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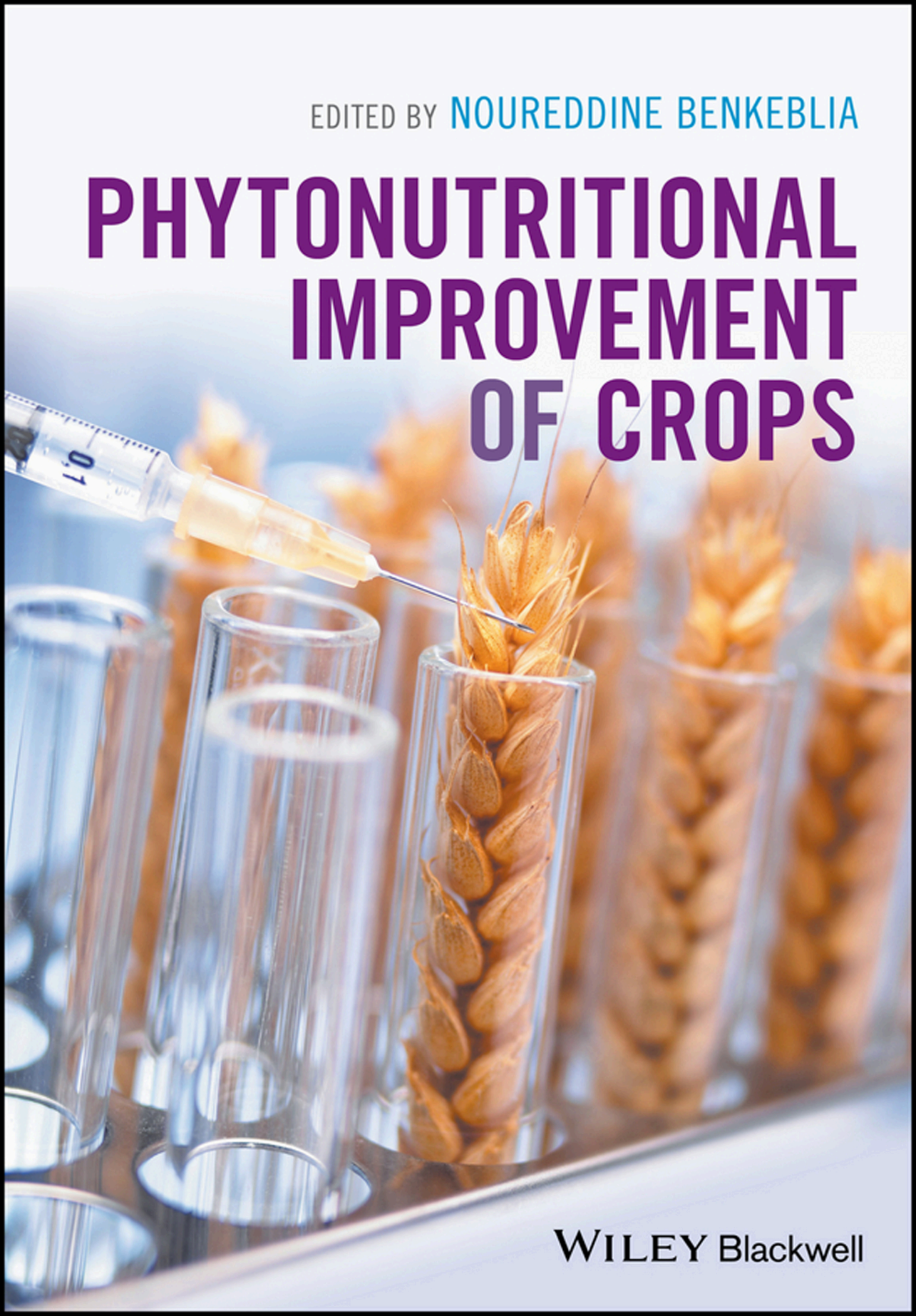
PHYTONUTRITIONAL IMPROVEMENT OF CROPS



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Foreword

From the twentieth century, modern agriculture is providing high quality foods, and 'classic' biotechnology has been used for centuries in breeding to produce improved food crops. However, with development of 'modern' biotechnology and the use of gene technology, much potential for further advances in crops improvement in nutritional qualities. At the end the twentieth century and the turn of the twenty-first century, interests in improving the nutritional and health benefits of crops became a priority aiming to improve diet, and control and prevent many other nutritional diseases particularly obesity, cardiovascular diseases, diabetes and cancers. During the last three decades and the better understanding of gene action and metabolic pathways, tremendous progress has been made in manipulating genes to enhance nutrients, phytochemicals and nutraceuticals of a large number of crops. Despite these developments, still a lot remains to be understood for example the interaction of genes and genomic environment, and/or genes with the environment. Nevertheless, the extensive existing genetic resources available including the wild relative species, and recombinant DNA methods are offering greatly expanded potential resources. Therefore, new options for improving the nutritional value of crops are open. This book is aiming to report recent advances and updated data on the use of molecular engineering to enhance the phytonutritional quality of crops. The different chapters are covering different molecular engineering techniques to increase phytonutrient levels in crops, as well as the potentials of improving specific crops.

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1

Important Plant-Based Phytonutrients

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List of Abbreviations

ALL	Acute Lymphoblastic Leukaemia
CAD	Coronary Artery Disease
CML	Chronic Myeloid Leukaemia
DNA	Deoxyribonucleic acid
FDA	Food and Drug Administration
HDL	High Density Lipoprotein
IDDM	Insulin Dependent Diabetes Mellitus
IHD	Ischemic Heart Disease
LDL	Low Density Lipoprotein
MDA	Malondialdehyde
NIDDM	Non-Insulin Dependent Diabetes Mellitus
UV	Ultraviolet

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VLDL Very High Density Lipoprotein
SOD Superoxide dismutase

1.1 Introduction

Present-day consumers are more nutrition savvy. Each year, health magazines and articles in the newspapers are increasingly dedicated to the relationship between health and diet, especially to plant-based nutraceuticals, functional foods and value-added food products. Additionally, health-related research journals, magazines, books and television programmes tackle topics of treatment and prevention of diseases more than ever. The advent of the internet has acted as an active super highway for free information and has contributed significantly as one of the momentous events influencing communal knowledge and awareness across the planet (Wildman & Kelley 2007). In addition, powerful tools such as publicly available technical and non-technical search engines and social media have further strengthened the global community in the realm of knowledge empowerment. Several international food companies are also taking full benefit of the increasing health awareness and have contributed millions of dollar into the study of nutraceutical compounds, marketing and development of new products and have recognised a quickly developing new market with remarkable pledge. These products fall in the category of immense deemed functional foods. These manufactured food products or natural foods (vegetables and fruits) that can definitely influence human physiology action have bioactive compounds (Wildman 2001).

