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CARAWAY, CHINESE CHIVES AND CASSIA AS FUNCTIONAL FOODS WITH CONSIDERING NUTRIENTS AND HEALTH BENEFITS

Mohamad Hesam Shahrajabian[1]✉, Wenli Sun[1], Mehdi Khoshkharam[3], Qi Cheng[1,2]✉

[1]Biotechnology Research Institute, Chinese Academy of Agricultural Sciences, Beijing 100081, China
[2]College of Life Sciences, Hebei Agricultural University, Baoding, Hebei, 071000, China; Global Alliance of HeBAU-CLS&HeQiS for BioAl-Manufacturing, Baoding, Hebei 071000, China.
[3]Faculty of Agriculture, Islamic Azad University Isfahan (Khorasgan) Branch, Isfahan, Iran
✉chenqi@caas.cn; ✉Hesamshahrajabian@gmail.com

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ABSTRACT
Since ancient times, the medicinal properties of plant material improve the quality of life. Medicinal plants and foods may provide phytotherapy a new dimension and enable their application to treat and prevention of diseases with the advantage of reducing chemical drugs. Historically, caraway, Chinese chives and cassia have enjoyed a rich tradition of use for flavouring, and medicinal purposes, because of wide range of secondary metabolites with potent antibacterial, antioxidant, antimicrobial, anti-inflammatory, anticancer and other tremendous benefits. In many countries, medicinal plants are widely used as functional foods and daily supplements with the aim of promoting public health and both preventing and curing diseases. The main characteristics, components, active substance and important pharmacological and health benefits of caraway, Chinese chives and cassia was reviewed.

1. Introduction

Medicinal and aromatic plants are the prospective source of bio-molecules in curative drug formulations (Shahrajabian et al., 2020a,b). Medicinal plants application dates back to the origin of human civilization (Sun et al., 2019a,b; Shahrajabian et al., 2019a,b), which works to prevent and treatment of diseases by boosting immune system (Shahrajabian et al., 2020c). Caraway (*Carum carvii* L.) of the *Apiaceae* family, appears to have its origin in Asia minor. It is mainly cultivated in the Netherlands, Finland, Hungary, Morocco, Iran, India and Russia (Laribi et al., 2011). Caraway is basically a biennial but usually treated as an annual from crop production techniques. Chinese chives (*Allium tuberosum*) are an herb-like perennial which is indigenous to Eurasia and North America. Chinese chives are low in calories but high in beneficial nutrients such as vitamins, minerals and antioxidants. Cassia (*Cinnamomum cassia*) is a tree, native to Southern China, Laso, Vietnam and Sumatra. *Cinnamomum cassia* from Lauraceae family is considered as one of the 50 fundamental herbs in traditional Chinese medicine. It is used in food products, such as liqueurs, flavourings and perfumes and regularly used in therapeutic aromatherapy products. The goal of this manuscript is review of important pharmacological benefits of caraway, Chinese chives and cassia.

2. Caraway (*Carum carvi*)

2.1. Introduction and chemical constituents of caraway

Caraway oil is more effective when topically applied than when supplemented in the diet (Shwaireb, 1993). The dried fruit contains 2-8% essential oil with carvone and limonene the principal components (Bailer et al., 2001; Lopez et al., 2008). Morphological characteristics of the caraway flowers influenced by temperatures and photoperiod (Nemeth et al., 1998). Other important oil components of caraway are β-myrcene, *trans*-dihydrocarvone, *trans*-carveole, α-pinene, sabinene, n-octanal, *trans*-β-ocimene, γ-terpinene, linalool, *cis*- and *trans*-limonene oxide, *cis*-dihydrocarvone, *cis*-carveol, perillaldehyde, *trans*-anethole, and *trans-β*-caryo-phyllene (Raal et al., 2012). *Carum carvi* (caraway) seed have shown that they contain large numbers of terpenes in different concentrations which vary greatly with geographical origin, climate, and harvest time (Grevsen et al., 2009; Laribi et al., 2012). The major constituents of caraway essential oil isolated by hydrodistillation (HD) are limonene (43.5%), carvone (32.6%), and apiole (15.1%); and by microwave-assisted hydrodistillation (MHD) are apiole (12.3%), carvone (31.1%), and limonene (48.4%), consisting of 99.6% of total essential oil, respectively (Jiang et al., 2011). Putievsky et al. (1994) reported that two main compounds in the various caraway oils were limonene (34%-50%), and carvone (47%-62%). Galambosi and Peura (1996) reported that the carvone/limonene ration of the wild populations from the northern parts of Finland was higher than that from the Southern parts of the country. Abdalaziz et al. (2017) reported that from the eight identified constituents, representing 100% of the oil, the most abundant compounds detected were L-Fenchone (55.01%), *p*-Methoxy benzaldehyde (19.15%), and *p*-Methoxy allyl benzene (9.46%), and *Carum carvi* L. seeds are rich sources of oils containing diverse group of phytochemicals.

