. H., Lai, S. C., & Lee, C. Y. (2011). Anti-inflammatory effects of Scoparia dulcis L. and betulinic acid. The American Journal of Chinese Medicine, 39(05), 943-956.
Anti-HIV	Huang, Q. X., Chen, H. F., Luo, X. R., Zhang, Y. X., Yao, X., & Zheng, X. (2018). Structure and anti-HIV activity of betulinic acid analogues. Current medical science, 38(3), 387-397.
Antibacterial	Fontanay, S., Grare, M., Mayer, J., Finance, C., & Duval, R. E. (2008). Ursolic, oleanolic and betulinic acids: antibacterial spectra and selectivity indexes. Journal of ethnopharmacology, 120(2), 272-276.
Antimalarial	de Sá, M. S., Costa, J. F. O., Krettli, A. U., Zalis, M. G., Maia, G. L. D. A., Sette, I. M. F., ... & Soares, M. B. P. (2009). Antimalarial activity of betulinic acid and derivatives in vitro against Plasmodium falciparum and in vivo in P. berghei-infected mice. Parasitology research, 105, 275-279.
Comprehensive Review	Yogeeswari, P., & Sriram, D. (2005). Betulinic acid and its derivatives: a review on their biological properties. Current medicinal chemistry, 12(6), 657-666.

Chapter 14

Soursop Leaves

14.1 General Description

Soursop which goes by several names such as paw paw, guanabana, sirsak, and graviol is scientifically known as Annona muricata. It has been used in beverages such as teas, juices, smoothies, rum and cocktails. It also used for making ice creams and sorbets, candies and the leaf is used as a meat tenderizer. Annona muricata leaf extract has been reported to hold anti-inflammatory properties as well as neurogenerative effects and is widely regarded for other phytochemically rich properties. In particular the leaf, fruit and bark is known to be comprised hundreds of compounds many that have shown anticancer properties.

14.2 Phytochemical Benefits

14.2.1 Nonanal*

Table 14.1: Benefits of nonanal are shown in the table below

Benefit	*Reference*
Antidiarrhoeal	Zavala-Sanchez, M. A., Pérez-Gutiérrez, S., P? rez-González, C., Sánchez-Saldivar, D., & Arias-García, L. (2002). Antidiarrhoeal activity of nonanal, an aldehyde isolated from Artemisia ludoviciana. Pharmaceutical biology, 40(4), 263-268.
Antidiarrhoeal	Gohari, A. R., Saeidnia, S., Malmir, M., Yazdanpanah, M., & Ajani, Y. (2011). Sterols and flavonoids of Lomatopodium staurophyllum. Journal of Medicinal Plants, 10(39), 43-48.
Anti-fungal	Zhang, J. H., Sun, H. L., Chen, S. Y., Zeng, L. I., & Wang, T. T. (2017). Anti-fungal activity, mechanism studies on alpha-Phellandrene and Nonanal against Penicillium cyclopium. Botanical studies, 58, 1-9.
Anti-fungal	Li, Q., Zhu, X., Xie, Y., & Liang, J. (2021). Antifungal properties and mechanisms of three volatile aldehydes (octanal, nonanal and decanal) on Aspergillus flavus. Grain & Oil Science and Technology, 4(3), 131-140.
Anti-fungal	Zhang, J., Zeng, L., Sun, H., Chen, S., Wang, T., & Ma, S. (2017). Use of Nonanal-wax as Postharvest Fungicide of Tomato against Botrytis cinereal. J. Food Nutr. Res, 5, 458-466.

14.2.2 Quercetin

Table 14.2: Benefits of quercetin are shown in the table below

Benefit	*Reference*
Antioxidant	Zhang, M., Swarts, S. G., Yin, L., Liu, C., Tian, Y., Cao, Y., ... & Okunieff, P. (2011). Antioxidant properties of quercetin. In Oxygen transport to tissue XXXII (pp. 283-289). Springer US.
Antioxidant	Xu, D., Hu, M. J., Wang, Y. Q., & Cui, Y. L. (2019). Antioxidant activities of quercetin and its complexes for medicinal application. Molecules, 24(6), 1123.
Antioxidant and Anti-inflammatory	Lesjak, M., Beara, I., Simin, N., Pintać, D., Majkić, T., Bekvalac, K., ... & Mimica-Dukić, N. (2018). Antioxidant and anti-inflammatory activities of quercetin and its derivatives. Journal of Functional Foods, 40, 68-75.
Anticancer	Ezzati, M., Yousefi, B., Velaei, K., & Safa, A. (2020). A review on anti-cancer properties of Quercetin in breast cancer. Life sciences, 248, 117463.
Anticancer	Shafabakhsh, R., & Asemi, Z. (2019). Quercetin: a natural compound for ovarian cancer treatment. Journal of ovarian research, 12, 1-9.
Cardioprotective	Bhat, I. U. H., & Bhat, R. (2021). Quercetin: a bioactive compound imparting cardiovascular and neuroprotective benefits: scope for exploring fresh produce, their wastes, and by-products. Biology, 10(7), 586.
Antioxidant and Anti-inflammatory	Davis, J. M., Carlstedt, C. J., Chen, S., Carmichael, M. D., & Murphy, E. A. (2010). The dietary flavonoid quercetin increases VO2max and endurance capacity. International journal of sport nutrition and exercise metabolism, 20(1), 56-62.

14.2.3 Kaempferol

Table 14.3: Benefits of kaempferol are shown in the table below

Benefit	*Reference*
Anticancer	Imran, M., Salehi, B., Sharifi-Rad, J., Aslam Gondal, T., Saeed, F., Imran, A., ... & Estevinho, L. M. (2019). Kaempferol: A key emphasis to its anticancer potential. Molecules, 24(12), 2277.
Anti-inflammation	Devi, K. P., Malar, D. S., Nabavi, S. F., Sureda, A., Xiao, J., Nabavi, S. M., & Daglia, M. (2015). Kaempferol and inflammation: From chemistry to medicine. Pharmacological research, 99, 1-10.
Anti-inflammation	Rho, H. S., Ghimeray, A. K., Yoo, D. S., Ahn, S. M., Kwon, S. S., Lee, K. H., ... & Cho, J. Y. (2011). Kaempferol and kaempferol rhamnosides with depigmenting and anti-inflammatory properties. Molecules, 16(4), 3338-3344.
Antiatherogenic	Tu, Y. C., Lian, T. W., Yen, J. H., Chen, Z. T., & Wu, M. J. (2007). Antiatherogenic effects of kaempferol and rhamnocitrin. Journal of agricultural and food chemistry, 55(24), 9969-9976.
Antitumor, Antioxidant and Anti-inflammatory	Wang, J., Fang, X., Ge, L., Cao, F., Zhao, L., Wang, Z., & Xiao, W. (2018). Antitumor, antioxidant and anti-inflammatory activities of kaempferol and its corresponding glycosides and the enzymatic preparation of kaempferol. PLoS One, 13(5), e0197563.
Antimicrobial and Antioxidant	Tatsimo, S. J. N., Tamokou, J. D. D., Havyarimana, L., Csupor, D., Forgo, P., Hohmann, J., ... & Tane, P. (2012). Antimicrobial and antioxidant activity of kaempferol rhamnoside derivatives from Bryophyllum pinnatum. BMC Research notes, 5(1), 1-6.
Antidiabetic	Yang, Y., Chen, Z., Zhao, X., Xie, H., Du, L., Gao, H., & Xie, C. (2022). Mechanisms of Kaempferol in the treatment of diabetes: A comprehensive and latest review. Frontiers in Endocrinology, 13, 990299.
Anti-bacterial	Escandón, R. A., Del Campo, M., López-Solis, R., Obreque-Slier, E., & Toledo, H. (2016). Antibacterial effect of kaempferol and epicatechin on Helicobacter pylori. European Food Research and Technology, 242, 1495-1502.

14.2.4 Anonaine

Table 14.4: Benefits of anonaine are shown in the table below

Benefit	*Reference*
Anticancer, Antimicrobial, Antioxidant	Li, H. T., Wu, H. M., Chen, H. L., Liu, C. M., & Chen, C. Y. (2013). The pharmacological activities of (-)-anonaine. Molecules, 18(7), 8257-8263.
Antioxidant	Ethiraj, S. U. M. A. T. H. I., & Sridar, V. A. N. D. A. N. A. (2018). Phytochemical screening, antioxidant activity and extraction of active compound (Anonaine) from fruit peel extract of Annona reticulata L. Asian J Pharm Clin Res, 11(11), 372-377.
Neuroprotective e	Porwal, M., & Kumar, A. (2015). Neuroprotective effect of Annona squamosa & (-) Anonaine in decreased GABA receptor of epileptic rats. Journal of Applied Pharmaceutical Science, 5(1), 018-023.
Antiparasitic	Bettarini, F., Borgonovi, G. E., Fiorani, T., Gagliardi, I., Caprioli, V., Massardo, P., ... & Chapya, A. (1993). Antiparasitic compounds from East African plants: Isolation and biological activity of anonaine, matricarianol, canthin-6-one and caryophyllene oxide. International Journal of Tropical Insect Science, 14(1), 93-99.
Anticancer	Ata, F. K., Ercan, F., & Azarkan, S. Y. (2022). In vivo, in vitro and Molecular Modelling Analysis of Isoquercetin, Roseoside, Coreximine, Anonaine, and Arianacin Molecules. Current Computer-Aided Drug Design, 18(3), 168-184.

14.2.5 Isolaureline

Table 14.5: Benefits of isolaureline are shown in the table below

Benefit	*Reference*
Anti-obesity	Elekofehinti, O. O., Lawal, A. O., Ejelonu, O. C., Molehin, O. R., & Famusiwa, C. D. (2020). Involvement of fat mass and obesity gene (FTO) in the anti-obesity action of Annona muricata Annonaceae: in silico and in vivo studies. Journal of Diabetes & Metabolic Disorders, 19, 197-204.
Antidiabetic	Wang, F. X., Zhu, N., Zhou, F., & Lin, D. X. (2021). Natural aporphine alkaloids with potential to impact metabolic syndrome. Molecules, 26(20), 6117.

14.2.6 Xylopine

Table 14.6: Benefits of Xylopine are shown in the table below

Benefit	*Reference*
Anticancer	de Souza Santos, L., Silva, V. R., Menezes, L. R. A., Soares, M. B. P., Costa, E. V., & Bezerra, D. P. (2017). Xylopine Induces Oxidative Stress and Causes G.
Antidiabetic	Damayanti, D. S., Utomo, D. H., & Kusuma, C. (2017). Revealing the potency of Annona muricata leaves extract as FOXO1 inhibitor for diabetes mellitus treatment through computational study. In silico pharmacology, 5, 1-7.
Anticancer	Pena-Hidalgo, M., Furtado, L. C., Costa-Lotufo, L. V., Ferreira, M. J., & Santos, D. Y. (2021). Alkaloids from the Leaves of Annona crassiflora and Their Cytotoxic Activity. Revista Brasileira de Farmacognosia, 31, 244-248.

14.2.7 Coclaurine

Table 14.7: Benefits of coclaurine are shown in the table below

Benefit	*Reference*
Cardiovascular effect	Morales, M. A., Bustamante, S. E., Brito, G., Paz, D., & Cassels, B. K. (1998). Cardiovascular effects of plant secondary metabolites norarmepavine, coclaurine and norcoclaurine. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives, 12(2), 103-109.
Anticancer	Al-Ghazzawi, A. M. (2019). Anti-cancer activity of new benzyl isoquinoline alkaloid from Saudi plant Annona squamosa. BMC chemistry, 13(1), 1-6.
Anti-Inflammatory and Anti-Arthritic	Fan, G., Li, Q., Li, H. J., Zhang, Y. S., Xu, X. M., Fang, G., ... & Du, L. L. (2020). Active Ingredients and Anti-Arthritic Mechanisms of Ba-Wei-Long-Zuan Granule Revealed by 1H-NMR-Based Metabolomics Combined with Network Pharmacology Analysis. Chemistry & Biodiversity, 17(6), e2000122.