The term '*nutraceuticals*' was first coined by Stephen DeFelice, founder and chairman of the Foundation for Innovation in Medicine, in the United States in 1988. The definition given by the organisation was '*products isolated and purified from foods that are generally sold in medicinal forms and are usually associated with food*.' However, another definition was given by Health Canada in 1998. The same organisation coined a definition for the term '*functional foods*,' which defined it as '*similar in appearance to, or may be, conventional foods that are consumed as part of a usual diet, and have demonstrated physiological benefits and/or reduce the risk of chronic diseases beyond the basic nutritional functions*.' Hence, there exists a fine line of demarcation between the two terms (Acharya *et al.* 2008).

The global market of nutraceuticals and functional foods is on the rise with the United States and Japan being the top two countries having the biggest share of it. However, in other countries, the expansion of the market is being restricted due to stringent laws governing food labelling, formulation, processing, packaging and marketing. Such issues need to be dealt with properly to facilitate the growth of functional food markets in every other country (Basu *et al.* 2007). Two more countries that are likely to emerge as promising markets for nutraceuticals in the near future are India and China. Both these countries have a rich source of herbs and trees, which have formed an essential part of traditional Indian and Chinese medicines. Even today, such traditional medicines play an important role in keeping the lives of a major part of the enormous population in both these countries. Moreover, the lion share of India's people live in the rural areas where there is almost no access to standard conventional health care centres providing modern day drugs. Hence, they depend on the local herbal products for cure of diseases (Basu *et al.* 2007). In both the countries, there are no strict government

regulations pertaining to the sale and consumption of these traditional medicines. They are available to the people as over-the-counter drugs without the need for any prescription. These facts point to their potential to grow as leaders in market for nutraceuticals and functional foods and thus contribute significantly to the export industry (Basu *et al.* 2007). This review aims at providing a detailed coverage of health as well as industrial aspects of plant-based nutraceuticals, functional foods and value-added food products to the readers as to understand: what they are and their applications in human health from a global perspective.

1.2 Nutraceuticals and Functional Foods in Human Health

Plants have always been a significant source of trace elements in our diet (Aberoumand 2012). They not only help us by meeting our optimum nutrient requirements but also provide an effective barrier to the occurrence of several morbid conditions (Aberoumand 2012). Many of these medicinal plants produce a number of different phytonutrients that play an important role in maintaining our very own physiological system. But most of those underlying biochemical processes still remain obscure (Thomas 2012). However, rapid development in the field of deoxyribonucleic acid (DNA) sequencing and other biotechnological *know-hows* are slowly paving the way to unlocking these secrets and will one day make plants a more indispensable part of human life than they were once thought to be (Thomas 2012).

With the growth of different pharmaceutical companies, the use of traditional medicinal plants has indeed received a severe blow. But in the last few decades, there has been a turn in the tide. Scientists and health experts have started to recognise the value of the plants in human health and this has thus led to the positive growth of nutraceuticals and functional food markets all over the globe. The National Centre for Traditional Medicine has been set up in Cambodia to provide medical care to people in traditional medicine yet with scientific means. Several medicinal plants (Tables 1.1–1.5) with nutraceutical values have been identified and the proper dosage forms have been prepared after carefully designed and repeated clinical trials. The use of traditional medicines in the country is under strict regulation of the Ministry of Health to ensure quality and safety of the products (Kraisintu 2003).

Community health study and investigation in metabolic syndrome of poor nutrition, dyslipidemia, hepatic derangement and associated cardiovascular risk factors are of immense importance in the present time. In concurrence with technological advancements, occupational and dietary lifestyles in all ages of both the sexes of men and women, irrespective of racial and ethnic differences are rapidly changing. Habitual changes of lifestyle of people in both urban and rural settings are also of no great difference like before. Adults (18 years and above) of both sexes are affected by this massive pathos of psychosomatic disorders. Clinical manifestation of early age of onset of atherosclerosis, ischemic heart disease along with hepatic derangements and dyslipidemia are the most common health disorders prevalent in every society. Data on health-related issues and nutrition from developed countries are easily available, but, unfortunately, the data from under developed and developing nations in Asia, Africa and Latin America are remarkably lacking. In addition, survey records and information are also less available from rural sectors and least from the tribal/aboriginal/first nation

Table 1.1 Medicinally important plants from Africa that are commonly used by local tribes as nutraceutical sources and as potential functional food components in their daily diets.

No	Local name	English name	Plant Family	Scientific name	Nutraceutical / Phytochemical	Habit	Part used	Medicinal properties	Tribes using the plant	References
1	Talamong	Blackthorn	Fabaceae	*Acacia mellifera* (Vahl) Benth	30-hydroxylup-20 (29)-en-3-one, 30-hydroxylup-20 (29)-en-3ß-ol, atranorin, methyl-2hyndroxy-4-hydroxy-3, 6 dimethy benzoate, ß-stosterol-3 ß-O-glucoside, linoleic acid, pentacyclic triterpenoids: (20R) 3-oxolupane-30al and (20S) 3-oxolupane-30al, (20*R*)-28-hydroxylupen-30-al-3-one, (20*S*)-3β-hydroxylupan-30-al	Shrub	Stem bark	Treatment of pneumonia, malaria, primary infection of syphilis, sterility and stomach ache, skin diseases, coughs and gastrointestinal ailments	Pokot (Kenya)	Kokwaro (1993), Mutai *et al.* (2007), Mutai *et al.* (2009)
2	Iwongewonge	Indian liquorice, White thorn apple	Solanaceae	*Datura metel* L.	Alkaloids, tripenoid, steroids, flavonoid, triterpenes, phenolic compounds, tannins	Herb	Leaves, seeds	Tuberculosis, asthma, cough, convulsions, antibacterial, insanity, catarrh, diarrhoea, hysteria, rheumatic pains	Sukuma (Tanzania)	Bharathi *et al.* (2010), Kokwaro (1993), Siva Sakthi *et al.* (2011)

3	Acak-acak	Asthma herb, pill bearing spurge	Euphorbiaceae	*Euphorbia hirta* L.	Flavonoids (Quercitrin, Myricitrin), Sterols (Cycloarternol, 24-methylene-cycloarternol, β-sitosterol, euphorbol hexacozonate, 1-hexacosanol, tinyaloxin, campesterol, stigmasterol), tannins (1,2,3,4, 6-penta-O-galloyl-β-D-glucose, 3,4-di-O-galloylquinic acid, gallic acid, 2,4, 6-tri-O-galloyl-D-glucose, euphorbin A,B,E), triterpenoids (α-amyrin, β-amyrin, taraxerone, taxerol, β-amyrin, acetate, taraxerone, 11α, 12α –oxidotaraxero)	Herb	Leaves, latex (whole plant)	Asthma, colic troubles, dysentery, cough, worms and vomiting, antibacterial, molluscicidal activity, anti-diarrhoeal, anti-inflammatory	Acholi (Uganda)	Chen (1991), Chitra *et al.* (2011), Kokwaro (1993), Lee (2011), Shih *et al.* (2010), Shih and Cherng (2012)
4	Magwagwa	Tick berry	Verbenaceae	*Lantana camara* L.	Tannin, catachin, saponin, steroids, alkaloids, phenol, anthroquinone, protein and reducing sugar	Shrub	Leaves, roots, flowers	Coughs, antibacterial, antihypertensive, treatment of malaria, rheumatism, and skin rashes, anti- repellent, antiseptic, anti-inflammatory	Luo (Kenya)	Kokwaro (1993), Mary Kensa (2011), Patel *et al.* (2011)