2.2. Pharmaceutical benefits in traditional and modern pharmaceutical sciences of caraway

Carvone as the main constituent of caraway essential oil is used as a natural inhibitor of sprouting mainly in stored potatoes and onions (Bouwmeester et al., 1998; Laribi et al., 2009), which has been shown to be biologically active, inhibiting germination of seeds, and promoting the growth of certain fungi and microbes (Toxopeus and Bouwmeester, 1992; Iacobellis et al., 2005; Khan and Sastry, 2009). The monoterpenoid limonene has antibacterial, anticancer, antispasmodic, expectorant, fungistatic and other properties (Duke et al., 2003). The traditional use of caraway as a hypoglycemic agent is proved and its extract shows a dose-dependent hypoglycemic activity (Eidi et al., 2010).

In traditional Persian medicine, Ibn Sina traditionally used caraway for weight loss, stomach ache, burping, flatulence and intestinal spasms (Mahboubi, 2019). Carvone has various applications, such as fragrance, and flavor, potato sprouting inhibitor, antimicrobial agent and also in the medical field (Baysal and Starmans, 1999; Laribi et al., 2013). Carvone (*p*-mentha-6,8-dien-2-on, $C_{10}H_{14}O$), molecular weight 150,21, density 0.965, boiling point 230-231°C) is a colorless or yellow oil, insoluble in water and miscible with ethanol (Bailer et al., 2001). Wichtl (1994) reported that caraway promotes gastric secretion, stimulates appetite, and is used as a remedy for colic, loss of appetite and digestive disorders. Caraway oil inhibited the motor activities of SMC of the gallbladder, stomach, trachea and ileum (Boskabady et al., 2003; Micklefield et al., 2003). It is beneficial effect in relieving gastrointestinal symptoms associated with dyspepsia was reported (Al-Essa et al., 2010). Caraway extract has positive role in the management of obesity (Kazemipoor et al., 2013).

Colon premalignant lesions induced by 1,2-dimethylhydrazine (DMH) is mediated by interference of caraway oil components in the activities of the main hepatic xenobiotic metabolizing enzymes (Dadkhah et al., 2011). The aqueous extract of *Carum carvi* may exhibit a potent lowering activity in both normal and severe hyperglycemic rats after repeated oral administration of *Carum carvi* aqueous extract (Lemhadri et al., 2006).

The chronic intake of caraway essential oil influences the pharmacokinetic properties of both orally and intraperitoneally applied paracetamol (Samojlik et al., 2012). Treatment with the black caraway seed essential oil sub-acute toxicity study attenuated histopathological changes in lung, liver, kidney, testes and spleen tissues, but its essential oil can not affect the immune and blood system (Tabarraei et al., 2019). Pharmaceutical benefits of caraway are shown in Table 1.

Table 1. Pharmaceutical benefits of caraway.