14.2.8 Luteolin

Table 14.8: Benefits of luteolin are shown in the table below

Benefit	*Reference*
Anti-cancer	Lin, Y., Shi, R., Wang, X., & Shen, H. M. (2008). Luteolin, a flavonoid with potential for cancer prevention and therapy. Current cancer drug targets, 8(7), 634-646.
Anti-cancer	Seelinger, G., Merfort, I., Wölfle, U., & Schempp, C. M. (2008). Anti-carcinogenic effects of the flavonoid luteolin. Molecules, 13(10), 2628-2651.
Anti-oxidant, anti-inflammatory and anti-allergic	Seelinger, G., Merfort, I., & Schempp, C. M. (2008). Anti-oxidant, anti-inflammatory and anti-allergic activities of luteolin. Planta medica, 74(14), 1667-1677.
Anti-inflammatory and neuroprotective	Nabavi, S. F., Braidy, N., Gortzi, O., Sobarzo-Sanchez, E., Daglia, M., Skalicka-Woźniak, K., & Nabavi, S. M. (2015). Luteolin as an anti-inflammatory and neuroprotective agent: A brief review. Brain research bulletin, 119, 1-11.
Anticancer	Imran, M., Rauf, A., Abu-Izneid, T., Nadeem, M., Shariati, M. A., Khan, I. A., ... & Mubarak, M. S. (2019). Luteolin, a flavonoid, as an anticancer agent: A review. Biomedicine & Pharmacotherapy, 112, 108612.
Anti-inflammatory	Aziz, N., Kim, M. Y., & Cho, J. Y. (2018). Anti-inflammatory effects of luteolin: A review of in vitro, in vivo, and in silico studies. Journal of ethnopharmacology, 225, 342-358.
Anti-diabetic	Zang, Y., Igarashi, K., & Li, Y. (2016). Anti-diabetic effects of luteolin and luteolin-7-O-glucoside on KK-A y mice. Bioscience, Biotechnology, and Biochemistry, 80(8), 1580-1586.
Skin protective and Anti-inflammatory Gendrisch, F., Esser, P. R., Schempp, C. M.,	Wölfle, U. (2021). Luteolin as a modulator of skin aging and inflammation. Biofactors, 47(2), 170-180.
Multiple sclerosis	Theoharides, T. C. (2009). Luteolin as a therapeutic option for multiple sclerosis. Journal of Neuroinflammation, 6, 1-3.

14.2.9 Homoorientin

Table 14.9: Benefits of homoorientin are shown in the table below

Benefit	*Reference*
Antioxidant	Lee, K. J., Shin, Y. K., & Kim, Y. S. (2009). Enhanced effect extraction of antioxidant substance homoorientin from Pseudosasa japonica and Phyllostachys bambusoides leaves using ultrasonic wave system. Korean Society for Biotechnology and Bioengineering Journal.
Antioxidant	Lee, K. J., & Um, B. H. (2008). Extraction and Antioxidant activity analysis of Homoorientin from Phyllostachys bambusoides S. leaves. Applied Biological Chemistry, 51(3), 245-246.
Antioxidant	Kang, J., Li, Z., Wu, T., Jensen, G. S., Schauss, A. G., & Wu, X. (2010). Anti-oxidant capacities of flavonoid compounds isolated from acai pulp (Euterpe oleracea Mart.). Food Chemistry, 122(3), 610-617.

14.2.10 tangeretin

Table 14.10: Benefits of tangeretin are shown in the table below

Benefit	*Reference*
Anticancer	Raza, W., Luqman, S., & Meena, A. (2020). Prospects of tangeretin as a modulator of cancer targets/pathways. Pharmacological Research, 161, 105202.
Neuroprotective effects	Datla, K. P., Christidou, M., Widmer, W. W., Rooprai, H. K., & Dexter, D. T. (2001). Tissue distribution and neuroprotective effects of citrus flavonoid tangeretin in a rat model of Parkinson's disease. Neuroreport, 12(17), 3871-3875.
Neuroprotective effects	Braidy, N., Behzad, S., Habtemariam, S., Ahmed, T., Daglia, M., Mohammad Nabavi, S., ... & Fazel Nabavi, S. (2017). Neuroprotective effects of citrus fruit-derived flavonoids, nobiletin and tangeretin in Alzheimer's and Parkinson's disease. CNS & Neurological Disorders-Drug Targets (Formerly Current Drug Targets-CNS & Neurological Disorders), 16(4), 387-397.
Antibacterial	Yao, X., Zhu, X., Pan, S., Fang, Y., Jiang, F., Phillips, G. O., & Xu, X. (2012). Antimicrobial activity of nobiletin and tangeretin against Pseudomonas. Food Chemistry, 132(4), 1883-1890.
Anti-inflammatory and antioxidant	Lee, Y. Y., Lee, E. J., Park, J. S., Jang, S. E., Kim, D. H., & Kim, H. S. (2016). Anti-inflammatory and antioxidant mechanism of tangeretin in activated microglia. Journal of Neuroimmune Pharmacology, 11, 294-305.
Anti-neuroinflammatory	Shu, Z., Yang, B., Zhao, H., Xu, B., Jiao, W., Wang, Q., ... & Kuang, H. (2014). Tangeretin exerts anti-neuroinflammatory effects via NF-kB modulation in lipopolysaccharide-stimulated microglial cells. International immunopharmacology, 19(2), 275-282.
Anticancer	Arafa, E. S. A., Zhu, Q., Barakat, B. M., Wani, G., Zhao, Q., El-Mahdy, M. A., & Wani, A. A. (2009). Tangeretin sensitizes cisplatin-resistant human ovarian cancer cells through downregulation of phosphoinositide 3-kinase/Akt signaling pathway. Cancer research, 69(23), 8910-8917.
Neuroprotective and anti-inflammatory	Yang, T., Feng, C., Wang, D., Qu, Y., Yang, Y., Wang, Y., & Sun, Z. (2020). Neuroprotective and anti-inflammatory effect of tangeretin against cerebral ischemia-reperfusion injury in rats. Inflammation, 43, 2332-2343.
Anticancer	Arafa, E. S. A., Shurrab, N. T., & Buabeid, M. A. (2021). Therapeutic implications of a polymethoxylated flavone, tangeretin, in the management of cancer via modulation of different molecular pathways. Advances in Pharmacological and Pharmaceutical Sciences, 2021.

14.2.11 Genistein

Table 14.11: Benefits of genistein are shown in the table below

Benefit	*Reference*
Anticancer	Banerjee, S., Li, Y., Wang, Z., & Sarkar, F. H. (2008). Multi-targeted therapy of cancer by genistein. Cancer letters, 269(2), 226-242.
Anticancer	Russo, M., Russo, G. L., Daglia, M., Kasi, P. D., Ravi, S., Nabavi, S. F., & Nabavi, S. M. (2016). Understanding genistein in cancer: The "good" and the "bad" effects: A review. Food chemistry, 196, 589-600.
Anti-inflammatory	Verdrengh, M., Jonsson, I. M., Holmdahl, R., & Tarkowski, A. (2003). Genistein as an anti-inflammatory agent. Inflammation Research, 52, 341-346.
Anti-inflammatory	Goh, Y. X., Jalil, J., Lam, K. W., Husain, K., & Premakumar, C. M. (2022). Genistein: a review on its anti-inflammatory properties. Frontiers in Pharmacology, 13, 820969.
Antioxidant	Record, I. R., Dreosti, I. E., & McInerney, J. K. (1995). The antioxidant activity of genistein in vitro. The journal of nutritional biochemistry, 6(9), 481-485.
Cardiovascular effects	Si, H., & Liu, D. (2007). Phytochemical genistein in the regulation of vascular function: new insights. Current medicinal chemistry, 14(24), 2581-2589.
Anti-obesity and Anti-diabetic	Behloul, N., & Wu, G. (2013). Genistein: a promising therapeutic agent for obesity and diabetes treatment. European journal of pharmacology, 698(1-3), 31-38.

14.2.12 Homoorientin

Table 14.12: Benefits of homoorientin are shown in the table below

Benefit	*Reference*
Anti-oxidant and anti-allergic	Shimoda, K., & Hamada, H. (2010). Synthesis of beta-maltooligosaccharides of glycitein and daidzein and their anti-oxidant and anti-allergic activities. Molecules, 15(8), 5153-5161.
Anti-oxidant	Pratt, D. E., Pietro, C. D., Porter, W. L., & Giffee, J. W. (1982). Phenolic antioxidants of soy protein hydrolyzates. Journal of Food Science, 47(1), 24-35.
Anticancer	Zhang, B., Su, J. P., Bai, Y., Li, J., & Liu, Y. H. (2015). Inhibitory effects of O-methylated isoflavone glycitein on human breast cancer SKBR-3 cells. International Journal of Clinical and Experimental Pathology, 8(7), 7809.
Anticancer	Xiang, T., & Jin, W. (2023). Mechanism of glycitein in the treatment of colon cancer based on network pharmacology and molecular docking. Lifestyle Genomics, 16, 1-10.
Neuroprotective effects	Dong, N., & Yang, Z. (2022). Glycitein exerts neuroprotective effects in Rotenone-triggered oxidative stress and apoptotic cell death in the cellular model of Parkinson's disease. Acta Biochimica Polonica, 69(2), 447-452.
Anti-inflammatory and neuroprotective effect	Marotta, F., Mao, G. S., Liu, T., Chui, D. H., Lorenzetti, A., Xiao, Y., & Marandola, P. (2006). Anti-inflammatory and neuroprotective effect of a phytoestrogen compound on rat microglia. Annals of the New York Academy of Sciences, 1089(1), 276-281.

14.2.13 Emodin

Table 14.13: Benefits of Emodin are shown in the table below

Benefit	*Reference*
Antitumor	Srinivas, G., Babykutty, S., Sathiadevan, P. P., & Srinivas, P. (2007). Molecular mechanism of emodin action: transition from laxative ingredient to an antitumor agent. Medicinal research reviews, 27(5), 591-608.
Anticancer Hsu, S. C.,	Chung, J. G. (2012). Anticancer potential of emodin. BioMedicine, 2(3), 108-116.
Anti-inflammatory	Chang, C. H., Lin, C. C., Yang, J. J., Namba, T., & Hattori, M. (1996). Anti-inflammatory effects of emodin from ventilago leiocarpa. The American journal of Chinese medicine, 24(02), 139-142.
Anticancer	Huang, P. H., Huang, C. Y., Chen, M. C., Lee, Y. T., Yue, C. H., Wang, H. Y., & Lin, H. (2013). Emodin and aloe-emodin suppress breast cancer cell proliferation through ERα inhibition. Evidence-Based Complementary and Alternative Medicine, 2013.
Antitumor	Wei, W. T., Lin, S. Z., Liu, D. L., & Wang, Z. H. (2013). The distinct mechanisms of the antitumor activity of emodin in different types of cancer. Oncology reports, 30(6), 2555-2562.
Anticancer	Akkol, E. K., Tatlı, I. I., Karatoprak, G. Ş., Ağar, O. T., Yücel, Ç., Sobarzo-Sánchez, E., & Capasso, R. (2021). Is emodin with anticancer effects completely innocent? Two sides of the coin. Cancers, 13(11), 2733.
Antiviral	Shuangsuo, D., Zhengguo, Z., Yunru, C., Xin, Z., Baofeng, W., Lichao, Y., & Yan'an, C. (2006). Inhibition of the replication of hepatitis B virus in vitro by emodin. Medical science monitor: international medical journal of experimental and clinical research, 12(9), BR302-6.

14.2.14 Cinnamic acid

Table 14.14: Benefits of cinnamic acid are shown in the table below

Benefit	*Reference*
Anticancer	De, P., Baltas, M., & Bedos-Belval, F. (2011). Cinnamic acid derivatives as anticancer agents-a review. Current medicinal chemistry, 18(11), 1672-1703.
Anticancer	Liu, L., Hudgins, W. R., Shack, S., Yin, M. Q., & Samid, D. (1995). Cinnamic acid: a natural product with potential use in cancer intervention. International journal of cancer, 62(3), 345-350.
Anticancer	Su, P., Shi, Y., Wang, J., Shen, X., & Zhang, J. (2015). Anticancer agents derived from natural cinnamic acids. Anti-Cancer Agents in Medicinal Chemistry (Formerly Current Medicinal Chemistry-Anti-Cancer Agents), 15(8), 980-987.
Antioxidant and antimicrobial	Sova, M. (2012). Antioxidant and antimicrobial activities of cinnamic acid derivatives. Mini reviews in medicinal chemistry, 12(8), 749-767.
Antidiabetic	Adisakwattana, S. (2017). Cinnamic acid and its derivatives: mechanisms for prevention and management of diabetes and its complications. Nutrients, 9(2), 163.
antifungal	Bisogno, F., Mascoti, L., Sanchez, C., Garibotto, F., Giannini, F., Kurina-Sanz, M., & Enriz, R. (2007). Structure - antifungal activity relationship of cinnamic acid derivatives. Journal of agricultural and food chemistry, 55(26), 10635-10640.
Antioxidants	Foti, M., Piattelli, M., Baratta, M. T., & Ruberto, G. (1996). Flavonoids, coumarins, and cinnamic acids as antioxidants in a micellar system. Structure -activity relationship. Journal of Agricultural and Food Chemistry, 44(2), 497-501.