(Continued)

Table 1.1 (Continued)

No	Local name	English name	Plant Family	Scientific name	Nutraceutical / Phytochemical	Habit	Part used	Medicinal properties	Tribes using the plant	References
5	Muvunza hukuma	African mistletoe, Dwarf red hibiscus, Poppy hibiscus	Malvaceae	*Hibiscus micranthus* L. f.	Steroids, flavonoids, carbohydrates, phenols, tannins and few compounds like phenolic acids, flavonoids, β-sitosterol, alkanes, fatty alcohols, acids	Shrub	Roots, stems	Bronchitis, antimicrobial, antiviral, antitumour, antipyretic, anti-inflammatory, haematological effects	Pokomo (Kenya)	Kokwaro (1993), Kumar *et al.* (2010a, 2010b), Kumar *et al.* (2011)
6	Lihululu	Yellow justicia, Sand Paper plant	Acanthaceae	*Justicia flava* (Forssk.) Vahl	Sterols, salicylic acid, lignans helioxanthin[(+)-isolariciresinol, justicinol, decosanoic acid, β-sitosterol- β-D-glucoside], 1-aryl-2,3-naphthalide lignans [Orosunol, 8-demethylorosunol]	Herb	Leaves, root	Diarrhoea, fever, treatment of convulsions and feverish pains, yaws	Luhya (Kenya)	Kokwaro (1993), Johnson (2004), Olaniyi (1982), Olaniyi and Powell (1980),
7	Msalanga	Eastern cape resin tree	Anacardiaceae	*Ozoroa mucronata* (Bernh.) R. Fern. & A. Fern.	Anarcardic acid (LOX inhibition), maronic acid (olean-18-ene keto acid)	Tree	Roots	Dysentery, LOX inhibition, PG synthase inhibition, antimicrobial	Digo (Kenya)	Hostettmann-Kaldas and Nakanishi (1979), Kokwaro (1993), Kubo *et al.* (1987)

8	Mukonda kundi	Mozambique bitter apples	Solanaceae	*Solanum renschii* Vatke	Steroidal alkaloids, steroidal sapogenins	Shrub	Root	Typhoid fever, throat, wounds healing	Kamba (Kenya)	Bussmann (2006), Carle (1981), Heine *et al.* (1988), Kokwaro (1993)
9	Ng'owo	Bush fig, Broom cluster fig, Cape fig	Moraceae	*Ficus capensis* Thunb.	Flavanol, coumarins, steroids and triterpenes, alkaloids, balsams, tannins, resin, carbohydrates, phenolic	Tree	Roots, leaves, stem bark	Constipation, tonic, anti-rheumatic, fever, treatment of tuberculosis, antibacterial	Luo (Kenya)	Adebayo-Tayo and Odeniyi (2012), Dafalla (2005), Kokwaro (1993), Oyeleke *et al.* (2008)
10	Msahala	Alexandrian senna, East Indian senna	Fabaceae	*Cassia senna* L.	Alkaloids, saponins, tannins, phytosterols, naphthalene glycosides, 6-hydroxymusizin glycoside, tinnevellin glycoside, anthranoids (dianthrones, anthrones, anthraquinone)	Shrub	Leaflets, fruits (pods)	Indigestion, foot infections, subcutaneous parasitic infection	Swahili (Kenya)	Kokwaro (1993), Lemli *et al.* (1981), Mengs *et al.* (2004), Viswanathan and Nallamuthu (2012)
11	Segatet	Cape myrtle	Primulaceae	*Myrsine africana* L.	Saponins, tannins, flavonoids, amino acids, steroids and reducing sugar. embelin, rapanone (2,5 dihydroxy benzoquinone)	Shrub	Fruits, stem bark, leaves, root bark	Roundworm, tapeworm, remedy for chest pains and stiff joints	Marakwet (Kenya)	Kokwaro (1993), Midiwo *et al.* (2010), Vasudha *et al.* (2011)

(Continued)

Table 1.1 (Continued)

No	Local name	English name	Plant Family	Scientific name	Nutraceutical / Phytochemical	Habit	Part used	Medicinal properties	Tribes using the plant	References
12	Kemagugu	Flame lily, Creeping lily, Climbing lily, Fire lily, Tiger claw, Glory lily	Colchicaceae	*Gloriosa superba* L.	Alkaloids (colchine and colchicoside), glycosides, steroids, terpenoids, tannins, phenols, saponin, flavonoids	Herb	Seeds, tubers	Abortion, antidote for snake bites, antibacterial, treatment of bruises, sprains and colic, wounds, fever	Marakwet (Kenya)	Kokwaro (1993), Rehana banu and Nagarajan (2012), Senthilkumar (2013a, 2013b)
13	Ol-erbat	Babul, Indian gum Arabic tree	Fabaceae	*Acacia nilotica* (L.) Willd. ex Delile	Tannins, saponin, saponin glycosides, volatile oils, phenols, triterpenes, flavonoids and alkaloid, resin, steroids, oleosins, D-glucoronic acid, 1-acetyl beta carboline, hydroxy citronellal, trans decalone, lavandulyl acetate, propionic acid-2-chloro, ethyl ester, 3-picoline-2-nitro	Tree	Whole plant	Gonorrhoea, cough, antibacterial, antimalarial, antifungal, anti-diarrhoea, anticancer, antimutagenic, spasmogenic, vasoconstrictor, anti -pyretic, anti-asthamatic, cytotoxic, anti-diabetic, anti-platelet agregatory, antiplasmodial, molluscicidal	Maasai (Kenya)	Ali *et al.* (2012), Hemamalini *et al.* (2013), Kokwaro (1993), Solomon-Wisdom and Shittu (2010)

14	Iravu	White caper brush, Woolly caper brush	Capparidaceae	*Capparis tomentosa* Lam.	Oxindole (3-Hydroxy-3-methyl-4-methoxyoxindole), glucocapparin, gluconorcappasalin, benzylglucosinolates, rutin, fatty acids, hydrocarbons, sitosterol, β-carotene	Shrub	Roots, fruits, leaves (aerial parts)	Syphilis, skin irritant, antibacterial, spices, cough, infertility, impotence, anti-convulsant	Chagga (Tanzania)	Dekker *et al.* (1987), Kokwaro (1993), Tlili *et al.* (2011)
15	Huhunga	Zambezi false-nettle	Euphorbiaceae	*Acalypha ornata* Hochst. ex A. Rich.	Isopulegly acetate, valenchi, vividiflorene, α-muurolene, 2-hexyne, 6-methyl-α-ionone, γ-elemene, (E)-2-methyl-4-undecene, ledol, cis-3-hexynyl benzoate, 2-methyl-1-octadecene, apiole, oplopanone, γ-endesmol, flavonoids, phenols, resins, sterols, tannins	Shrub	Leaves, roots	Leprosy, antiemetic, relief of postpartum pain, haemorrhoids, leprosy, scabies, antimicrobial	Sukuma (Tanzania)	Ahmed and Onocha (2013), Kokwaro (1993); Onocha *et al.* (2011a, 2011b)

Table 1.2 Medicinal plants from Central and West Asia with potential for use as nutraceutical and functional food.