Pharmaceutical benefits	Mechanism and impacts	References
Anti-oxidant activity	a. Black caraway seed oil may be used as a natural antioxidative food additive for improving food quality and stability. b. Caraway seeds and by-product flour can improve the antioxidant potential and overall quality of protein bread.	Yu et al., 2005 Polovka and Suhaj, 2010 Kozlowska et al., 2016 Ahmad et al., 2018
Anti-microbial activity	a. Caraway essential oil has effective antimicrobial agents against *Escherichia coli* and *Staphylococcus aureus*.	Simic et al., 2008 Dimic et al., 2009 Seidler-Lozykowska et al., 2013 Hormis et al., 2015 Khalil et al., 2018
Anti-bacterial activity	a. Caraway essential oil may have the inhibiting effect to reduce the number of *Staphylococcus aureus* and *Escherichia coli*.	Singh et al., 2002 Kwiatkowski et al., 2015
Anti-ulcerogenic activity		Khayyal et al., 2001
Anti-proliferative activity		Nakano et al., 1998
Anti-mutagenic activity		Akram et al., 2020
Anti-cancer activities	a. Caraway may inhibit tumorigenesis though the effect of the intermediary dose of 60 mg/kg body weight was clear. b. Thymoquinone (TQ) from black caraway seeds has several anticancer activities. c. TQ may enhance cisplatin- and docetaxel-induced cytotoxicity.	Naderi-Kalali et al., 2005 Kamaleeswari et al., 2006 Sutton et al., 2014
Anti-hyperglycaemic		Eddouks et al., 2004 Ene et al., 2007 Tahraoui et al., 2007
Anti-diabetes	a. Caraway maybe useful in the control of postprandial rise of blood glucose particularly in diabetic condition. b. Caraway may exhibit blood glucose and lipid lowering activities in diabetes without any effect on C-reactive protein level.	Li et al., 2004 Sushruta et al., 2006 Sadjadi et al., 2014
Anti-inflammatory	a. Combined treatment with peppermint and caraway oil modulates post-inflammatory visceral hyperalgesia synergistically.	Adam et al., 2006 Lacatusu et al., 2017
Improve sleep quality	a. Consuming caraway with aerobic exercise has positive effects on the level of C-reactive protein and sleep quality.	Mohammadkhani et al., 2019
Bio-herbicide	a. Oil-in-water emulsion containing 2.5% of caraway essential oil can be considered as a foliar applied botanical herbicide against barnyardgrass in maize cultivation.	Synowiec et al., 2017 Synowiec et al., 2019

3. Chinese chives (*Allium tuberosum*)

3.1. Chemical components and pharmacological benefits

Chinese chives (*Allium tuberosum*) is a perennial plant cultivated in different parts of Asia, with smelly odor which had been caused by the sulfur-containing compounds (Block, 2013). Its aerial parts of Chinese chive are one of the daily edible green vegetable for Chinese cuisine which is widely cultivated and used for both food and medicine (Mnayer et al., 2014). Chinese chives can have different nutritional and functional components depending on their harvest time (Kim et al., 2018). It is a long-day plant, similar to leek (*A. ampeloprasum* L.) or rakkyo (*A. chinense* G. Don), which are both in the same genus, *Allium* (Kamenetsky and Rabinowitch, 2002). The leaves and seeds of this plant are often used in traditional folk medicines for the treatment of impotence and nocturnal emission in China (Hu et al., 2009). Polysaccharide which is an important type of natural biopolymers has posses various nutritional value and health functions (Zhang et al., 2016). The green leaves are smooth, slim, linear, flat, have a distinctive mild garlic flavor, and are rich in vitamins, fiber, mineral compounds and sulfur compounds that have antibiotic properties (Imahori et al., 2004), but they are highly perishable and quickly lose freshness after harvest (Jia et al., 2017). The major pest of Chinese chives in china is the oligophagous insect *Bradysia odoriphaga* Yang & Zhang (Diptera: Sciaridae) (Feng and Zheng, 1987; Chen et al., 2019), which is distributed in the soil layer at 0-5 cm (Shi et al., 2016), and the rhizomes particularly damaged by Chinese chive (Zhang et al., 2015).