14.2.15 p-Coumaric acid

Table 14.15: Benefits of coumaric acid are shown in the table below

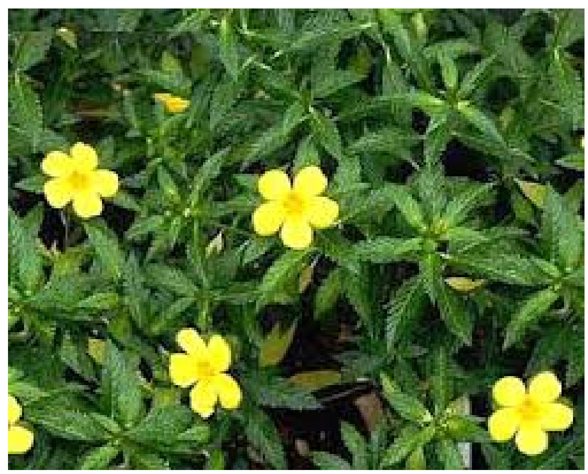
Benefit	*Reference*
Antimelanogenic	Boo, Y. C. (2019). p-Coumaric acid as an active ingredient in cosmetics: A review focusing on its antimelanogenic effects. Antioxidants, 8(8), 275.
Antioxidant and antimicrobial	Boz, H. (2015). p-Coumaric acid in cereals: presence, antioxidant and antimicrobial effects. International Journal of Food Science & Technology, 50(11), 2323-2328.
Antioxidant	Stražišar, M., Andrenšek, S., & Šmidovnik, A. (2008). Effect of β-cyclodextrin on antioxidant activity of coumaric acids. Food Chemistry, 110(3), 636-642.
Antioxidant and antimicrobial	Stojković, D., Petrović, J., Soković, M., Glamočlija, J., Kukić-Marković, J., & Petrović, S. (2013). In situ antioxidant and antimicrobial activities of naturally occurring caffeic acid, p-coumaric acid and rutin, using food systems. Journal of the Science of Food and Agriculture, 93(13), 3205-3208.
Antioxidant	Godarzi, S. M., Gorji, A. V., Gholizadeh, B., Mard, S. A., & Mansouri, E. (2020). Antioxidant effect of p-coumaric acid on interleukin 1-beta and tumor necrosis factor-alpha in rats with renal ischemic reperfusion. Nefrologia, 40(3), 311-319.
Antioxidant and antibacterial	Yu, C., Liu, X., Pei, J., & Wang, Y. (2020). Grafting of laccase-catalyzed oxidation of butyl paraben and p-coumaric acid onto chitosan to improve its antioxidant and antibacterial activities. Reactive and Functional Polymers, 149, 104511.
Antioxidant, anti-inflammatory, antimicrobial, and antidiabetic	Venkatesan, A., Antony Samy, J. V. R., Balakrishnan, K., Natesan, V., & Kim, S. J. (2022). In vitro antioxidant, anti-inflammatory, antimicrobial, and antidiabetic activities of synthesized chitosan-loaded p-Coumaric acid nanoparticles. Current Pharmaceutical Biotechnology.

Chapter 15

Damiana Leaves

15.1 General Description

Damiana is a wild shrub that is common in the Caribbean, Mexico and Central. It is scientifically known as turnera diffusa. The stem and leaves are used to make beverages such as teas, liquor, tequila and smoothies. It is commonly used for medicinal purposes in the form of pills powders supplements and essential oils. In particular, it is used medicinally in The Bahamas and in the herbal industry as an aphrodisiac, stimulant, and for treating gastrointestinal issues. There are numerous phytochemicals found in damiana such as a-pinene*, linalool, eucalyptol Beta-Caryophyllene, alpha-terpineol, guaiol, cadinene, spathulenol and isoledene .



15.2 Phytochemical Benefits

15.2.1 a-Pinene*

Table 15.1: Benefits of a-pinene are shown in the table below

Benefit	*Reference*
Anti-inflammatory effects	Bhagat, M., Gupta, S., Jamwal, V. S., Sharma, S., Kattal, M., Dawa, S., ... and Bindu, K. (2016). Comparative study on chemical profiling and Antimicrobial properties of essential oils from different parts of Eucalyptus lanceolatus.
Antimicrobial	https://doi.org/10.3390/molecules17066305
Antimicrobial	https://dx.doi.org/10.3390/biom9110738
Antimicrobial	https://doi.org/10.1080/10412905.1999.9701162
Antibacterial	https://doi.org/10.3390/molecules17066305
Antibacterial (hand sanitizer)	Wijayati, N., Widiyastuti, A., Mursiti, S., and Rakainsa, S. K. (2020, May). Formulation of Hand Sanitizer Gel of A-Pinene Isolated from Turpentine Oil and its Antibacterial Activity. In IOP Conference Series: Materials Science and Engineering (Vol. 846, No. 1, p. 012069). IOP Publishing.
Fungicidal	https://dx.doi.org/10.3390/biom9110738
Fungicidal	https://doi.org/10.3390/molecules17066305
Flavoring	https://dx.doi.org/10.3390/biom9110738
Flavoring	https://doi.org/10.3390/molecules17066305
Fragrances	https://dx.doi.org/10.3390/biom9110738
Antiviral	https://dx.doi.org/10.3390/biom9110738
Renal and Hepatic Drugs	https://dx.doi.org/10.3390/biom9110738
Inhibitory effects on breast cancer and leukemia	https://dx.doi.org/10.3390/biom9110738
Cytotoxic	https://doi.org/10.3390/molecules17066305
Polymer synthetization	https://dx.doi.org/10.3390/biom9110738
Neuroprotective activity	https://dx.doi.org/10.3390/biom9110738
Bathtub, tile, and toilet surface cleaners	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 6654, alpha-Pinene. Retrieved January 20, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/alpha-Pinene.
Insect repellant	National Center for Biotechnology Information (2022). PubChem Compound Summary for CID 6654, alpha-Pinene. Retrieved January 20, 2022 from https://pubchem.ncbi.nlm.nih.gov/compound/alpha-Pinene.
Insecticide	https://doi.org/10.3390/molecules17066305

15.2.2 Nonanal*

Table 15.2: Benefits of nonanal are shown in the table below

Benefit	*Reference*
Antidiarrhoeal	Zavala-Sanchez, M. A., Pérez-Gutiérrez, S., P? rez-González, C., Sánchez-Saldivar, D., & Arias-García, L. (2002). Antidiarrhoeal activity of nonanal, an aldehyde isolated from Artemisia ludoviciana. Pharmaceutical biology, 40(4), 263-268.
Antidiarrhoeal	Gohari, A. R., Saeidnia, S., Malmir, M., Yazdanpanah, M., & Ajani, Y. (2011). Sterols and flavonoids of Lomatopodium staurophyllum. Journal of Medicinal Plants, 10(39), 43-48.
Anti-fungal	Zhang, J. H., Sun, H. L., Chen, S. Y., Zeng, L. I., & Wang, T. T. (2017). Anti-fungal activity, mechanism studies on alpha-Phellandrene and Nonanal against Penicillium cyclopium. Botanical studies, 58, 1-9.
Anti-fungal	Li, Q., Zhu, X., Xie, Y., & Liang, J. (2021). Antifungal properties and mechanisms of three volatile aldehydes (octanal, nonanal and decanal) on Aspergillus flavus. Grain & Oil Science and Technology, 4(3), 131-140.
Anti-fungal	Zhang, J., Zeng, L., Sun, H., Chen, S., Wang, T., & Ma, S. (2017). Use of Nonanal-wax as Postharvest Fungicide of Tomato against Botrytis cinereal. J. Food Nutr. Res, 5, 458-466.

15.2.3 Linalool

Table 15.3: Benefits of linalool are shown in the table below

Benefit	*Reference*
Antimicrobial, Antibacterial and Anti-oxidant	Van Zyl, R. L., Seatlholo, S. T., Van Vuuren, S. F., & Viljoen, A. M. (2006). The biological activities of 20 nature identical essential oil constituents. Journal of Essential Oil Research, 18(sup1), 129-133.
Anti-inflammatory	Peana, A. T., D'Aquila, P. S., Panin, F., Serra, G., Pippia, P., & Moretti, M. D. L. (2002). Anti-inflammatory activity of linalool and linalyl acetate constituents of essential oils. Phytomedicine, 9(8), 721-726.
Anti-inflammatory	Moretti, M. D., Peana, A. T., & Satta, M. (1997). A study on Anti-inflammatory and peripheral analgesic action of Salvia sclarea oil and its main components. Journal of Essential Oil Research, 9(2), 199-204.
Anti-inflammatory	Peana, A. T., & Moretti, M. D. (2002). Pharmacological activities and applications of Salvia sclarea and Salvia desoleana essential oils. Studies in natural products chemistry, 26, 391-423.
Antinociceptive	Peana, A. T., Marzocco, S., Popolo, A., & Pinto, A. (2006). Linalool inhibits in vitro NO formation: probable involvement in the Antinociceptive activity of this monoterpene compound. Life sciences, 78(7), 719-723.
Anti-oxidant	Van Zyl, R. L., Seatlholo, S. T., Van Vuuren, S. F., & Viljoen, A. M. (2006). The biological activities of 20 nature identical essential oil constituents. Journal of Essential Oil Research, 18(sup1), 129-133.
Anti-oxidant	Lin KH, Yeh SY, Lin MY, Shih MC, Yang KT, Hwang SY. (2007) Major chemotypes and Anti-oxidative activity of the leaf essential oils of Cinnamomum osmophloeum Kaneh. from a clonal orchard. Food Chemistry, 105, 133-139.
Anticancer	Cherng, J. M., Shieh, D. E., Chiang, W., Chang, M. Y., & Chiang, L. C. (2007). Chemopreventive effects of minor dietary constituents in common foods on human cancer cells. Bioscience, biotechnology, and biochemistry, 71(6), 1500-1504.
Anticancer	Silva, S. L. D., Figueiredo, P. M., & Yano, T. (2007). Cytotoxic evaluation of essential oil from Zanthoxylum rhoifolium Lam. leaves. Acta Amazonica, 37, 281-286.

15.2.4 Eucalyptol*

Table 15.4: Benefits of Eucalyptol are shown in the table below

Benefit	*Reference*
Flavouring agent	DOI: 10.5530/rjps.2015.4.2
Fragrance	DOI: 10.5530/rjps.2015.4.2
Mouthwash and toothpaste	DOI: 10.5530/rjps.2015.4.2
Cosmetics: perfumes, soap, cream, lotion	DOI: 10.5530/rjps.2015.4.2
Antinociceptive properties (potential calmative and depressant)	DOI: 10.5530/rjps.2015.4.2
blood circulation	DOI: 10.5530/rjps.2015.4.2
Anti-inflammatory effects	DOI: 10.5530/rjps.2015.4.2
Anti-inflammatory	https://doi.org/10.3390/molecules26164933
Anti-inflammatory	https://doi.org/10.1080/10412905.2020.1716867
Anti-inflammatory (Bronchial asthma)	https://doi.org/10.1053/rmed.2003.1432
Secretolytic properties and myorelaxant effects	DOI: 10.5530/rjps.2015.4.2
Antifungal and Antibacterial	DOI: 10.5530/rjps.2015.4.2
Antimicrobial	https://doi.org/10.3390/molecules26164933
Antimicrobial	https://doi.org/10.3390/catal12010048
Antioxidant and lipoxygenase inhibitory actions Antioxidant	DOI: 10.5530/rjps.2015.4.2
Hepatoprotective effect	DOI: 10.5530/rjps.2015.4.2
Antitumorogenic effect (potential to treat coloreactal cancer) Anticancer	DOI: 10.5530/rjps.2015.4.2
bio-insecticidal efficacy	https://doi.org/10.1590/S0036-46652004000200008
Repellent	https://doi.org/10.3390/catal12010048
potential treatment to act as COVID-19 Mpro inhibitor	doi: 10.20944/preprints202003.0455.v1
Antiseptic	https://doi.org/10.3390/molecules26164933
Bronchodilatory effects (clears respiratory tract and nasal cavities from secretions)	https://doi.org/10.3390/molecules26164933
Bronchodilatory effects	https://doi.org/10.1080/10412905.2020.1716867
Antitussive	https://doi.org/10.3390/catal12010048

15.2.5 beta-Caryophyllene*

Table 15.5: Benefits of beta-Caryophyllene are shown in the table below

Benefit	*Reference*
Antibacterial activity	https://doi.org/10.1016/j.sajb.2021.07.046
Antibacterial activity (pneumonia - mice)	https://doi.org/10.1016/j.sjbs.2021.06.034
Antiviral activity (zika virus)	https://doi.org/10.1016/j.indcrop.2021.113281; https://doi.org/10.1016/j.actatropica.2020.105556
Anticonvulsant/epileptic seizure (mice)	https://doi.org/10.1016/j.eplepsyres.2021.106842
increased libido in women	https://doi.org/10.1016/j.esxm.2020.06.001
Osteoarthritis Treatment (mice)	https://doi.org/10.1016/j.neuropharm.2021.108908
general review	https://doi.org/10.1016/j.biopha.2021.111639
Alcohol addiction	10.1016/j.pbb.2014.06.025
Neuropathic pain	10.1016/j.euroneuro.2013.10.008
Neuropathic pain	10.1016/j.phymed.2013.08.006
Neuropathic pain	10.4236/pp.2012.34053
Nociception	10.1038/ncpneuro0113
Neuropathic pain	https://doi.org/10.3390/molecules25010106
Insulin resistance and dyslipidemia	10.1016/j.cbi.2018.10.010
Insulin resistance and associated neurobehavioral changes	10.1016/j.biopha.2018.11.039
Atherosclerosis	10.1016/j.taap.2017.06.016
Ulcerative colitis	10.1016/j.ajpath.2010.11.052
Immunomodulation	10.3390/ijms18040691
Peripheral neuropathy	10.1016/j.neuropharm.2017.07.015
Chemotherapy-induced cardiotoxicity	10.1016/j.cbi.2019.02.028
Nephroprotective	10.1016/j.freeradbiomed.2012.01.014
Parkinson's disease	10.3389/fnins.2016.00321
Parkinson's disease	10.3390/ph10030060
Alzheimer's disease	10.1159/000362689
Post-stroke cognitive deficits	10.3389/fphar.2017.00002
Cerebral ischemia	10.1016/j.ajpath.2012.11.024