No	Local name	English name	Plant Family	Scientific name	Nutraceutical	Habit	Part used	Medicinal Properties	References
1	Bumadaran-e-Sabzekoh	Achillea	Asteraceae	*Achillea kellalensis* Bioss. & Hausskn.	Camphor, borneol, α-thujone, cineol, bornyl acetate and camphene	Herb	Flowers	Carminative, indigestion, edema, burns, skin infection gastric ulcer, antibacterial, anti-inflammatory, haemorrhage, dysmenorrhoea, enema, diarrhoea	Pirbalouti *et al.* (2010a), Rustaiyan *et al.* (1999), Zargari (1996)
2	Golnare-e-farsi	Pomegranate	Lythraceae	*Punica granatum* L.	Pomegranatate, ellagic acid,3,3′,4′-tri-O-methylellagic acid, ethyl brevifolincarboxylate, urolic and maslinic acids, daucosterol	Tree	Flowers	Wound healing, antiviral, antibacterial, antifungal, remedy for cut wound, bronchitis, diarrhoea, digestive problems, man sex power reconstituent, dermal infected wounds, diabetes	Pirbalouti *et al.* (2010a, 2010b), Wang *et al.* (2006)
3	Panirak	Common Mallow	Malvaceae	*Malva sylvestris* L.	Phenolics, flavonoids, carotenoids, ascorbic acid	Herb	Flowers, leaves, mature fruits and leafy flowered stems	Treatment of various ailments, including cold, cough and burn, and cut wound-healing	Zargari (1996)

4	Zarrin giah	–	Lamiaceae	*Dracocephalum multicaule* Montbr. & Auch. ex Bentham	Limonene, α-pinene, methyl fgeraniate	Herb	Leaves, flowers (aerial parts)	Foot pain, sedative, analgesia, inflammatory, antibacterial, antiseptic	Mojab *et al.* (2002), Pirbalouti *et al.* (2010a)
5	Khosharizeh	–	Apiaceae	*Echinophora platyloba* DC.	Trans-β-ocimene, 2-furanone, myrcene, linalool and cis-β-ocimene	Shrub	Aerial parts	Antifungal, spice and culinary	Entezari *et al.* (2009), Pirbalouti *et al.* (2010a)
6	Golpar	–	Apiaceae	*Heracleum lasiopetalum* Boiss.	Flavonoids, tannins, saponins	Herb	Fruit	Antiseptic, spice, and condiment	Pirbalouti (2009), Pirbalouti *et al.* (2010a); Rohi Boroujeni *et al.* (2012)
7	Bakhtyari karafs	Wild clery	Apiaceae	*Kelussia odoratissima* Mozaff.	E-ligustilide Phthalide, 3- e - butyldiene phthalide and z-ligustilide	Herb	Leaves	Edible as vegetable, flavouring, indigestion, rheumatism, also used to cure some rheumatism disorders, common cold, cough, blood pressure, blood lipid and stomachache	Pirbalouti *et al.* (2010a, 2010c); Rohi Boroujeni *et al.* (2012), Sedighi *et al.* (2012), Sultana *et al.* (2005)

(Continued)

Table 1.2 (Continued)

No	Local name	English name	Plant Family	Scientific name	Nutraceutical	Habit	Part used	Medicinal Properties	References
8	Pooneh	Spearmint	Lamiaceae	*Mentha longifolia* (L.) Hudson.	Carvone, cis- piperitone epoxide, piperitenone oxide, menthone, flavonoids: 5,7,4′-trihydroxy-6,2′,3′-trimethoxyflavone	Herb	Leaves, flowers	Edible as vegetable, flavouring, indigestion, cough, anti-inflammatory, carminative, antiemetic, diaphoretic, anti spasmodic, analgesic, stimulant, emmenagogue, and anticatharral activities	Džamić *et al.* (2010), Ghoulami *et al.* (2001), Pirbalouti *et al.* (2010a), Sharopov *et al.* (2012a)
9	Marzeh Koohi	Bakhtiari *savory*	Lamiaceae	*Satureja bachtiarica* Bunge	Thymol, γ-terpinene, p-cymene, β-caryophyllene and borneol	Herb	Leaves, flowers	Edible as vegetable, flavouring, indigestion, cough, antibacterial	Pirbalouti (2009) Pirbalouti *et al.* (2010a, 2010c), Sefidkon and Jamzad (2000)
10	Lolopashmak (Chay-e-kohi)	Betony	Lamiaceae	*Stachys lavandulifolia* Vahl.	α-thujone, α-pinene, myrcene, β-phellandrene, germacrene D, Δ-cadinene, and 1, 4-methano-1 H-indene	Herb	Leaves, flowers	Green tea, antibacterial, skin diseases, menorrhagia, sedative, antispasmodic, diuretic, ulcers, fevers and diarrhoea	Pirbalouti and Mohammadi (2013), Pirbalouti *et al.* (2010a), Rohi Boroujeni *et al.* (2012), Zargari (1996)

11	Avishan	Deanaie thyme	Lamiaceae	*Thymus daenensis* Celak.	Geraniol, geranyl acetate, β-caryophyllene, thymol, p-cymene, methyl carvacrol,	Herb	Leaves, flowers	Green tea, spice, culinary, cough, antibacterial, carminative, anti-inflammatory, expectorant, treatment of colds, antifungal, antiviral, anti-parasites	Nickavar *et al.* (2005), Pirbalouti *et al.* (2010a, 2010c), Pirbalouti *et al.* (2011), Sabahi *et al.* (2013), Zargari (1996)
12	Kakouti	–	Lamiaceae	*Ziziphora tenuior* L.	Pulegone, limonene, piperitenone	Herb	Leaves, flowers	Green tea, spice, culinary, antibacterial, carminative, antiasthmatic	Ebrahimi *et al.* (2012), Meral *et al.* (2002), Pirbalouti *et al.* (2010a), Sezik *et al.* (1991)
13	Khakeshir	Flixweed	Brassicaceae	*Descurainia sophia* (L.) Webb ex Prantl	Cis-β-ocimene, menthol, neoisomenthyl acetate	Herb	Seeds	Laxative, gasteralgia, fever, treatment of some cancers, cough	Li *et al.* (2010), Pirbalouti (2009)
14	Gavzaban-e-koohi	Bugloss	Boraginaceae	*Anchusa italica* Retz.	Saponins, pyrrolizidine alkaloids, γ,α-linoleic acid, stearidonic acid	Herb	Flowers, leaves	Green tea, antidepressant, nerve system relaxant, antianxiety, cold, chest pain, sore throat, antibacterial, asthma, neurasthenia	Mojab *et al.* (2003), Pirbalouti (2009), Safa *et al.* (2012), Zaurov *et al.* (2013)

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Table 1.2 (Continued)