Analysis of the amino acid content of Chinese chive seed revealed that it is a good source of the essential amino acids, isoleucine, tryptophan and lysine with high levels of nutritionally important components, such as oil, minerals and essential amino acids (Hu et al., 2006). Its seeds contain amounts of steroidal saponins (Sang et al., 2001; Zou et al., 2001). The most important constituents isolated from various parts of *Allium tuberosum* are thymidine, adenosine, daucosterol, dimethyl disulfide, allyl methyl disulfide, dimethyl trisulfide, allyl methyl trisulfide, diallyl disulfide, tuberosine A, and tuberoside A. *A. tubersoum* L. contains thiosulfinates which are unstable intermediates in the enzymatically initiated degradation of *S*-alk(en)yl-L-cysteine sulfoxide (Ashe and Berry, 2003). Chinese chive contains high concentrations of organic sulfur compounds, which confer characteristics flavors (Randle and Lancaster, 2002), and human health benefits (Griffiths et al., 2002). Chinese chive is used for kidney protection in traditional Chinese medicine (Guohua et al., 2009; Pandey et al., 2014). Chinese chive polysaccharides (CCP) could improve the kidney functions of adenine-induced chronic renal failure (CRF) mice and the renoprotective effect might be associated with its antioxidant, anti-inflammatory and anti-fibrosis activities (Li et al., 2018). Combined extracts from *Lepidium meyenii* (maca) root and *Allium tuberosum* Rottl. (Chinese chive) seed produce better synergistic effects on male sexual function than maca extract or Chinese chive extract alone, and the positive effects may involve the up-regulation of nitric oxide (NO) and cyclic guanosine monophosphate (cGMP) concentrations in penis (Zhang et al., 2019). Results suggest that *n*-BuOH extract preparation of *Allium tuberosum* seeds possesses aphrodisiac property (Guohua et al., 2009). *Allium tuberosum* has a significant hepatoprotective and antioxidant activity which may be useful for adjuvant chemotherapy doxorubicin (Sutejo and Efendi, 2017). Ferulic acid from *A. tuberoum* Rottl is the strong choline acetytrasferase (ChAT) activator (Kim et al., 2007). It is also possess sexual enhancing properties (Tang et al., 2017). It is also reported that its extract possess strong hair growth promoting potential which controls the expression of insulin like growth factor-1 (IGF-1) (Park et al., 2015). Pharmaceutical benefits of Chinese chives are presented in Table 2.

Table 2. Pharmaceutical benefits of Chinese chives.

Pharmaceutical benefits	Mechanism and impacts	References
Anti-cancer activity	a. Thiosulfinates from A. tuberosum L. inhibit cell proliferation and induce apoptosis in PC-3 cells, which may be mediated via both caspase-dependent and –independent pathways. b. Thiosulfinates from *A. tubersoum* L. inhibited cell proliferation and activated both the caspase-dependent and caspase-independent apoptotic pathways in HT-29 cells.	Kim et al., 2008 Lee et al., 2009
Anti-diabetic activity	a. The anti-diabetic and hepatoprotective effect of *Allium tuberosum* maybe associated with its antioxidant and its ability to inhibit the pro-inflammatory mediators.	Tang et al., 2017
Antifungal activity	a. It exhibited antifungal activity against *Rhizoctonia solani*, *Fusarium oxysporum*, *Coprinus comatus*, *Mycosphaerella arachidicola*, and *Botrytis cinerea*.	Lam et al., 2000 Benkeblia and Virginia, 2007 Rattanachaikunsopon and Phumkhachorn, 2009 Kocevski et al., 2013
Anti-bacterial activity	a. *S*-Methyl methanethiosufinate and *S*-methyl 2-propene-1-thiosulfinate separated from Chinese chive showed significant antibacterial activities against *E. coli* O-157:H7 including spoilage microorganism in food.	Seo et al., 2001 Nauman et al., 2014 Sharifi-rad et al., 2016
Anti-oxidant activity	a. It can be concluded that ethanolic extract of *Allium tuberosum* has a significant hepatoprotective and antioxidant activity.	Sutejo and Efendi, 2017
Antiparasitic activity	a. It has nematicidal property against root-know nematodes particularly against *Meloidogyne incognita* J2 which attacks root.	Yong-hong et al., 2016
Aphrodisiac	a. It has traditional usage for its aphrodisiac property.	Baljinder et al., 2010 Cinara et al., 2012 Ramandeep et al., 2012
Hypolipidemic	a. It may process sulfur ameliorated liver dysfunction and reduce serum LDL level and intra-abdominal fat.	Eun-Jeong et al., 2012
Anti-inflammation activity	a. Polysaccharides from *Allium* plants have been shown to be effective in resisting oxidation and alleviating inflammation. b. Caraway extract has preventive and anti-inflammatory impact against vascular disease and has potential for supporting prevention against the early process of atherosclerosis.	Lee et al., 2009 Mladenovic et al., 2011 Nikolova et al., 2013 Hur and Lee, 2017