[Cont'd] Benefits of beta-Caryophyllene are shown in the table below

Benefit	*Reference*
Cerebral ischemia	10.1186/s12944-018-0661-4
Depression and anxiety	10.1016/j.physbeh.2014.06.003
Depression	10.1016/j.bbr.2019.112439
Liver fibrosis	10.1016/j.ejphar.2014.08.021
Alcohol liver damage	10.1111/bph.13722
Nicotine addiction	10.1111/bph.14969
Arthritis	10.3390/biom9080326
Obesity and related complications	10.1016/j.bbrc.2013.05.108
Hyperglycemia	10.1016/j.bbrc.2013.11.136
Atherosclerosis	10.1016/j.taap.2017.06.016
Cancer	10.3390/cancers12041038
Parkinson's disease	10.1016/j.biopha.2018.03.168
Cerebral ischemia-reperfusion injury	10.1080/07391102.2019.1567384
Multiple sclerosis	10.1016/j.lfs.2018.12.059
Multiple sclerosis	10.1016/j.bcp.2018.12.001
Neuroinflammation	10.1007/s12031-014-0243-5
Glioma	10.1016/j.neuroscience.2014.08.043
Depression	10.1016/j.bbr.2019.112439
Hepatic steatosis	10.1002/mnfr.201600197
Osteoporosis	10.1002/iub.158
Mucositis	10.3390/BIOMEDICINES8060164
Antifungal	10.1023/A:1007178924408
Fragrance	https://doi.org/10.1016/j.fct.2008.06.030
skin creams, shampoos and lotions	https://www.naturemary.com/beta-caryophyllene-for-skin/

15.2.6 alpha-Terpineol

Table 15.6: Benefits of alpha-terpineol are shown in the table below

Benefit	*Reference*
neuropathic pain reduction	Gouveia, D. N., Guimarães, A. G., Oliveira, M. A., Rabelo, T. K., Pina, L. T., Santos, W. B., ... & Quintans-Junior, L. J. (2022). Nanoencapsulated alpha-terpineol attenuates neuropathic pain induced by chemotherapy through calcium channel modulation. Polymer Bulletin, 1-18.
Antispasmodic	Magalhães, P. J., Criddle, D. N., Tavares, R. A., Melo, E. M., Mota, T. L., & Leal-Cardoso, J. H. (1998). Intestinal myorelaxant and Antispasmodic effects of the essential oil of Croton nepetaefolius and its constituents cineole, methyl-eugenol and terpineol. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives, 12(3), 172-177.
Antimicrobial	Park, S. N., Lim, Y. K., Freire, M. O., Cho, E., Jin, D., & Kook, J. K. (2012). Antimicrobial effect of linalool and alpha-terpineol against periodontopathic and cariogenic bacteria. Anaerobe, 18(3), 369-372.
Antifungal	Prakash, B., Singh, P., Goni, R., Raina, A. K. P., & Dubey, N. K. (2015). Efficacy of Angelica archangelica essential oil, phenyl ethyl alcohol and alpha-terpineol against isolated molds from walnut and their Antiaflatoxigenic and Antioxidant activity. Journal of food science and technology, 52, 2220-2228.
Antibacterial	Dorman, H. D., & Deans, S. G. (2000). Antimicrobial agents from plants: Antibacterial activity of plant volatile oils. Journal of applied microbiology, 88(2), 308-316.

15.2.7 Guaiol

Table 15.7: Benefits of guaiol are shown in the table below

Benefit	*Reference*
Antibacterial	Choudhary, M. I., Batool, I., Atif, M., Hussain, S., & Atta-ur-Rahman, F. (2007). Microbial transformation of (-)-guaiol and antibacterial activity of its transformed products. Journal of natural products, 70(5), 849-852.
Antitumor	Yang, X., Yang, J., Gu, X., Tao, Y., Ji, H., Miao, X., ... & Zang, H. (2022). (-)-Guaiol triggers immunogenic cell death and inhibits tumor growth in non-small cell lung cancer. Molecular and Cellular Biochemistry, 1-10.
Anti-inflammatory	Souza, M. A., Guzatti, J. G., Martello, R. H., Schindler, M. S., Calisto, J. F., Morgan, L. V., ... & Dal Magro, J. (2020). Supercritical CO2 extraction of Aloysia gratissima leaves and evaluation of anti-inflammatory activity. The Journal of Supercritical Fluids, 159, 104753.

15.2.8 Cadinene

Table 15.8: Benefits of cadinene are shown in the table below

Benefit	*Reference*
Antifungal	Kundu, A., Saha, S., Walia, S., Shakil, N. A., Kumar, J., & Annapurna, K. (2013). Cadinene sesquiterpenes from Eupatorium adenophorum and their antifungal activity. Journal of Environmental Science and Health, Part B, 48(6), 516-522.
Anticancer	Hui, L. M., Zhao, G. D., & Zhao, J. J. (2015). δ-Cadinene inhibits the growth of ovarian cancer cells via caspase-dependent apoptosis and cell cycle arrest. International journal of clinical and experimental pathology, 8(6), 6046.
Antioxidant	Kundu, A., Saha, S., Walia, S., Ahluwalia, V., & Kaur, C. (2013). Antioxidant potential of essential oil and cadinene sesquiterpenes of Eupatorium adenophorum. Toxicological & Environmental Chemistry, 95(1), 127-137.
Insecticidal and antibacterial	Ouyang, C. B., Liu, X. M., Yan, D. D., Yuan, L. I., Wang, Q. X., & Cao, A. C. (2016). Immunotoxicity assessment of cadinene sesquiterpenes from Eupatorium adenophorum in mice. Journal of integrative agriculture, 15(10), 2319-2325.

15.2.9 Spathulenol

Table 15.9: Benefits of spathulenol are shown in the table below

Benefit	*Reference*
Antioxidant, anti-inflammatory, antiproliferative and antimycobacterial	do Nascimento, K. F., Moreira, F. M. F., Santos, J. A., Kassuya, C. A. L., Croda, J. H. R., Cardoso, C. A. L., ... & Formagio, A. S. N. (2018). Antioxidant, anti-inflammatory, antiproliferative and antimycobacterial activities of the essential oil of Psidium guineense Sw. and spathulenol. Journal of ethnopharmacology, 210, 351-358.
Anti-nociceptive	Dos Santos, E., Radai, J. A. S., do Nascimento, K. F., Formagio, A. S. N., de Matos Balsalobre, N., Ziff, E. B., ... & Kassuya, C. A. L. (2022). Contribution of spathulenol to the anti-nociceptive effects of Psidium guineense. Nutritional Neuroscience, 25(4), 812-822.
Insecticides	Benelli, G., Pavela, R., Drenaggi, E., Desneux, N., & Maggi, F. (2020). Phytol,(E)-nerolidol and spathulenol from Stevia rebaudiana leaf essential oil as effective and eco-friendly botanical insecticides against Metopolophium dirhodum. Industrial Crops and Products, 155, 112844.
Anticancer	Martins, A., Hajdú, Z., Vasas, A., Csupor-Löffler, B., Molnár, J., & Hohmann, J. (2010). Spathulenol inhibit the human ABCB1 efflux pump. Planta Medica, 76(12), P608.

15.2.10 Isoledene

Table 15.10: Benefits of isoledene are shown in the table below

Benefit	*Reference*
Anticancer	Johnson, T. O., Odoh, K. D., Nwonuma, C. O., Akinsanmi, A. O., & Adegboyega, A. E. (2020). Biochemical evaluation and molecular docking assessment of the anti-inflammatory potential of Phyllanthus nivosus leaf against ulcerative colitis. Heliyon, 6(5), e03893.
Anticancer	Asif, M., Shafaei, A., Jafari, S. F., Mohamed, S. K., Ezzat, M. O., Majid, A. S. A., ... & Majid, A. M. S. A. (2016). Isoledene from Mesua ferrea oleo-gum resin induces apoptosis in HCT 116 cells through ROS-mediated modulation of multiple proteins in the apoptotic pathways: a mechanistic study. Toxicology letters, 257, 84-96.

15.2.11 Isoledene

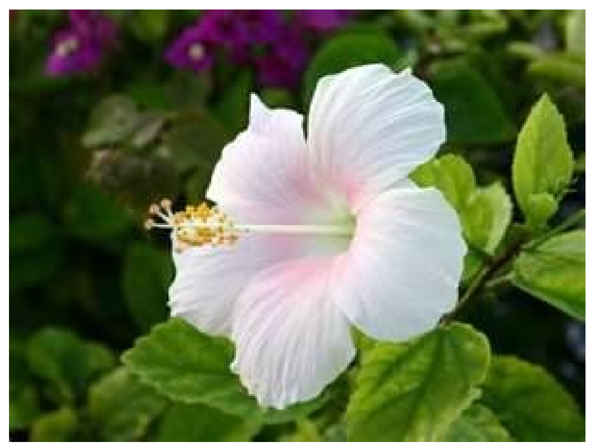
Table 15.11: Benefits of isoledene are shown in the table below

Benefit	*Reference*
Anticancer	Johnson, T. O., Odoh, K. D., Nwonuma, C. O., Akinsanmi, A. O., & Adegboyega, A. E. (2020). Biochemical evaluation and molecular docking assessment of the anti-inflammatory potential of Phyllanthus nivosus leaf against ulcerative colitis. Heliyon, 6(5), e03893.
Anticancer	Asif, M., Shafaei, A., Jafari, S. F., Mohamed, S. K., Ezzat, M. O., Majid, A. S. A., ... & Majid, A. M. S. A. (2016). Isoledene from Mesua ferrea oleo-gum resin induces apoptosis in HCT 116 cells through ROS-mediated modulation of multiple proteins in the apoptotic pathways: a mechanistic study. Toxicology letters, 257, 84-96.

Chapter 16

Hibiscus Leaves

16.1 General Description



Hibiscus is common through Asia, the Caribbean and North, South and Central America. The species that is common to the Bahamas is the Hibiscus rosa-sinensis which is sometimes referred to as Chinese hibiscus, China rose or Hawaiian hibiscus. The leaves contain many fatty materials, fatty alcohols, sugars, alkaloids, glucosides, resins and sterols. It is often used as teas to regulate menstruation and to stimulate blood circulation. Decoction of leaves, root and fruits were helpful in treatments of arthritis, boils and coughs. It is also known for its antifertility and contraceptive affects and should thus be avoided during pregnancy properties. It is often used to treat dandruff or used in general as a natural shampoo.
rientin (luteolin-8-C-glucoside)

16.2 Phytochemical Benefits

16.2.1 Nonanal*

Table 16.1: Benefits of nonanal are shown in the table below

Benefit	*Reference*
Antidiarrhoeal	Zavala-Sanchez, M. A., Pérez-Gutiérrez, S., P? rez-González, C., Sánchez-Saldivar, D., & Arias-García, L. (2002). Antidiarrhoeal activity of nonanal, an aldehyde isolated from Artemisia ludoviciana. Pharmaceutical biology, 40(4), 263-268.
Antidiarrhoeal	Gohari, A. R., Saeidnia, S., Malmir, M., Yazdanpanah, M., & Ajani, Y. (2011). Sterols and flavonoids of Lomatopodium staurophyllum. Journal of Medicinal Plants, 10(39), 43-48.
Anti-fungal	Zhang, J. H., Sun, H. L., Chen, S. Y., Zeng, L. I., & Wang, T. T. (2017). Anti-fungal activity, mechanism studies on alpha-Phellandrene and Nonanal against Penicillium cyclopium. Botanical studies, 58, 1-9.
Anti-fungal	Li, Q., Zhu, X., Xie, Y., & Liang, J. (2021). Antifungal properties and mechanisms of three volatile aldehydes (octanal, nonanal and decanal) on Aspergillus flavus. Grain & Oil Science and Technology, 4(3), 131-140.
Anti-fungal	Zhang, J., Zeng, L., Sun, H., Chen, S., Wang, T., & Ma, S. (2017). Use of Nonanal-wax as Postharvest Fungicide of Tomato against Botrytis cinereal. J. Food Nutr. Res, 5, 458-466.