No	Local name	English name	Plant Family	Scientific name	Nutraceutical	Habit	Part used	Medicinal Properties	References
15	Sorya	Ratanjot	Boraginaceae	*Arnebia euchroma* (Royle) I.M. Johnston.	Naphthoquinone red pigments: ethyl 9-(2′,5′-dihydroxyphenyl) nonanoate, octyl ferulate, arnebiabinone and isohexenylnaphthazarins (e.g. acetylshikonin)	Herb	Roots, rhizome	Burn wound, anti-eczema, antimicrobial, anti- inflammatory, anti-viral, anti-tumour, cardiotonic and contraceptive properties	Damianakos *et al.* (2012), Kumar *et al.* (2011), Liu *et al.* (2010), Pirbalouti *et al.* (2010c)
16	Golraye dayhimi	–	Hypericaceae	*Hypericum scabrum* L.	α-pinen, thymol, carvacrol, spathulenol, *p*-Cymene	Herb	Flowers, aerial parts	Green tea, sedative, headache, analgesic, trauma, rheumatism, neuralgia, anti-inflammatory, antiseptic, gastroenteritis, ulcers, hysteria, bedwetting	Baser *et al.* (2002), Pirbalouti *et al.* (2010c)
17	Mort	Myrtle	Myrtaceae	*Myrtus communis* L.	Acylphloroglucinols, phenolic compounds: phenolic acids, flavonol glycosides, volatile components: 1,8-cineole, α-terpineol, methyl eugenol, linalool	Tree	Leaves	Skin discords, digestive discords, astringent, good hair condition, bronchodilatotor, anti- inflammatory	Messaoud *et al.* (2012), Pirbalouti (2009), Pirbalouti *et al.* (2010c)

18	Pesteh Koohi (baneh)	Persian turpentine tree	Anacardiaceae	*Pistacia atlantica* Desf.	Sterols (betasitosterol), triacylglycerol tocopherols (α-tocopherol), phenols (caffeic acid)	Tree	Fruit, resin	Indigestion, tonic, toothache, astringent	Pirbalouti (2009), Pirbalouti *et al.* (2010c), Pirbalouti *et al.* (2012), Saber-Tehrani *et al.* (2013)
19	Gol-e Arooneh, (aruone)	–	Lamiaceae	*Salvia hydrangea* DC. ex Bentham	β-caryophyllene, caryophyllene oxide, spathulenol, 1,8-cineole, α-pinene	Herb	Flowers, leaves	Cough, emollient, sore throat, antibacterial, antispasmodic, carminative and sedative	Barazandeh (2004), Pirbalouti *et al.* (2010c), Rustaiyan *et al.* (1997), Sonboli *et al.* (2009)
20	Zalzalak	Hawthorn	Rosaceae	*Crataegus curvisepala* Lindm. (= *Crataegus oxyacantha* L.)	Sobutylamine, ursolic acid, oleanolic acid, crategolic acid, adenosine, adenine, guanine, caffeic acid, quercetin, hyperoside, rutin, vitexin-4′-rhamnoside, tyramine, flavonoglycosyls, epicatechol, saponins, tannins, o-ethoxy phenylethylamine	Tree	Fruits, flowers, leaves	Heart discords, edible as wild fruit, hypolipidaemic, anti- inflammatory, antianxiety, antimicrobial	Kashyap *et al.* (2012), Pirbalouti (2009), Verma *et al.* (2007)

(Continued)

Table 1.2 (Continued)

No	Local name	English name	Plant Family	Scientific name	Nutraceutical	Habit	Part used	Medicinal Properties	References
21	Nakhonak	Southern Milk Vetch	Fabaceae	*Astragalus hamosus* L.	Flavonoids: rhamnocitrin 4′-β-D-galactopyranoside, flavonols hyperoside, isoquercitrin, astragalin, 3-O- gentiobioside, rutin rhamnetin 3-O- glucoside	Shrub	Whole plant	Carminative, astringent, good for ulcers, leucoderma and inflammation, treatment of nervous affections	Bratkov *et al.* (2016), Krasteva *et al.* (2007), Pirbalouti (2009)
22	Mousir	Persian shallot	Alliaceae	*Allium stipitatum* Regel (= *Allium hirtifolium* Boiss.)	Organosulphur, phenolic compounds, allicin, diallyl disulphide diallyl trisulphide, 9-hexadecenoic acid, 11,14-eicosadienoic acid, n-hexadecanoic acid, furostanol and spirostanol saponins, flavonol glycosides	Herb	Bulbs	Edible as vegetable, flavouring, antihypertensive, antibacterial, antioxidant	Barile *et al.* (2005), Ghahremani-Majd *et al.* (2012), Ismail *et al.* (2013), Pirbalouti (2009)
23	Spand	Syrian rue	Nitrariaceae	*Peganum harmala* L.	Alkaloids (β-carboline), reducing compounds, tannins, volatile oils, saponins, flavonoids, sterols (triterpenes), harmine, harmaline, anthraquinone	Shrub	Fruit, seed	Antimicrobial, anti-parasite, asthma, colic, anthelmintic, antiseptic, gastrointestinal, antispasmodic, antiperiodic,	Benbott *et al.* (2013), Dastagir *et al.* (2012), Pirbalouti (2009)

24	Spharzeh	Plantain (psyllium)	Plantaginaceae	*Plantago psyllium* L.	Polyphenolic acid, flavonoids, mucilages (anionic polysaccharide of L-arabinose, D-xylose and D-galactoronic acid), iridoid glycosides	Herb	Seeds	Cough, emollient, cough, sore throat	Naghdi *et al.* (2004), Pirbalouti (2009), Saeedi *et al.* (2010)
25	Rivas	Syrian Rhubarb	Polygonaceae	*Rheum ribes* L.	Chrysophanol, physcion, rhein, aloe-emodin, physcion-8-O-glucoside, aloe-emodin-8-O-glucoside, Sennoside A, rhaponticin, flavonoids	Herb	Leaves, root	edible as vegetable, flavouring, jaundice, indigestion, skin discords, treatment of diabetes, haemorrhoids, ulcer, diarrhoea	Oktay *et al.* (2007), Pirbalouti (2009), Sayyah *et al.* *(2009)*

Table 1.3 Medicinal plants from the Himalayas with potential for use as nutraceutical source and as functional food component.