4. Cassia (*Cinnamomum cassia*)

4.1. Introduction and chemical constituents

The genus *Cinnamomum* comprises of several hundreds species which are distributed in all over the world. Cassia, which is the bark of the evergreen tree, is a similar spice to cinnamon but of an inferior quality, which is native to Myanmar, China, Indonesia, and central America. Cassia bark is coarser and less fragrant than cinnamon and is sometimes used as a substitute. *Cinnamomum cassia* from Lauraceae family is considered as one of the 50 fundamental herbs in traditional Chinese medicine. Cinnamon is a spice obtained from the inner bark of several tree species from the genus *Cinnamomum*. Cinnamon has been reported to have significant benefits for human health, especially as an anti-inflammatory, antitumor, anticancer, anti-diabetic and anti-hypertriglyceridemia agent (Muhammad and Dewettinck, 2017; Han and Parker, 2017; Kaur et al., 2019). Other important derivatives are cinnamaldehyde, cinnamic acid and cinnamate (Rao and Gan, 2014). Liu et al. (2018) reported that 39 isolated compound of *C. cassia*, including 12 flavonoid glycosides, three cinnamic acid amides, 12 lignans, five sesquiterpenoids, three cinnamaldehyde derivatives, two phenols, and two indole derivatives. The dominant constituents found in the essential oils of *C. cassia* were aromatic compounds (> 90%) including (E)-cinnamaldehyde (CAL) and (*E*)-cinnamyl acetate (CAC) as the major components (Dong et al., 2013; Jeyaratnam et al., 2016; Le et al., 2020). He et al. (2016) reported three new compounds, including two new diterpenoids, named epianhydrocinnzeylanol, cinnacasiol H., and one hydroxylasiodiplodin, (3R,4S,6R)-4,6-dihydroxy-de-*O*-methyllasiodiplodin, together with five known diterpenoids, and two know phenolic glycosides isolated from the barks of *Cinnamomum cassia*. Zeng et al. (2017) isolated two new glycosides, cinnacassides F, and G from the barks of *Cinnamomum cassia*.

4.2. Pharmaceutical benefits of *Cinnamomum cassia*

Some *Cinnamomum* species such as *C. cassia* is consumed as a spice in cooking to add flavor (Mendis Abeysekera et al., 2019) or some other are cultivated as landscape plants and sidewalk trees (Wang et al., 2020). In traditional medicine in countries like China, India, Indonesia and Vietnam, cassia leaves are used to treat headache, chills, abdominal pain, dysentery, vomiting, cold stomachache, chest tightness, diarrhea, frostbite and cough, and twigs are used to treat blood circulation disturbances, diabetes, dyspepsia and gastritis (Ngoc et al., 2009), the stem barks are used to treat tussis, gastrointestinal neurosis, diarrhea, amenorrhea, dysmenorrheal, impotency, arthralgia, edema, and cardiac palpitation (Liao et al., 2009), and the buds are used to treat cardiothoracic pains, cold pain in the stomach and abdomen nausea, vomiting, belch, hiccup, cough and dyspnea (Zhou et al., 2019). Prasanth et al. (2020) showed that the nine phytochemicals of *Cinnamon* are very likely against the main protease enzyme of COVID-19. Promising antimutagenic and antimicrobial properties were revealed by the cinnamon bark ethanolic extract and cinnamaldehyde, respectively (Vijayan and Mazumder, 2018). Both in vivo and in vitro findings suggest that the EOCC possesses significant spasmolytic effect on uterine contraction which can be a good candidate for the prevention and treatment of primary dysmenorrheal (Sun et al., 2017). *C. cassia* inhibits fibrogensis, followed by HSC-T6 cell activation and may increase restoration of liver function, ultimately resulting in acute liver injury (Lim et al., 2010). Kim et al. (2015) found that the water extract of *Cinnamomum cassia* (CCWE) was a potent inhibitor of angiogenesis. Combined treatment with cinnamaldehyde and β-TCP promoted bone formation and angiogenesis in osteoporotic bone defects, which provides a promising new strategy for repairing bone defects in osteoporotic conditions (Weng et al., 2019).