16.2.2 Quercetin

Table 16.2: Benefits of quercetin are shown in the table below

Benefit	*Reference*
Antioxidant	Zhang, M., Swarts, S. G., Yin, L., Liu, C., Tian, Y., Cao, Y., ... & Okunieff, P. (2011). Antioxidant properties of quercetin. In Oxygen transport to tissue XXXII (pp. 283-289). Springer US.
Antioxidant	Xu, D., Hu, M. J., Wang, Y. Q., & Cui, Y. L. (2019). Antioxidant activities of quercetin and its complexes for medicinal application. Molecules, 24(6), 1123.
Antioxidant and Anti-inflammatory	Lesjak, M., Beara, I., Simin, N., Pintać, D., Majkić, T., Bekvalac, K., ... & Mimica-Dukić, N. (2018). Antioxidant and anti-inflammatory activities of quercetin and its derivatives. Journal of Functional Foods, 40, 68-75.
Anticancer	Ezzati, M., Yousefi, B., Velaei, K., & Safa, A. (2020). A review on anti-cancer properties of Quercetin in breast cancer. Life sciences, 248, 117463.
Anticancer	Shafabakhsh, R., & Asemi, Z. (2019). Quercetin: a natural compound for ovarian cancer treatment. Journal of ovarian research, 12, 1-9.
Cardioprotective	Bhat, I. U. H., & Bhat, R. (2021). Quercetin: a bioactive compound imparting cardiovascular and neuroprotective benefits: scope for exploring fresh produce, their wastes, and by-products. Biology, 10(7), 586.
Antioxidant and Anti-inflammatory	Davis, J. M., Carlstedt, C. J., Chen, S., Carmichael, M. D., & Murphy, E. A. (2010). The dietary flavonoid quercetin increases VO2max and endurance capacity. International journal of sport nutrition and exercise metabolism, 20(1), 56-62.

16.2.3 Orientin(Luteolin-8-C-Glucoside)

Table 16.3: Benefits of orientin (luteolin-8-C-glucoside) are shown in the table below

Benefit	*Reference*
Antioxidant	Praveena, R., Sadasivam, K., Deepha, V., & Sivakumar, R. (2014). Antioxidant potential of orientin: a combined experimental and DFT approach. Journal of Molecular Structure, 1061, 114-123.
Anti-inflammatory	Ku, S. K., Kwak, S., & Bae, J. S. (2014). Orientin inhibits high glucose-induced vascular inflammation in vitro and in vivo. Inflammation, 37, 2164-2173.
Anti-inflammatory	Lee, W., Ku, S. K., & Bae, J. S. (2014). Vascular barrier protective effects of orientin and isoorientin in LPS-induced inflammation in vitro and in vivo. Vascular Pharmacology, 62(1), 3-14.
Neuroprotective	Law, B. N. T., Ling, A. P. K., Koh, R. Y., Chye, S. M., & Wong, Y. P. (2014). Neuroprotective effects of orientin on hydrogen peroxide induced apoptosis in SH SY5Y cells. Molecular medicine reports, 9(3), 947-954.
Anticancer	An, F., Wang, S., Tian, Q., & Zhu, D. (2015). Effects of orientin and vitexin from Trollius chinensis on the growth and apoptosis of esophageal cancer EC-109 cells. Oncology letters, 10(4), 2627-2633.
Antinociceptive	Da Silva, R. Z., Yunes, R. A., de Souza, M. M., Monache, F. D., & Cechinel-Filho, V. (2010). Antinociceptive properties of conocarpan and orientin obtained from Piper solmsianum C. DC. var. solmsianum (Piperaceae). Journal of Natural Medicines, 64, 402-408.
Cognition enhancement	Zhong, Y., Zheng, Q. Y., Sun, C. Y., Zhang, Z., Han, K., & Jia, N. (2019). Orientin improves cognition by enhancing autophagosome clearance in an Alzheimer's mouse model. Journal of Molecular Neuroscience, 69, 246-253.
Anti-inflammatory and anti-oxidant	Xiao, Q., Cui, Y., Zhao, Y., Liu, L., Wang, H., & Yang, L. (2021). Orientin relieves lipopolysaccharide-induced acute lung injury in mice: The involvement of its anti-inflammatory and anti-oxidant properties. International Immunopharmacology, 90, 107189.

16.2.4 β-Sitosterol

Table 16.4: Benefits of β-sitosterol are shown in the table below

Benefit	*Reference*
Anti-fungal and anti-bacterial Kiprono	P. C., Kaberia, F., Keriko, J. M., & Karanja, J. N. (2000). The in vitro anti-fungal and anti-bacterial activities of β-sitosterol from Senecio lyratus (Asteraceae). Zeitschrift für Naturforschung C, 55(5-6), 485-488.
Anticancer	Choi, Y. H., Kong, K. R., Kim, Y., Jung, K. O., Kil, J. H., Rhee, S. H., & Park, K. Y. (2003). Induction of Bax and activation of caspases during β-sitosterol-mediated apoptosis in human colon cancer cells. International journal of oncology, 23(6), 1657-1662.
Anticancer	Awad, A. B., Roy, R., & Fink, C. S. (2003). β-sitosterol, a plant sterol, induces apoptosis and activates key caspases in MDA-MB-231 human breast cancer cells. Oncology reports, 10(2), 497-500.
Antibacterial	Suhartati, T., & Yandri, Y. (2021). Potential Antibacterial Activity of Bioactive ß-sitosterol from Root Bark of Rhizophora apiculata from Lampung Coastal. Jurnal Kimia Sains dan Aplikasi, 24(4), 114-119.
Hepatoprotective	Gumede, N. M., Lembede, B. W., Nkomozepi, P., Brooksbank, R. L., Erlwanger, K. H., & Chivandi, E. ß-Sitosterol mitigates the development of high-fructose diet-induced nonalcoholic fatty liver disease in growing male Sprague–Dawley rats.

16.2.5 Undecanoic Acid

Table 16.5: Benefits of undecanoic acid are shown in the table below

Benefit	*Reference*
Antifungal	Rossi, A., Martins, M. P., Bitencourt, T. A., Peres, N. T., Rocha, C. H., Rocha, F. M., ... & Martinez-Rossi, N. M. (2021). Reassessing the use of undecanoic acid as a therapeutic strategy for treating fungal infections. Mycopathologia, 186, 327-340.
Antimicrobial	Ammendola, S., Lembo, A., Battistoni, A., Tagliatesta, P., Ghisalberti, C., & Desideri, A. (2009). 10-Undecanhydroxamic acid, a hydroxamate derivative of the undecanoic acid, has strong antimicrobial activity through a mechanism that limits iron availability. FEMS microbiology letters, 294(1), 61-67.
Antimicrobial	Doležalová, M., Janiš, R., Svobodová, H., Kašpárková, V., Humpolíček, P., & Krejčí, J. (2010). Antimicrobial properties of 1-monoacylglycerols prepared from undecanoic (C11: 0) and undecenoic (C11: 1) acid. European journal of lipid science and technology, 112(10), 1106-1114.

16.2.6 Lauric Acid

Table 16.6: Benefits of lauric acid are shown in the table below

Benefit	*Reference*
Antimicrobial	Nakatsuji, T., Kao, M. C., Fang, J. Y., Zouboulis, C. C., Zhang, L., Gallo, R. L., & Huang, C. M. (2009). Antimicrobial property of lauric acid against Propionibacterium acnes: its therapeutic potential for inflammatory acne vulgaris. Journal of investigative dermatology, 129(10), 2480-2488.
Anticancer	Fauser, J. K., Matthews, G. M., Cummins, A. G., & Howarth, G. S. (2013). Induction of apoptosis by the medium-chain length fatty acid lauric acid in colon cancer cells due to induction of oxidative stress. Chemotherapy, 59(3), 214-224.
Anticancer	Lappano, R., Sebastiani, A., Cirillo, F., Rigiracciolo, D. C., Galli, G. R., Curcio, R., ... & Maggiolini, M. (2017). The lauric acid-activated signaling prompts apoptosis in cancer cells. Cell death discovery, 3(1), 1-9.
Antibacterial	Anzaku, A. A., Akyala, J. I., Juliet, A., & Obianuju, E. C. (2017). Antibacterial activity of lauric acid on some selected clinical isolates. Ann. Clin. Lab. Res, 5(2), 1-5.
Antiviral	Bartolotta, S., Garcí, C. C., Candurra, N. A., & Damonte, E. B. (2001). Effect of fatty acids on arenavirus replication: inhibition of virus production by lauric acid. Archives of virology, 146, 777-790.
Antiviral	Hornung, B., Amtmann, E., & Sauer, G. (1994). Lauric acid inhibits the maturation of vesicular stomatitis virus. Journal of General Virology, 75(2), 353-361.
Antimicrobial	Yang, D., Pornpattananangkul, D., Nakatsuji, T., Chan, M., Carson, D., Huang, C. M., & Zhang, L. (2009). The antimicrobial activity of liposomal lauric acids against Propionibacterium acnes. Biomaterials, 30(30), 6035-6040.

Chapter 17

Sapodilla Leaves

17.1 General Description

Sapodilla or as it is known scientifically, Manilkara zapota, is particularly popular in the Caribbean, Mexico, Central America and Asia, where it goes by several names including naseberry, sapote, chico and nispero. Because of its extremely sweet and malty flavour of its fruit is used in beverages such as juices and teas as well as desert sauces, syrup and jams. The sap was used for gum and the seed oil for hair care and facial products. The leaves, fruit and bark is valued for its numerous medicinal purposes and for its sedative, antidiabetic, antioxidant and anti-inflammation properties.

17.2 Sapodilla Leaves Phytochemical Benefits

17.2.1 Myricetin

Table 17.1: Benefits of myricetin are shown in the table below

Benefit	*Reference*
Anti-oxidant	Yao, Y., Lin, G., Xie, Y., Ma, P., Li, G., Meng, Q., & Wu, T. (2014). Preformulation studies of myricetin: a natural antioxidant flavonoid. Die Pharmazie-An International Journal of Pharmaceutical Sciences, 69(1), 19-26.
Anti-oxidant	Pekkarinen, S. S., Heinonen, I. M., & Hopia, A. I. (1999). Flavonoids quercetin, myricetin, kaempferol and (+)-catechin as antioxidants in methyl linoleate. Journal of the Science of Food and Agriculture, 79(4), 499-506.
Anti-inflammatory	Wang, S. J., Tong, Y., Lu, S., Yang, R., Liao, X., Xu, Y. F., & Li, X. (2010). Anti-inflammatory activity of myricetin isolated from Myrica rubra Sieb. et Zucc. leaves. Planta medica, 76(14), 1492-1496.
Anticancer	Sun, F., Zheng, X. Y., Ye, J., Wu, T. T., Wang, J. L., & Chen, W. (2012). Potential anticancer activity of myricetin in human T24 bladder cancer cells both in vitro and in vivo. Nutrition and cancer, 64(4), 599-606.
Anticancer	Ha, T. K., Jung, I., Kim, M. E., Bae, S. K., & Lee, J. S. (2017). Anti-cancer activity of myricetin against human papillary thyroid cancer cells involves mitochondrial dysfunction–mediated apoptosis. Biomedicine & Pharmacotherapy, 91, 378-384
Cardiovascular Effects	Zhang, N., Feng, H., Liao, H. H., Chen, S., Yang, Z., Deng, W., & Tang, Q. Z. (2018). Myricetin attenuated LPS induced cardiac injury in vivo and in vitro. Phytotherapy Research, 32(3), 459-470.
Comprehensive Review	Imran, M., Saeed, F., Hussain, G., Imran, A., Mehmood, Z., Gondal, T. A., ... & Islam, S. (2021). Myricetin: A comprehensive review on its biological potentials. Food Science & Nutrition, 9(10), 5854-5868.

17.2.2 Nonanal

Table 17.2: Benefits of nonanal are shown in the table below

Benefit	*Reference*
Antidiarrhoeal	Zavala-Sanchez, M. A., Pérez-Gutiérrez, S., P? rez-González, C., Sánchez-Saldivar, D., & Arias-García, L. (2002). Antidiarrhoeal activity of nonanal, an aldehyde isolated from Artemisia ludoviciana. Pharmaceutical biology, 40(4), 263-268.
Antidiarrhoeal	Gohari, A. R., Saeidnia, S., Malmir, M., Yazdanpanah, M., & Ajani, Y. (2011). Sterols and flavonoids of Lomatopodium staurophyllum. Journal of Medicinal Plants, 10(39), 43-48.
Anti-fungal	Zhang, J. H., Sun, H. L., Chen, S. Y., Zeng, L. I., & Wang, T. T. (2017). Anti-fungal activity, mechanism studies on alpha-Phellandrene and Nonanal against Penicillium cyclopium. Botanical studies, 58, 1-9.
Anti-fungal	Li, Q., Zhu, X., Xie, Y., & Liang, J. (2021). Antifungal properties and mechanisms of three volatile aldehydes (octanal, nonanal and decanal) on Aspergillus flavus. Grain & Oil Science and Technology, 4(3), 131-140.
Anti-fungal	Zhang, J., Zeng, L., Sun, H., Chen, S., Wang, T., & Ma, S. (2017). Use of Nonanal-wax as Postharvest Fungicide of Tomato against Botrytis cinereal. J. Food Nutr. Res, 5, 458-466.