No	Local name	English name	Plant Family	Scientific name	Nutraceutical/Phytochemical	Habit	Part used	Uses/Medicinal properties	References
1	Bongkar	Aconite	Ranunculaceae	*Aconitum orochryseum* Stapf	Diterpenoid alkaloids [Hetisine-type (orochrine, 2–O–acetylorochrine, 2–O–acetyl–7α–hydroxyorochrine), atisinium chloride and virescenine], flavonoids, flavonol glycosides, diterpenoid, norditerpenoid	Herb	Aerial parts	Antidote for poisons of scorpion and snake; cures contagious diseases and inflammation of intestines, common cough and cold, bilious fever, dysentery, febrifuge for fevers associated with malaria infection, kidney dysfunction and stomach ulceration, diarrhoea, dysentery, tonsillitis, headache, high altitude sickness, antimalarial	Gajalakshmi *et al.* (2011), Krug and Milliken (2008), Samten (2009), Wangchuk *et al.* (2007), Wangchuk *et al.* (2010)

2	Bongnag, Bikh	Indian Aconite	Ranunculaceae	*Aconitum heterophylloides* (Brühl) Stapf (= *Aconitum laciniatum* (Bruhl) Stapf)	Diterpene alkaloids	Herb	Tubers, leaves, roots, flowers	Anthelmintic, allays bone disease, mumps, gout, chronic infection and leprosy, analgesic, anti-inflammation, used for poison for arrows	Gajalakshmi *et al.* (2011), Krug and Milliken (2008), Samten (2009), Sarkar *et al.* (2012), Wangchuk *et al.* (2013)
3	Lug-mig	Weak violet Aster	Asteraceae	*Aster flaccidus* Bunge	Phenylpropanoids [(7′R, 8S)-9′-lariciresinol-(alpha-methyl)-butanoate, 5,9-dimethoxyl-7-(alpha-methyl)-butanoxyl-phenyl-2E-propenol-(alpha-methyl)-butanoate], 2-oxo-isocostic acid, mussaenoside,kaempferol-3-O-β-Dglucopyranoside,1β,6α-dihydroxyeudesm-4(15)-ene,6β-propionyloxy-1,10-dehydrofuranoeremophil-9-on, indaconitine, lupeol, liquiritigenin, apigenin, tricine, coniferyl aldehyde, friedelin, apigenin, p-hydroxybenzoicacid, 2-O-β-D-glucopyranoside-vicodiol, 10-O-β-D-glucopyranoside-oplopanone	Herb	Whole plant including flowers, roots, aerial part	Useful for treating affliction by evil spirits, antitumour, bronchitis, cramps, common cold and relieves pain	Gan *et al.* (2006), Gangwar *et al.* (2010), Krug and Milliken (2008), Liu *et al.* (2010), Miao *et al.* (2012), Samten (2009)

(Continued)

Table 1.3 (Continued)

No	Local name	English name	Plant Family	Scientific name	Nutraceutical/Phytochemical	Habit	Part used	Uses/Medicinal properties	References
4	Pangram	Red knotweed or Large leaved knotweed	*Polygonaceae*	*Bistorta macrophylla* (D. Don) Soják	(-)-epicatechin-5-O-beta-D-glucopyranoside, (+)-catechin-7-O-beta-D-glucopyranoside, 1-(3-O-beta-D-glucopyranosyl 4,5-dihydroxy-phenyl)-ethanone (-)-epicatechin, chlorogenic acid, gallic acid, anthraquinone glucoside 1-hydroxy-8-methoxy-3-methyl-6-O-β-D-glucopyranosyl-anthraquinone, 1, 6-dihydroxy- 8-methoxy-3-methyl-anthraquinone, quercitrin, kaempferol-3-O-α-rhamnoside, arborinol , β-sitosterol, β-sitosterol-D-glucoside	Herb	Rhizome, leaves	Allays diarrhoea, stomach pain, dysentery, wound healing	Krug and Milliken (2008), Phondani (2011), Samten (2009), Semwal *et al.* (2010), Wang *et al.* (2004)
5	Yakima	Gold saxifrage	Saxifragaceae	*Chrysosplenium nudicaule* Bunge	Triterpenoids, flavonol glycosides, volatile oil, hexadecanoic acid, ethyl ester, dibutyl phthate, (Z, Z, Z)-9, 12, 15-octadecatrienoic acid, ethyl ester, 2, 6-butylated hydroxytoluene, and 5, 6, 7, 7a-tetrahydro 4, 4, 7a-trimethyl-2(4H)-benzofuranone	Herb	Whole plant including aerial parts	Anti-inflammatory and cholagogue; for headaches, gall bladder problem	Krug and Milliken (2008), Samten (2009), Yanli (2006), Yunshang *et al.* (2004)

6	Bashaka	Primrose, Climbing corydalis	Papaveraceae	*Corydalis crispa* Prain	Isoquinoline alkaloids (protopine, 13-oxoprotopine, 13-oxocryptopine, stylopine, coreximine, rheagenine, ochrobirine, sibiricine, bicuculline)	Herb	Whole plant including roots	Used as tonic, promotes vigour, treatment of infections in the blood, liver and bile, antiplasmodial, antimicrobial, anti-inflammatory	Krug and Milliken (2008), Samten (2009), Wangchuk *et al.* (2012a)
7	Re-skon	Corydalis	Papaveraceae	*Corydalis dubia* Prain	Dubiamine, and isoquinoline alkaloids (cheilanthifoline scolerine, protopine, capnoidine, bicuculline, hydrastine, corydecumbine)	Herb	Whole plant including roots	Impure blood detoxifier and neuralgia, treatment of fever arising from affections of heart, lung, pancreas and kidney, antiplasmodial, antimicrobial, cytotoxicity and antiplasmodial activity	Krug and Milliken (2008), Samten (2009), Wangchuk *et al.* (2011), Wangchuk *et al.* (2012b)
8	Dbang-lag	Early Marsh Orchid	Orchidaceae	*Dactylorhiza hatagirea* (D. Don) Soó	Dactylorhins A-B-C-D-E, dactyloses A and B, lipids, glucoside	Herb	Tubers, roots	General tonic, promotes heat, dysentery, diarrhoea, chronic fever, cough, stomach ache, wounds, cuts, burns, fractures, general weakness, bone fracture,	Krug and Milliken (2008), Kizu *et al.* (1999), Pant and Rinchen (2012), Samten (2009)

(Continued)

Table 1.3 (Continued)

No	Local name	English name	Plant Family	Scientific name	Nutraceutical/Phytochemical	Habit	Part used	Uses/Medicinal properties	References
9	Bya-rgod-spos	Delphinium glaciale	Ranunculaceae	*Delphinium glaciale* Hook.f. & Thomson	Alkaloids	Herb	Aerial parts	For fever, loss of appetite, headache, dysentery, body swelling of wounds	Churyukanov (1986), Krug and Milliken (2008), Mashkovsky and Samten (2009)
10	Gongthogpa	Tall Wormseed Mustard, Hawkweed-leaved Mustard, Wallflower	Brassicaceae	*Erysimum hieraciifolium* L.f.	Glucosinolates (5-methylthiopentyl, (R)-5-methyl-sulphinylpentyl, 3-hydroxy-5-methylthiopentyl, 3-hydroxy-5-methylsulphinylpentyl,3-hydroxy-5-methylsulphonylpentyl isothiocyanate, 3-hydroxypropyl isothiocyanate, erysinoside, helveticoside	Herb	Aerial parts including fruits, seeds	Useful for meat poisoning, lung problems and in reducing stress and insomnia	Daxenbichler *et al.* (1980), Kjær and Schuster (1970), Krug and Milliken (2008), Samten (2009)