Table 3. Pharmaceutical benefits of cassia.

Pharmaceutical benefits	Mechanism and impacts	References
Anti-microbial activity	a. *C. cassia* oil is a promising natural antimicrobial for food industry.	Cava et al., 2007 Andrade et al., 2014 Sheng and Zhu, 2014
Anti-fungal activity	a. Trans-Cinnamaldehyde showed the highest antifungal activity, also thymol and carvacrol had additive effect with trans-cinnamaldehyde in preventing the mycelia growth of *Sclerotinia sclerotiorum*. b. *C. cassia* extracts showed notable antifungal potential towards *Penicillium italicum* and *Penicillium digitatum*. c. The antifungal effects of acetone extracts of *C. cassia* against five kinds of plant pathogenic germ including *Alternaria solani*, *Alternaria alternate*, *Fusarium decemcellulare*, *Botrytis cinerea* and *Colletotrichum glycines* were reported.	Jiang et al., 2013 Liu et al., 2015 Pekmezovic et al., 2015 Lu et al., 2019
Anti-bacterial activity	a. Total polyphenols in the non-volatile parts of *C. cassia* branches and leaves showed antibacterial activity in vitro against Gram-positive (*Staphylococcus aureus* and *Streptococcus pneumoniae*), and Gram-negative (*Escherichia coli* and *Pseudomonas aeruginosa*) bacteria. Its hexane extract of bark may inhibit MRSA, *Enterococcus faecalis*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia* and *Acinetobacter baumannii*.	Hossan et al., 2018 Li et al., 2018 Vaillancourt et al., 2018 El Atki et al., 2019 Song et al., 2019
Anti-oxidant activity	a. *Cinnamomum* leaf can be used potentially as a readily accessible source of natural antioxidants. Its ethanol extract has significant anti-oxidant properties.	Hwa et al., 2012 Yang et al., 2012
Anti-inflammation activity	a. The essential oil (EO) from the twigs of C. cassia demonstrates the antinociceptive and anti-inflammatory properties. b. It can significantly attenuated danger signals-induced inflammatory responses via regulation of inflammasome activation. c. Ethyl acetate extracts of cinnamon could alleviate the lung injury of endotoxin-poisoned mice by antagonizing the activation of the NLRP3 inflammasome.	Xu et al., 2019
Anti-viral activity	a. *C. cassia* prevents airway epithelia from human respiratory syncytial virus (HRSV) infection through	Yeh et al., 2013