17.2.3 Vanillic Acid

Table 17.3: Benefits of vanillic acid are shown in the table below

Benefit	*Reference*
Antioxidant	Tai, A., Sawano, T., & Ito, H. (2012). Antioxidative properties of vanillic acid esters in multiple antioxidant assays. Bioscience, biotechnology, and biochemistry, 76(2), 314-318.
Heptaprotective	Itoh, A., Isoda, K., Kondoh, M., Kawase, M., Watari, A., Kobayashi, M., ... & Yagi, K. (2010). Hepatoprotective effect of syringic acid and vanillic acid on CCl4-induced liver injury. Biological and Pharmaceutical Bulletin, 33(6), 983-987.
Anti-inflammatory	Kim, M. C., Kim, S. J., Kim, D. S., Jeon, Y. D., Park, S. J., Lee, H. S., ... & Hong, S. H. (2011). Vanillic acid inhibits inflammatory mediators by suppressing NF-κB in lipopolysaccharide-stimulated mouse peritoneal macrophages. Immunopharmacology and immunotoxicology, 33(3), 525-532.
Anti-inflammatory	Ziadlou, R., Barbero, A., Martin, I., Wang, X., Qin, L., Alini, M., & Grad, S. (2020). Anti-inflammatory and chondroprotective effects of vanillic acid and epimedin C in human osteoarthritic chondrocytes. Biomolecules, 10(6), 932.
Neurodegeneration	Singh, J. C. H., Kakalij, R. M., Kshirsagar, R. P., Kumar, B. H., Komakula, S. S. B., & Diwan, P. V. (2015). Cognitive effects of vanillic acid against streptozotocin-induced neurodegeneration in mice. Pharmaceutical biology, 53(5), 630-636.
Antihypertensive and antioxidant	Kumar, S., Prahalathan, P., & Raja, B. (2011). Antihypertensive and antioxidant potential of vanillic acid, a phenolic compound in L-NAME-induced hypertensive rats: a dose-dependence study. Redox Report, 16(5), 208-215.
Antioxidant and antimicrobial	Mourtzinos, I., Konteles, S., Kalogeropoulos, N., & Karathanos, V. T. (2009). Thermal oxidation of vanillin affects its antioxidant and antimicrobial properties. Food Chemistry, 114(3), 791-797.
Anticancer	Gong, J., Zhou, S., & Yang, S. (2019). Vanillic acid suppresses HIF-1α expression via inhibition of mTOR/p70S6K/4E-BP1 and Raf/MEK/ERK pathways in human colon cancer HCT116 cells. International journal of molecular sciences, 20(3), 465.
Anticancer	Singh, B., Kumar, A., Singh, H., Kaur, S., Arora, S., & Singh, B. (2022). Protective effect of vanillic acid against diabetes and diabetic nephropathy by attenuating oxidative stress and upregulation of NF-κB, TNF-α and COX-2 proteins in rats. Phytotherapy Research, 36(3), 1338-1352.

17.2.4 Caffeic Acid

Table 17.4: Benefits of caffeic acid are shown in the table below

Benefit	*Reference*
Antioxidant	Gülçin, İ. (2006). Antioxidant activity of caffeic acid (3, 4-dihydroxycinnamic acid). Toxicology, 217(2-3), 213-220.
Antioxidant	Sato, Y., Itagaki, S., Kurokawa, T., Ogura, J., Kobayashi, M., Hirano, T., ... & Iseki, K. (2011). In vitro and in vivo antioxidant properties of chlorogenic acid and caffeic acid. International journal of pharmaceutics, 403(1-2), 136-138.
Antimicrobial and cosmetics	Magnani, C., Isaac, V. L. B., Correa, M. A., & Salgado, H. R. N. (2014). Caffeic acid: a review of its potential use in medications and cosmetics. Analytical Methods, 6(10), 3203-3210.
Anti-inflammatory	Da Cunha, F. M., Duma, D., Assreuy, J., Buzzi, F. C., Niero, R., Campos, M. M., & Calixto, J. B. (2004). Caffeic acid derivatives: in vitro and in vivo anti-inflammatory properties. Free radical research, 38(11), 1241-1253.
Antiviral	Wang, G. F., Shi, L. P., Ren, Y. D., Liu, Q. F., Liu, H. F., Zhang, R. J., ... & Zuo, J. P. (2009). Anti-hepatitis B virus activity of chlorogenic acid, quinic acid and caffeic acid in vivo and in vitro. Antiviral research, 83(2), 186-190.
Anticorrosive	de Souza, F. S., & Spinelli, A. (2009). Caffeic acid as a green corrosion inhibitor for mild steel. Corrosion science, 51(3), 642-649.
Antidiabetic	Hsu, F. L., Chen, Y. C., & Cheng, J. T. (2000). Caffeic acid as active principle from the fruit of xanthium-strumarium to lower plasma glucose in diabetic rats. Planta medica, 66(03), 228-230.
Antimicrobial	Khan, F., Bamunuarachchi, N. I., Tabassum, N., & Kim, Y. M. (2021). Caffeic acid and its derivatives: antimicrobial drugs toward microbial pathogens. Journal of Agricultural and Food Chemistry, 69(10), 2979-3004.
Anticancer	Alam, M., Ahmed, S., Elasbali, A. M., Adnan, M., Alam, S., Hassan, M. I., & Pasupuleti, V. R. (2022). Therapeutic implications of caffeic acid in cancer and neurological diseases. Frontiers in Oncology, 12.

17.2.5 Ampelopsin

Table 17.5: Benefits of ampelopsin are shown in the table below

Benefit	*Reference*
Anti-inflammatory	Qi, S., Xin, Y., Guo, Y., Diao, Y., Kou, X., Luo, L., & Yin, Z. (2012). Ampelopsin reduces endotoxic inflammation via repressing ROS-mediated activation of PI3K/Akt/NF-ϰB signaling pathways. International immunopharmacology, 12(1), 278-287.
Anticancer	Kou, X., Fan, J., & Chen, N. (2017). Potential molecular targets of ampelopsin in prevention and treatment of cancers. Anti-Cancer Agents in Medicinal Chemistry (Formerly Current Medicinal Chemistry-Anti-Cancer Agents), 17(12), 1610-1616.
Anticancer	Tuli, H. S., Sak, K., Garg, V. K., Kumar, A., Adhikary, S., Kaur, G., ... & Singh, T. (2022). Ampelopsin targets in cellular processes of cancer: Recent trends and advances. Toxicology Reports.
Anticancer	Ni, F., Gong, Y., Li, L., Abdolmaleky, H. M., & Zhou, J. R. (2012). Flavonoid ampelopsin inhibits the growth and metastasis of prostate cancer in vitro and in mice. PloS one, 7(6), e38802.
Hepatoprotective	Murakami, T., Miyakoshi, M., Araho, D., Mizutani, K., Kambara, T., Ikeda, T., ... & Igarashi, K. (2004). Hepatoprotective activity of tocha, the stems and leaves of Ampelopsis grossedentata, and ampelopsin. Biofactors, 21(1-4), 175-178.
Antioxidant	Hou, X., Zhang, J., Ahmad, H., Zhang, H., Xu, Z., & Wang, T. (2014). Evaluation of antioxidant activities of ampelopsin and its protective effect in lipopolysaccharide-induced oxidative stress piglets. PloS one, 9(9), e108314.
Antifungal	Matsumoto, T., & Tahara, S. (2001). Ampelopsin, a major antifungal constituent from Salix sachalinensis, and its methyl ethers. Journal of the Agricultural Chemical Society of Japan (Japan).
Anti-HIV	Liu, D. Y., Ye, J. T., Yang, W. H., Yan, J., Zeng, C. H., & Zeng, S. A. (2004). Ampelopsin, a small molecule inhibitor of HIV-1 infection targeting HIV entry. Biomedical and Environmental Sciences , 17(2), 153-164.
Antioxidant	Liang, X., Zhang, T., Shi, L., Kang, C., Wan, J., Zhou, Y., ... & Mi, M. (2015). Ampelopsin protects endothelial cells from hyperglycemia-induced oxidative damage by inducing autophagy via the AMPK signaling pathway. Biofactors, 41(6), 463-475.
Antidiabetic	Zhou, Y., Wu, Y., Qin, Y., Liu, L., Wan, J., Zou, L., ... & Mi, M. (2016). Ampelopsin improves insulin resistance by activating PPARγ and subsequently upregulating FGF21-AMPK signaling pathway. PLoS One, 11(7), e0159191.

17.2.6 Epicatechin

Table 17.6: Benefits of epicatechin are shown in the table below

Benefit	*Reference*
Antidiabetic and anticancer	Abdulkhaleq, L. A., Assi, M. A., Noor, M. H. M., Abdullah, R., Saad, M. Z., & Taufiq-Yap, Y. H. (2017). Therapeutic uses of epicatechin in diabetes and cancer. Veterinary world, 10(8), 869.
Antioxidant and anticancer	Qu, Z., Liu, A., Li, P., Liu, C., Xiao, W., Huang, J., ... & Zhang, S. (2021). Advances in physiological functions and mechanisms of (-)-epicatechin. Critical reviews in food science and nutrition, 61(2), 211-233.
Antioxidant	Yilmaz, Y., & Toledo, R. T. (2004). Major flavonoids in grape seeds and skins: antioxidant capacity of catechin, epicatechin, and gallic acid. Journal of agricultural and food chemistry, 52(2), 255-260.
Cardiovascular and neuropsychological health	Bernatova, I. (2018). Biological activities of (-) -epicatechin and (-)-epicatechin-containing foods: Focus on cardiovascular and neuropsychological health. Biotechnology Advances, 36(3), 666-681.
Cardiovascular health	Schroeter, H., Heiss, C., Balzer, J., Kleinbongard, P., Keen, C. L., Hollenberg, N. K., ... & Kelm, M. (2006). (−)-Epicatechin mediates beneficial effects of flavanol-rich cocoa on vascular function in humans. Proceedings of the National Academy of Sciences, 103(4), 1024-1029.
Antidiabetic	Hii, C. S., & Howell, S. L. (1984). Effects of epicatechin on rat islets of Langerhans. Diabetes, 33(3), 291-296.

17.2.7 Esculetin

Table 17.7: Benefits of esculetin are shown in the table below

Benefit	*Reference*
Anti-inflammatory	Duan, H., Zhang, Y., & Fan, K. (2007). Studies on anti-inflammatory mechanism of esculetin. Chinese Journal of Veterinary Medicine, 43(9), 45.
Anti-inflammatory	Kim, Y., Park, Y., Namkoong, S., & Lee, J. (2014). Esculetin inhibits the inflammatory response by inducing heme oxygenase-1 in cocultured macrophages and adipocytes. Food & function, 5(9), 2371-2377.
Anticoagulant	Dai, R., Zheng, Q. L., Xu, Q. S., & Zhu, W. (2009). Inhibitory effects of esculetin on proliferation of rat vascular smooth muscle cells in vitro and the underlying mechanism. Acta. Med. Univ. Sci. Technol. Huazhong, 38, 239-242.
Liver protective	Gilani, A. H., Janbaz, K. H., & Shah, B. H. (1998). Esculetin prevents liver damage induced by paracetamol and CCL4. Pharmacological Research, 37(1), 31-35.
Antidiabetic	Prabakaran, D., & Ashokkumar, N. (2013). Protective effect of esculetin on hyperglycemia-mediated oxidative damage in the hepatic and renal tissues of experimental diabetic rats. Biochimie, 95(2), 366-373.
Antidiabetic	Kushwaha, K., & Gupta, J. (2019). Esculetin and its similar compounds: Implications in binding Sirt1 and treating diabetic nephropathy. Think India Journal, 22(37), 912-930.
Antibacterial	Duncan, S. H., Leitch, E. C. M., Stanley, K. N., Richardson, A. J., Laven, R. A., Flint, H. J., & Stewart, C. S. (2004). Effects of esculin and esculetin on the survival of Escherichia coli O157 in human faecal slurries, continuous-flow simulations of the rumen and colon and in calves. British journal of nutrition, 91(5), 749-755.
Antibacterial	Yang, L., Ding, W., Xu, Y., Wu, D., Li, S., Chen, J., & Guo, B. (2016). New insights into the antibacterial activity of hydroxycoumarins against Ralstonia solanacearum. Molecules, 21(4), 468.
Antitumor	Jeon, Y. J., Jang, J. Y., Shim, J. H., Myung, P. K., & Chae, J. I. (2015). Esculetin, a coumarin derivative, exhibits anti-proliferative and pro-apoptotic activity in G361 human malignant melanoma. Journal of cancer prevention, 20(2), 106.
Anticancer	Wang, X., Yang, C., Zhang, Q., Wang, C., Zhou, X., Zhang, X., & Liu, S. (2019). In vitro anticancer effects of esculetin against human leukemia cell lines involves apoptotic cell death, autophagy, G0/G1 cell cycle arrest and modulation of Raf/MEK/ERK signaling pathway. J. BUON, 24(4), 1686-1691.

Chapter 18

Yellow Papaya Leaves

18.1 General Description

Yellow papaya or paw paw as it is often called is scientifically known as Carica papaya. It is found throughout Mexico, Central America and the Caribbean. The leaf is often used to make team while the pulp is used for making juices. The unripe fruit is known to have abortifacient effect which seems to decreases with the fruit's ripeness. The leaves of papaya plant contain many health-promoting phytochemicals such as tocopherol, phenolic acids, cystatin, chymopapain, glucosinolates, and vitamin C. The leaves are known for antidiabetic, antioxidant and anti-inflammatory properties.