11	Tseka	Fritillaria	Liliaceae	*Fritillaria delavayi* Franch.	Volatile oil, glycosides, sterol, triterpenes, polyoses, saponins, reducing compounds, quinones, flavonic glycosides, coumarins, isosteroidal alkaloids, delavine, delavinone, chuanbeinone, delafrinone, delafrine	Herb	Bulbs	Promotes vigour, counteract accumulation of fluids in joints, treatment of impotence, treatment of different lung diseases (bronchitis, tuberculosis, coughs), treatment of nervous system, antitussive and expectorant activity, anti-inflammatory	Krug and Milliken (2008), Maharjan *et al.* (2011), Saklani *et al.* (2011), Samten (2009)
12	Gangachung	Urn-shaped gentian.	Gentianaceae	*Gentiana urnula* Sm.	Iridoidal glycosides [gentiournosides A-C (*bis*-iridoidal glycosides), gentiournosides D-E (loganin)	Herb	Entire plant including roots	Treat fever, dysentery and poisoning, antipyretic, treatment of thrombus, dysentery and sore throat	Krug and Milliken (2008), Liu *et al.* (1994), Samten (2009)
13	Parpata	Thinfruit Hypecoum	Papaveraceae	*Hypecoum leptocarpum* Hook. f. & Thomson	Alkaloids (leptocarpinine, leptopine, leptopinine, leptopidine, leptopidinine), protopine, isohyperectine, oxohydrastinine (hypecoumine), cryptopine	Herb	Whole plant	Useful in treating common cough and cold, skin diseases, blood pressure and poisonings	Chen and Fang (1985), Krug and Milliken (2008), Samten (2009), Zhou *et al.* (1999)

(Continued)

Table 1.3 (Continued)

No	Local name	English name	Plant Family	Scientific name	Nutraceutical/Phytochemical	Habit	Part used	Uses/Medicinal properties	References
14	Ud-pel-sngon-po	*Himalayan Blue Poppy*	Papaveraceae	*Meconopsis simplicifolia* (D. Don) Walp.	Alkaloids (berberine, mecambridines)	Herb	Whole aerial part	Treat liver and lung inflammation and fever associated with cough and cold and malaria. heals the blood, liver and the lung infections,	Krug and Milliken (2008), Samten (2009), Tétényi (2005), Wangchuk *et al.* (2011)
15	Pang poe	Spikenard	Caprifoliaceae	*Nardostachys jatamansi* (D. Don) DC. (= *Nardostachys grandiflora* DC.)	Pranocoumarin [E-2-methyl, 3-(5,9-dimethylbicyclo[4.3.0]-nonen-9-yl)-2-propenoic acid and 2′,2′-dimethyl-3′-methoxy-3′,4′-dihydropyranocoumarin], susquiterpenes, lignans, neo-lignans, coumarins, terpenoid ester (nardostachysin)	Herb	Whole plant (rhizomes, roots)	Used for its astringent, diuretic, digestive, carminative and laxative properties, as liver stimulant, antipyretic and tonic , antiseptic, high blood pressure, insomnia, antispasmodic, treatment of epilepsy, hysteria, convulsions, heart palpitations and round worm	Chatterjee *et al.* (2000), Chatterjee *et al.* (2005), Krug and Milliken (2008), Mulliken and Crofton (2008), Samten (2009)

16	Tsher-sngon	Prickly Blue poppy	Papaveraceae	*Meconopsis horridula* Hook. f. & Thomson	Alkaloids [8, 9-dihydroprooxocryptochin, isoquinoline, protopine, (−)-reframoline, (−)-amurensinine], tricin, luteolin, apigenin, hydnocarpin, β-sitosterol, luteolin-7-O-β-D-glucopyranoside, kaempferol-3-O-β-D-glucopyranosyl(1→2)]-β-D-glucopyranoside, quercetin-3-O-β-D-galactopyranosyl(1→6)]-β-D-glucopyranoside, tricin-7-O-β-D-glucopyranoside, kaempferol-3-O-β-D-glucopyranoside, cinnamamide, N-p-hydroxyl-trans-coumaroyltyramine, quercetin, kaempferide, kaempferol, 3-(kaempferol-8-yl)-2,3-epoxyflavanone	Herb	Whole aerial part	Strong analgesic, strengthens bones and joints, treatment of headaches and fractures	Haifeng *et al.* (2009), Krug and Milliken (2008), Liu *et al.* (2014), Ming-Fang *et al.* (2009), Samten (2009)
17	Kutki, putishing	Figwort flower Picrorhiza	Plantaginaceae	*Neopicrorhiza scrophulariiflora* (Pennell) D.Y. Hong	Phenylpropanoid glycosides (scrophulosides A and B), androsin, picroside I, non-glycosidic iridoids, piscrocins (D, E, F, G), iridoid glycosides (piscrosides A and B)	Herb	Stolons, rhizomes, roots	Cold, cough and headache, also for problems related to bile, high blood pressure, sore throat, intestinal pain and conjunctivitis, fever	Kim *et al.* (2006), Krug and Milliken (2008), Rawal *et al.* (2009), Samten (2009), Wang *et al.* (2006)

(Continued)

Table 1.3 (Continued)

No	Local name	English name	Plant Family	Scientific name	Nutraceutical/Phytochemical	Habit	Part used	Uses/Medicinal properties	References
18	Drimug, muktsi	Tibetan Onosma	Boraginaceae	*Onosma hookeri* C.B. Clarke	Acetylshikonin, β,β-dimethylacrylshikonin, β,β-dimethylacrylalkannin or arnebin-1, shikonin, naphthaquinone pigments	Herb	Roots	To cure lung diseases, purify blood and stop vomiting of blood, also for tuberculosis, anti microbial, anticancer, antithrombotic, anti-inflammatory, wound healing, skin rashes	Krug and Milliken (2008), Ning and Cao (1996), Papageorgiou *et al.* (1999), Samten (2009)
19	Pangchidebo	-	Caprifoliaceae	*Pterocephalus hookeri* (C.B. Clarke) Diels	Loganin, triterpenoid saponins (hookerosides A–D), oleanolic and ursolic acids	Herb	Whole plant (roots)	Antidote, chronic inflammation, cold, cough	Krug and Milliken (2008), Samten (2009), Tian *et al.* (1993), Tan *et al.* (2011), Yang *et al.* (2006)

20	Domnag domthri	-	Plantaginaceae	*Veronica ciliata* Fisch.	Iridoid glycosides, benzoic acid	Herb	Entire plant including roots	Used as a substitute for bile, used to stop bleeding, wound treatment	Krug and Milliken (2008), Kun *et al.* (2003), Samten (2009)
21	A-bhi-sha, Xiao bai he	Dwarf lily	Liliaceae	*Lilium nanum* Klotzsch & Garcke	Not reported	Herb	Whole plant (bulbs as tonic)	Antidote and allays head injuries, heels bone fracture	Chen *et al.* (2000), Krug and Milliken (2008), Samten (2009)
22	Tsepara, lamichop	Bigflower Rhodiola	Crassulaceae	*Rhodiola crenulata* (Hook. f. & Thomson) H. Ohba	Salidroside (rhodioloside), rosavins, p-tyrosol, 2-Methyl-3-buten-2-ol, 3-Methyl-2-buten-1-ol,n-Octanol, geraniol, citronellol, myrtenol, linalool, 1-Octen-3-ol, pyrogallol, gallic acid, β- sitosterol, crenulatin, ellagic acid kaempferol,	Herb	Fleshy stems (rhizomes), roots	Alleviate depression , stimulation of nervous system, antioxidative	Krug and Milliken (2008), Qu *et al.* (2012), Samten (2009), Wang and Wang (1992)

Table 1.4 Medicinal plants from South Asia with potential for use as nutraceutical source and as functional food component.