	inhibiting viral attachment, internalization and syncytium formation.	
Anti-diabetes activity	a. Sesquiterpenoids may be the active compounds in its bark on diabetic nephropathy. b. The cinnamon is effective in controlling blood sugar of people with type 2 diabetes. c. Its extracts may enhance blood sugar lowering effect as compared with standard extracts, and better effects on lipid profile, liver enzymes and other biochemical parameters.	Soni and Bhatnagar, 2009 Gruenwalk et al., 2010 Yan et al., 2015 Kaur et al., 2018
Anti-cancer activity	a. *C. cassia* essential oil and its main component cinnamaldehyde had anti-oral cancer properties, and they could significantly reduce the viability of human oral squamous cell carcinoma HSC-3 cells, and induce DNA damage as well as G2/M cell cycle arrest and apoptosis. b. The cinnamon extract possess cytotoxicity at very low concentrations, and cinnamon extract has the potential use as a part of the food regime in patients suffering from gastric and colon cancer. c. Water-extracted branch of *C. cassia* (WBCC) and cinnamic acid can be potential candidates for developing novel anti-cancer drugs through glycolysis metabolism. d. Its extract may exhibit cytotoxic activity against HepG2.	Park et al., 2002 Wang et al., 2016 Chang et al., 2017 Anju et al., 2018 Lee et al., 2018
Anti-tyrosinase activity	a. It has inhibitory effects against tyrosinase	Chang et al., 2013 Chou et al., 2013
Anti-allergy activity	a. Inhibitory effects of cinnamaldehyde on phospholipase C (PLC) signaling pathway in human embryonic kidney cells have been shown. b. Inhibition of mucosal mast cell activation via suppression of PLCγl signaling pathway.	Kim et al., 2008
Anti-depressant activity	a. It might be an effective anxiolytic agent by regulating the serotonergic and GABAergic system. b. The standardized methanolic extract of *C. cassia* demonstrated antidepressant activity that can be attributed to rise in serotonin levels.	Yu et al., 2007 Jung et al., 2012 Zada et al., 2016
Lactation	a. Supplementing lactating goats rations with garlic, cinnamon or ginger oils has positive effect on milk yield, milk composition and milk fatty acids profile.	Kholif et al., 2012

Cardiovascular protective activity	a. Cinnamic acid, eugenol and cinnamyl alcohol are identified as the active components of cardiovascular protective. b. The water extract of *C. cassia* may have preventive and protective effects on diabetic cardiomyopathy through significantly increasing the content of PCR, ATP and ADP in myocardial tissue as well as improving cardiac energy metabolism to a certain extent.	Kim et al., 2015 Kwon et al., 2015 Wei et al., 2018
Anti-arthritic activity	a. *C. cassia* bark hydroalcoholic extract significantly reduce MDA levels and may lead to decrease in TNF-α receptor expression.	Sharma et al., 2018
Cytoprotective activity	a. The aqueous extract of *C. cassia* showed the *in vitro* cytotoxic effects of *cis*-diammine dichloroplatinum (CDDP), which was achieved by suppressing the increased expression of CDDP-induced mitochondrial Bax protein, releasing mitochondrial cytochrome *c*, activating caspase-3, making DNA fragmentation and generating ROS and up-regulating expression of cytoprotective gene (heme oxygenase (HO)-1).	El Kady and Ramadan, 2016
Anti-nematodes activity	a. Cinnamaldehyde was found to be the most potent chemical derived from Cinnamon.	Kong et al., 2007

5. Conclusions

Medicinal plants have been shown to have tremendous health benefits, such as digestive stimulant action, anti-inflammatory, antioxidant activity, antimicrobial, antimutagenic, hypolipidemic activities, anticarcinogenic potential and etc. Nutraceutical substances obtained from medicinal plants have demonstrated physiological benefits or are capable of providing some sort of protection against diseases. The most important pharmaceutical and health benefits of caraway are anti-oxidant, anti-microbial, anti-bacterial, anti-ulcerogenic, anti-proliferative, anti-mutagenic, anti-cancer, anti-hyperglycaemic, anti-diabetes, anti-inflammatory activities, improve sleep quality and bio-herbicide. The most important pharmacological properties of Chinese chives are anti-bacterial, anti-fungal, anti-parasitic, aphrodisiac, anti-cancer, hypolipidemic, pesticidal, renoprotective, promotion of hair growth, anti-coagulant, regulate hormonal balance, and mediate sensory perception. The most important health benefits of cassia are anti-microbial, anti-fungal, anti-bacterial, anti-oxidant, anti-inflammation, anti-viral, anti-diabetes, anti-cancer, anti-tyrosinase, anti-allergy, anti-depressant, cardiovascular protective activity, anti-arthritic, cytoprotective, anti nematodes activity and improve lactation. More researches are needed to find the potential challenges and benefits of incorporating these medicinal plants in the diet which may offer prospective opportunities for future drug development.

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