18.2 Yellow Papaya Leaves Phytochemical Benefits

18.2.1 Quercetin

Table 18.1: Benefits of quercetin are shown in the table below

Benefit	*Reference*
Antioxidant	Zhang, M., Swarts, S. G., Yin, L., Liu, C., Tian, Y., Cao, Y., ... & Okunieff, P. (2011). Antioxidant properties of quercetin. In Oxygen transport to tissue XXXII (pp. 283-289). Springer US.
Antioxidant	Xu, D., Hu, M. J., Wang, Y. Q., & Cui, Y. L. (2019). Antioxidant activities of quercetin and its complexes for medicinal application. Molecules, 24(6), 1123.
Antioxidant and Anti-inflammatory	Lesjak, M., Beara, I., Simin, N., Pintać, D., Majkić, T., Bekvalac, K., ... & Mimica-Dukić, N. (2018). Antioxidant and anti-inflammatory activities of quercetin and its derivatives. Journal of Functional Foods, 40, 68-75.
Anticancer	Ezzati, M., Yousefi, B., Velaei, K., & Safa, A. (2020). A review on anti-cancer properties of Quercetin in breast cancer. Life sciences, 248, 117463.
Anticancer	Shafabakhsh, R., & Asemi, Z. (2019). Quercetin: a natural compound for ovarian cancer treatment. Journal of ovarian research, 12, 1-9.
Cardioprotective	Bhat, I. U. H., & Bhat, R. (2021). Quercetin: a bioactive compound imparting cardiovascular and neuroprotective benefits: scope for exploring fresh produce, their wastes, and by-products. Biology, 10(7), 586.
Antioxidant and Anti-inflammatory	Davis, J. M., Carlstedt, C. J., Chen, S., Carmichael, M. D., & Murphy, E. A. (2010). The dietary flavonoid quercetin increases VO2max and endurance capacity. International journal of sport nutrition and exercise metabolism, 20(1), 56-62.

18.2.2 Nonanal*

Table 18.2: Benefits of nonanal are shown in the table below

Benefit	*Reference*
Antidiarrhoeal	Zavala-Sanchez, M. A., Pérez-Gutiérrez, S., P? rez-González, C., Sánchez-Saldivar, D., & Arias-García, L. (2002). Antidiarrhoeal activity of nonanal, an aldehyde isolated from Artemisia ludoviciana. Pharmaceutical biology, 40(4), 263-268.
Antidiarrhoeal	Gohari, A. R., Saeidnia, S., Malmir, M., Yazdanpanah, M., & Ajani, Y. (2011). Sterols and flavonoids of Lomatopodium staurophyllum. Journal of Medicinal Plants, 10(39), 43-48.
Anti-fungal	Zhang, J. H., Sun, H. L., Chen, S. Y., Zeng, L. I., & Wang, T. T. (2017). Anti-fungal activity, mechanism studies on alpha-Phellandrene and Nonanal against Penicillium cyclopium. Botanical studies, 58, 1-9.
Anti-fungal	Li, Q., Zhu, X., Xie, Y., & Liang, J. (2021). Antifungal properties and mechanisms of three volatile aldehydes (octanal, nonanal and decanal) on Aspergillus flavus. Grain & Oil Science and Technology, 4(3), 131-140.
Anti-fungal	Zhang, J., Zeng, L., Sun, H., Chen, S., Wang, T., & Ma, S. (2017). Use of Nonanal-wax as Postharvest Fungicide of Tomato against Botrytis cinereal. J. Food Nutr. Res, 5, 458-466.

18.2.3 Protocatechuic Acid

Table 18.3: Benefits of protocatechuic acid are shown in the table below

Benefit	*Reference*
A Anticancer	Tanaka, T., Kojima, T., Kawamori, T., Yoshimi, N., & Mori, H. (1993). Chemoprevention of diethylnitrosamine-induced hepatocarcinogenesis by a simple phenolic acid protocatechuic acid in rats. Cancer Research, 53(12), 2775-2779.
Anticoagulatory, anti-inflammatory, and antioxidant	Lin, C. Y., Huang, C. S., Huang, C. Y., & Yin, M. C. (2009). Anticoagulatory, antiinflammatory, and antioxidative effects of protocatechuic acid in diabetic mice. Journal of agricultural and food chemistry, 57(15), 6661-6667.
Antioxidant	Zhang, S., Gai, Z., Gui, T., Chen, J., Chen, Q., & Li, Y. (2021). Antioxidant effects of protocatechuic acid and protocatechuic aldehyde: old wine in a new bottle. Evidence-Based Complementary and Alternative Medicine, 2021.
Anticancer	Tanaka, T., Tanaka, T., & Tanaka, M. (2011). Potential cancer chemopreventive activity of protocatechuic acid. Journal of Experimental & Clinical Medicine, 3(1), 27-33.
of protocatechuic acid in diabetic mice. Journal of agricultural and food chemistry, 57(15), 6661-6667.	
Antibacterial	Liu, K. S., Tsao, S. M., & Yin, M. C. (2005). In vitro antibacterial activity of roselle calyx and protocatechuic acid. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives, 19(11), 942-945.
Antibacterial	Stojković, D. S., Živković, J., Soković, M., Glamočlija, J., Ferreira, I. C., Janković, T., & Maksimović, Z. (2013). Antibacterial activity of Veronica montana L. extract and of protocatechuic acid incorporated in a food system. Food and Chemical Toxicology, 55, 209-213.
Antitumor	Tseng, T. H., Hsu, J. D., Lo, M. H., Chu, C. Y., Chou, F. P., Huang, C. L., & Wang, C. J. (1998). Inhibitory effect of Hibiscus protocatechuic acid on tumor promotion in mouse skin. Cancer letters, 126(2), 199-207.
Antioxidant and antidiabetic	Adefegha, S. A., Oboh, G., Ejakpovi, I. I., & Oyeleye, S. I. (2015). Antioxidant and antidiabetic effects of gallic and protocatechuic acids: a structure–function perspective. Comparative clinical pathology, 24, 1579-1585.
Comprehensive Review	Kakkar, S., & Bais, S. (2014). A review on protocatechuic acid and its pharmacological potential. International Scholarly Research Notices, 2014.

18.2.4 Coumarins

Table 18.4: Benefits of coumarins are shown in the table below

Benefit	*Reference*
Anticancer	Thakur, A., Singla, R., & Jaitak, V. (2015). Coumarins as anticancer agents: A review on synthetic strategies, mechanism of action and SAR studies. European journal of medicinal chemistry, 101, 476-495.
Antioxidant	Kostova, I., Bhatia, S., Grigorov, P., Balkansky, S., S Parmar, V., K Prasad, A., & Saso, L. (2011). Coumarins as antioxidants. Current medicinal chemistry, 18(25), 3929-3951.
Antibacterial	Souza, S. M. D., Monache, F. D., & Smânia Jr, A. (2005). Antibacterial activity of coumarins. Zeitschrift fuer Naturforschung C, 60(9-10), 693-700.
Antibacterial	Joao Matos, M., Vazquez-Rodriguez, S., Santana, L., Uriarte, E., Fuentes-Edfuf, C., Santos, Y., & Munoz-Crego, A. (2012). Looking for new targets: simple coumarins as antibacterial agents. Medicinal chemistry, 8(6), 1140-1145.
Antifungal	Prusty, J. S., & Kumar, A. (2020). Coumarins: antifungal effectiveness and future therapeutic scope. Molecular Diversity, 24, 1367-1383.
Antiviral	Hassan, M. Z., Osman, H., Ali, M. A., & Ahsan, M. J. (2016). Therapeutic potential of coumarins as antiviral agents. European journal of medicinal chemistry, 123, 236-255.
Anticoagulant	Akoudad, S., Darweesh, S. K., Leening, M. J., Koudstaal, P. J., Hofman, A., van der Lugt, A., ... & Vernooij, M. W. (2014). Use of coumarin anticoagulants and cerebral microbleeds in the general population. Stroke, 45(11), 3436-3439.

18.2.5 Caffeic Acid

Table 18.5: Benefits of caffeic acid are shown in the table below

Benefit	*Reference*
Antioxidant	Gülçin, İ. (2006). Antioxidant activity of caffeic acid (3, 4-dihydroxycinnamic acid). Toxicology, 217(2-3), 213-220.
Antioxidant	Sato, Y., Itagaki, S., Kurokawa, T., Ogura, J., Kobayashi, M., Hirano, T., ... & Iseki, K. (2011). In vitro and in vivo antioxidant properties of chlorogenic acid and caffeic acid. International journal of pharmaceutics, 403(1-2), 136-138.
Antimicrobial and cosmetics	Magnani, C., Isaac, V. L. B., Correa, M. A., & Salgado, H. R. N. (2014). Caffeic acid: a review of its potential use in medications and cosmetics. Analytical Methods, 6(10), 3203-3210.
Anti-inflammatory	Da Cunha, F. M., Duma, D., Assreuy, J., Buzzi, F. C., Niero, R., Campos, M. M., & Calixto, J. B. (2004). Caffeic acid derivatives: in vitro and in vivo anti-inflammatory properties. Free radical research, 38(11), 1241-1253.
Antiviral	Wang, G. F., Shi, L. P., Ren, Y. D., Liu, Q. F., Liu, H. F., Zhang, R. J., ... & Zuo, J. P. (2009). Anti-hepatitis B virus activity of chlorogenic acid, quinic acid and caffeic acid in vivo and in vitro. Antiviral research, 83(2), 186-190.
Anticorrosive	de Souza, F. S., & Spinelli, A. (2009). Caffeic acid as a green corrosion inhibitor for mild steel. Corrosion science, 51(3), 642-649.
Antidiabetic	Hsu, F. L., Chen, Y. C., & Cheng, J. T. (2000). Caffeic acid as active principle from the fruit of xanthium-strumarium to lower plasma glucose in diabetic rats. Planta medica, 66(03), 228-230.
Antimicrobial	Khan, F., Bamunuarachchi, N. I., Tabassum, N., & Kim, Y. M. (2021). Caffeic acid and its derivatives: antimicrobial drugs toward microbial pathogens. Journal of Agricultural and Food Chemistry, 69(10), 2979-3004.
Anticancer	Alam, M., Ahmed, S., Elasbali, A. M., Adnan, M., Alam, S., Hassan, M. I., & Pasupuleti, V. R. (2022). Therapeutic implications of caffeic acid in cancer and neurological diseases. Frontiers in Oncology, 12.

18.2.6 Carpaine

Table 18.6: Benefits of carpaine are shown in the table below

Benefit	*Reference*
Antioxidant	Yap, J. Y., Hii, C. L., Ong, S. P., Lim, K. H., Abas, F., & Pin, K. Y. (2021). Quantification of Carpaine and antioxidant properties of extracts from Carica Papaya plant leaves and stalks. Journal of Bioresources and Bioproducts, 6(4), 350-358.
Antimalaria	Teng, W. C., Chan, W., Suwanarusk, R., Ong, A., Ho, H. K., Russell, B., ... & Koh, H. L. (2019). In vitro antimalarial evaluations and cytotoxicity investigations of Carica papaya leaves and carpaine. Natural Product Communications, 14(1), 1934578X1901400110.
Cardioprotective	Sudi, S., Chin, Y. Z., Wasli, N. S., Fong, S. Y., Shimmi, S. C., How, S. E., & Sunggip, C. (2022). Carpaine Promotes Proliferation and Repair of H9c2 Cardiomyocytes after Oxidative Insults. Pharmaceuticals, 15(2), 230.
Antiviral	Alagarasu, K., Punekar, M., Patil, P., Kasabe, B., Kakade, M., Davuluri, K. S., ... & Parashar, D. (2023). Effect of carpaine, a major alkaloid from Carica papaya leaves, on dengue virus-2 infection and replication-an in-vitro and in-silico study. Phytotherapy Research.
Antithrombocytopenic	Zunjar, V., Dash, R. P., Jivrajani, M., Trivedi, B., & Nivsarkar, M. (2016). Antithrombocytopenic activity of carpaine and alkaloidal extract of Carica papaya Linn. leaves in busulfan induced thrombocytopenic Wistar rats. Journal of ethnopharmacology, 181, 20-25.