No	Local name	English name	Plant Family	Scientific name	Nutraceutical /Phytochemical	Habit	Part used	Medicinal properties	References
1	Laasona	Garlic	Amaryllidaceae	*Allium sativum* L.	Saponins, sterols, tannins, proteins, carbohydrates, cardiac glycosides, sulphur compounds (trisulfide, di-2-propenyl; disulfide, di-2-propenyl; trisulfide, methyl 2-propenyl, diallyl disulide)	Herb	Bulb and oil	Anticancer, antimicrobial, reduces blood pressure and blood cholesterol, antiviral, antifungal, anti-inflammatory, stimulant, carminative, antiseptic, anthelmintic, expectorant, diuretic, diaphoretic, diuretic, antisorbutic aphrodisiac, antiasthmatic, pulmonary diseases	Douiri *et al.* (2013), Kadam *et al.* (2013), Mikail (2010)
2	Ghee Kunwar, Ghritkumari	Aloe	Xanthorrhoeaceae	*Aloe vera* (L.) Burm. f.	Barbaloin (10-β-D-glucopyranosyl-1,8-dihydroxy-3-(hydroxymethyl)-9(10*H*) - anthracenone), tannins, flavonoids, lectins, terpenoids, carbohydrates, alkaloids, saponin, fatty acids, cholesterol, anthraquinones, chromones, mono and polysaccharides, sterols (lupeol, campesterol, and β-sitosterol), salicylic acid, organic acids, enzymes, saponins, vitamins, minerals, anthrone, aloe emodin, aloetinic acid, choline, choline salicylate, sapogenins	Herb	Leaves, stems	Laxative, anti-helminthic, skin disorders, , anti-inflammatory, cathartic, antiviral, wound healing, burns, antimicrobial, anticancer, antioxidant activity, dysentery, diarrhoea	Basu *et al.* (2007), Joseph and Raj (2010), Patel *et al.* (2012), Raphael (2012)

3	Balsana, Dendhu	St. John's wort	Hypericaceae	*Hypericum perforatum* L.	Dianthrone derivatives (hypericin, pseudohypericin, protohypericin), phloroglucinol derivatives (hyperforin, furohyperforin, adhyperforin), flavonoids (hyperoside, quercetin, quercetrin, rutin, biapigenin, kaempferol), flavonols (catechins), xanthones, n-Alkanols, Monoterpenes (α-pinene, β-Pinene, limonene), sesquiterpenes (caryophyllene, humulene)	Herb	Leaves, flowers	Analgesic, anti-viral, anti-censor, antidepressant and antiviral activity, treatment of traumas, burns, scabs and ulcers	Basu *et al.* (2007), Vattikuti and Ciddi (2005),
4	Shimla mirch	hot peppers, chili pepper	Solanaceae	*Capsicum annuum* L.	Capsaicin, carotenoids [capsanthin, zeaxanthin, provitamin A carotenoids : β-cryptoxanthin, α-carotene, β-carotene], flavonoids (quercetin and luteolin), total soluble reducing equivalents, phenolic acids, ascorbic acid	Herb	Fruit	Anticancer, anti-inflammatory, antiapoptotic, analgestic, carminative, rubefacient, anti oxidant, hypoglycemic, antifungal, antimicrobial, used as carminative, an appetiser and a stomachic. treatment of rheumatism, lumbago, neuralgia, and mental disorders	Howard *et al.* (2000), Laroche (2007), Sunil *et al.* (2012)

(Continued)

Table 1.4 (Continued)

No	Local name	English name	Plant Family	Scientific name	Nutraceutical /Phytochemical	Habit	Part used	Medicinal properties	References
5	Kali mirch	Black pepper	Piperaceae	*Piper nigrum* L.	Piperine, alkaloids, coumarins, phenols, tannins, β-Elemene, tricyclo[6.2.1.0(4,11)]undec-5-ene,1,5,9,9-tetramethyl-(isocaryophyllene-II), β-caryophyllene, (+)-β-Selinene, eremophilene, nonacosane, methyl hexadecanoate, ethyl hexadecanoate, methyl 14-methyl heptadecanoate, methyl trans-8-octadecanote, ethyl cis-9-octadecanaote, hexadecanoic acid, octadecanoic acid	Herb	Fruit	Helps in digestion, antimicrobial, antiapoptotic, antibacterial, anti-Colon toxin, antidepressant, antifungal, anidiarrhoeal, anti-inflammatory, antimutagenic, anti-metastatic activity, antioxidative, antiriyretic, antispasmodic, antispermatogenic, antitumour, antithyroid, ciprofloxacin potentiator, cold extremities, gastric ailments, hepatoprotective, insecticidal activity, intermittent fever, larvisidal activity	Ahmad *et al.* (2012), Krishnaswamy (2008), Siddiqui *et al.* (2005), Trivedi *et al.* (2011)

6	*Kala-dhatura*	Thorn apple, Downy datura	Solanaceae	*Datura metel* L.	Tropane alkaloids, flavonoids, glycosides, phenols, tannins, sterols saponins	Herb	All parts	In treatment of heart ailments, antibacterial, antifungal, asthma, cough, convulsion, insanity, anaesthetic, antispasmodic, bronchodilator and as hallucinogenic	Akharaiyi (2011), Dahanukar *et al.* (2000), Kiruthika and Sornaraj (2011)
7	Vilayati pudina	peppermint	Lamiaceae	*Mentha* × *piperita* L.	Menthol (Monoterpene), alkaloids, flavonoids, steroids, tannins, phenols	Herb	Leaves	Topical pain reliever & antipyretic, antibacterial, common cold, musculoskeletal pain, to calm pruritus and relieve irritation, anti-inflammation	Galeotti *et al.* (2002), Herro and Jacob (2010), Pramila *et al.* (2012), Sujana *et al.* (2013)
8	-	Scots pine (Pine oil)	Pinaceae	*Pinus sylvestris* L.	Borneol (Monoterpenes: α-pinene, car-3-ene, β-pinene, β-phellandrene, camphene, myrcene, limonene, terpinolene), glycerol, 3′-O-methylcatechin, phenolic compounds	Tree	Needles (leaves)	Disinfectant, antibacterial, antifungal, antiviral, antiseptic (pulmonary, urinary, hepatic), antineuralgic, cholagogue, choleretic, diuretic, expectorant, hypertensive, cough, catarrh	Basu *et al.* (2007), Maciąg *et al.* (2007), Pan and Lundgren (1996)

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