18.2.7 p-Coumaric acid

Table 18.7: Benefits of coumaric acid are shown in the table below

Benefit	*Reference*
Antimelanogenic	Boo, Y. C. (2019). p-Coumaric acid as an active ingredient in cosmetics: A review focusing on its antimelanogenic effects. Antioxidants, 8(8), 275.
Antioxidant and antimicrobial	Boz, H. (2015). p-Coumaric acid in cereals: presence, antioxidant and antimicrobial effects. International Journal of Food Science & Technology, 50(11), 2323-2328.
Antioxidant	Stražišar, M., Andrenšek, S., & Šmidovnik, A. (2008). Effect of β-cyclodextrin on antioxidant activity of coumaric acids. Food Chemistry, 110(3), 636-642.
Antioxidant and antimicrobial	Stojković, D., Petrović, J., Soković, M., Glamočlija, J., Kukić-Marković, J., & Petrović, S. (2013). In situ antioxidant and antimicrobial activities of naturally occurring caffeic acid, p-coumaric acid and rutin, using food systems. Journal of the Science of Food and Agriculture, 93(13), 3205-3208.
Antioxidant	Godarzi, S. M., Gorji, A. V., Gholizadeh, B., Mard, S. A., & Mansouri, E. (2020). Antioxidant effect of p-coumaric acid on interleukin 1-beta and tumor necrosis factor-alpha in rats with renal ischemic reperfusion. Nefrologia, 40(3), 311-319.
Antioxidant and antibacterial	Yu, C., Liu, X., Pei, J., & Wang, Y. (2020). Grafting of laccase-catalysed oxidation of butyl paraben and p-coumaric acid onto chitosan to improve its antioxidant and antibacterial activities. Reactive and Functional Polymers, 149, 104511.
Antioxidant, anti-inflammatory, antimicrobial, and antidiabetic	Venkatesan, A., Antony Samy, J. V. R., Balakrishnan, K., Natesan, V., & Kim, S. J. (2022). In vitro antioxidant, anti-inflammatory, antimicrobial, and antidiabetic activities of synthesized chitosan-loaded p-Coumaric acid nanoparticles. Current Pharmaceutical Biotechnology.

18.2.8 Chlorogenic Acid

Table 18.8: Benefits of chlorogenic acid are shown in the table below

Benefit	*Reference*
Antioxidant	Sato, Y., Itagaki, S., Kurokawa, T., Ogura, J., Kobayashi, M., Hirano, T., ... & Iseki, K. (2011). In vitro and in vivo antioxidant properties of chlorogenic acid and caffeic acid. International journal of pharmaceutics, 403(1-2), 136-138.
Antioxidant	Niggeweg, R., Michael, A. J., & Martin, C. (2004). Engineering plants with increased levels of the antioxidant chlorogenic acid. Nature biotechnology, 22(6), 746-754.
Antioxidant	Tošović, J., Marković, S., Marković, J. M. D., Mojović, M., & Milenković, D. (2017). Antioxidative mechanisms in chlorogenic acid. Food chemistry, 237, 390-398.
Antibacterial	Lou, Z., Wang, H., Zhu, S., Ma, C., & Wang, Z. (2011). Antibacterial activity and mechanism of action of chlorogenic acid. Journal of food science, 76(6), M398-M403.
Antihypertensive	Zhao, Y., Wang, J., Ballevre, O., Luo, H., & Zhang, W. (2012). Antihypertensive effects and mechanisms of chlorogenic acids. Hypertension Research, 35(4), 370-374.
Cardioprotective	Meng, S., Cao, J., Feng, Q., Peng, J., & Hu, Y. (2013). Roles of chlorogenic acid on regulating glucose and lipids metabolism: a review. Evidence-based complementary and alternative medicine: eCAM, 2013.
Antiviral	Wang, G. F., Shi, L. P., Ren, Y. D., Liu, Q. F., Liu, H. F., Zhang, R. J., ... & Zuo, J. P. (2009). Anti-hepatitis B virus activity of chlorogenic acid, quinic acid and caffeic acid in vivo and in vitro. Antiviral research, 83(2), 186-190.
Neuroprotective	Heitman, E., & Ingram, D. K. (2017). Cognitive and neuroprotective effects of chlorogenic acid. Nutritional Neuroscience, 20(1), 32-39.
Comprehensive review	Tajik, N., Tajik, M., Mack, I., & Enck, P. (2017). The potential effects of chlorogenic acid, the main phenolic components in coffee, on health: a comprehensive review of the literature. European journal of nutrition, 56, 2215-2244.

Chapter 19

Aloe Vera

19.1 General Description

Aloe vera is commonly used in beverages such as teas, smoothies and juices because of its reputation as being beneficial for health. It is also has many external uses, for example, as a topical dressing for skin conditions such as burns, wounds, frostbite, rashes, psoriasis, cold sores or dry skin. It also used for hair care and lotion products, as a laxative and as a [preservative on produce. Therapeutic benefits include anti-inflammatory and antidiabetic, antioxidant properties. Several of the phytochemical compounds found in Aloe have also been shown to have anti-cancer and chemopreventive effects in preclinical and laboratory environments.

19.2 Phytochemical Benefits

19.2.1 Nonanal*

Table 19.1: Benefits of nonanal are shown in the table below

Benefit	*Reference*
Antidiarrhoeal	Zavala-Sanchez, M. A., Pérez-Gutiérrez, S., P? rez-González, C., Sánchez-Saldivar, D., & Arias-García, L. (2002). Antidiarrhoeal activity of nonanal, an aldehyde isolated from Artemisia ludoviciana. Pharmaceutical biology, 40(4), 263-268.
Antidiarrhoeal	Gohari, A. R., Saeidnia, S., Malmir, M., Yazdanpanah, M., & Ajani, Y. (2011). Sterols and flavonoids of Lomatopodium staurophyllum. Journal of Medicinal Plants, 10(39), 43-48.
Anti-fungal	Zhang, J. H., Sun, H. L., Chen, S. Y., Zeng, L. I., & Wang, T. T. (2017). Anti-fungal activity, mechanism studies on alpha-Phellandrene and Nonanal against Penicillium cyclopium. Botanical studies, 58, 1-9.
Anti-fungal	Li, Q., Zhu, X., Xie, Y., & Liang, J. (2021). Antifungal properties and mechanisms of three volatile aldehydes (octanal, nonanal and decanal) on Aspergillus flavus. Grain & Oil Science and Technology, 4(3), 131-140.
Anti-fungal	Zhang, J., Zeng, L., Sun, H., Chen, S., Wang, T., & Ma, S. (2017). Use of Nonanal-wax as Postharvest Fungicide of Tomato against Botrytis cinereal. J. Food Nutr. Res, 5, 458-466.

19.2.2 Oleic Acid

Table 19.2: Benefits of oleic acidare shown in the table below

Benefit	*Reference*
Antitumor	Carrillo Pérez, C., Cavia Camarero, M. D. M., & Alonso de la Torre, S. (2012). Antitumor effect of oleic acid; mechanisms of action. A review. Nutrición Hospitalaria, 2012, v. 27, n. 6 (Noviembre-Diciembre), p. 1860-1865.
Antidiabetic	Palomer, X., Pizarro-Delgado, J., Barroso, E., & Vázquez-Carrera, M. (2018). Palmitic and oleic acid: the yin and yang of fatty acids in type 2 diabetes mellitus. Trends in Endocrinology & Metabolism, 29(3), 178-190.
Vasculoprotective	Massaro, M., & De Caterina, R. (2002). Vasculoprotective effects of oleic acid: epidemiological background and direct vascular antiatherogenic properties. Nutrition, metabolism, and cardiovascular diseases: NMCD, 12(1), 42-51.
Antibacterial	Speert, D. P., Wannamaker, L. W., Gray, E. D., & Clawson, C. C. (1979). Bactericidal effect of oleic acid on group A streptococci: mechanism of action. Infection and Immunity, 26(3), 1202-1210.

19.2.3 Phytol

Table 19.3: Benefits of Phytol are shown in the table below

Benefit	*Reference*
Antinociceptive and antioxidant	Santos, C. C. D. M. P., Salvadori, M. S., Mota, V. G., Costa, L. M., de Almeida, A. A. C., de Oliveira, G. A. L., ... & de Almeida, R. N. (2013). Antinociceptive and antioxidant activities of phytol in vivo and in vitro models. Neuroscience Journal, 2013.
Antitumor	Pejin, B., Kojic, V., & Bogdanovic, G. (2014). An insight into the cytotoxic activity of phytol at in vitro conditions. Natural product research, 28(22), 2053-2056.
Antimycobacterial	Rajab, M. S., Cantrell, C. L., Franzblau, S. G., & Fischer, N. H. (1998). Antimycobacterial activity of (E)-phytol and derivatives: a preliminary structure-activity study. Planta medica, 64(01), 2-4.
Anticonvulsant	Costa, J. P., Ferreira, P. B., De Sousa, D. P., Jordan, J., & Freitas, R. M. (2012). Anticonvulsant effect of phytol in a pilocarpine model in mice. Neuroscience letters, 523(2), 115-118.
Antimicrobial	Ghaneian, M. T., Ehrampoush, M. H., Jebali, A., Hekmatimoghaddam, S., & Mahmoudi, M. (2015). Antimicrobial activity, toxicity and stability of phytol as a novel surface disinfectant. Environmental Health Engineering and Management Journal, 2(1), 13-16.
Anti-inflammatory	Silva, R. O., Sousa, F. B. M., Damasceno, S. R., Carvalho, N. S., Silva, V. G., Oliveira, F. R. M., ... & Medeiros, J. V. R. (2014). Phytol, a diterpene alcohol, inhibits the inflammatory response by reducing cytokine production and oxidative stress. Fundamental & clinical pharmacology, 28(4), 455-464.
Anti-inflammatory	Olofsson, P., Hultqvist, M., Hellgren, L. I., & Holmdahl, R. (2014). Phytol: A chlorophyll component with anti-inflammatory and metabolic properties. Recent Advances in Redox Active Plant and Microbial Products: From Basic Chemistry to Widespread Applications in Medicine and Agriculture, 345-359.
Antibacterial	Inoue, Y., Hada, T., Shiraishi, A., Hirose, K., Hamashima, H., & Kobayashi, S. (2005). Biphasic effects of geranylgeraniol, teprenone, and phytol on the growth of Staphylococcus aureus. Antimicrobial Agents and Chemotherapy, 49(5), 1770-1774.
Antibacterial	Lee, W., Woo, E. R., & Lee, D. G. (2016). Phytol has antibacterial property by inducing oxidative stress response in Pseudomonas aeruginosa. Free radical research, 50(12), 1309-1318.
Antioxidant	P Costa, J., Islam, T., S Santos, P., B Ferreira, P., LS Oliveira, G., VOB Alencar, M., ... & Melo-Cavalcante, A. C. (2016). Evaluation of antioxidant activity of phytol using non-and pre-clinical models. Current Pharmaceutical Biotechnology, 17(14), 1278-1284.

19.2.4 Squalene

Table 19.4: Benefits of squalene are shown in the table below

Benefit	*Reference*
Anticancer	cholesterol lowering Kelly, G. S. (1999). Squalene and its potential clinical uses. Alternative medicine review: a journal of clinical therapeutic, 4(1), 29-36.
Chemopreventive	Smith, T. J. (2000). Squalene: potential chemopreventive agent. Expert opinion on investigational drugs, 9(8), 1841-1848.
Chemopreventive	Reddy, L. H., & Couvreur, P. (2009). Squalene: A natural triterpene for use in disease management and therapy. Advanced drug delivery reviews, 61(15), 1412-1426.
Antioxidant	Amarowicz, R. (2009). Squalene: a natural antioxidant?. European journal of lipid science and technology, 111(5), 411-412.
Skin care	Wołosik, K. A. T. A. R. Z. Y. N. A., Knaś, M., Zalewska, A., Niczyporuk, M., & Przystupa, A. W. (2013). The importance and perspective of plant-based squalene in cosmetology. Journal of cosmetic science, 64(1), 59-66.
Skin care	Huang, Z. R., Lin, Y. K., & Fang, J. Y. (2009). Biological and pharmacological activities of squalene and related compounds: potential uses in cosmetic dermatology. Molecules, 14(1), 540-554.

19.2.5 Lupeol

Table 19.5: Benefits of Lupeol are shown in the table below

Benefit	*Reference*
Chemopreventive	Chaturvedi, P. K., Bhui, K., & Shukla, Y. (2008). Lupeol: connotations for chemoprevention. Cancer Letters, 263(1), 1-13.
Anti-inflammatory	Geetha, T., & Varalakshmi, P. (2001). Anti-inflammatory activity of lupeol and lupeol linoleate in rats. Journal of ethnopharmacology, 76(1), 77-80.
Anti-inflammatory and anticancer	Saleem, M. (2009). Lupeol, a novel anti-inflammatory and anti-cancer dietary triterpene. Cancer letters, 285(2), 109-115.
Antiangiogenic	You, Y. J., Nam, N. H., Kim, Y., Bae, K. H., & Ahn, B. Z. (2003). Antiangiogenic activity of lupeol from Bombax ceiba. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives, 17(4), 341-344.
Antiprotozoal, anticancer and anti-tumor	Wal, A., Srivastava, R. S., Wal, P., Rai, A., & Sharma, S. (2015). Lupeol as a magical drug. Pharm. Biol. Eval, 2(5), 142-151.
Anticancer	Saleem, M., Afaq, F., Adhami, V. M., & Mukhtar, H. (2004). Lupeol modulates NF-κB and PI3K/Akt pathways and inhibits skin cancer in CD-1 mice. Oncogene, 23(30), 5203-5214.
Hepatoprotective	Sunitha, S., Nagaraj, M., & Varalakshmi, P. (2001). Hepatoprotective effect of lupeol and lupeol linoleate on tissue antioxidant defence system in cadmium-induced hepatotoxicity in rats. Fitoterapia, 72(5), 516-523.
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