An Overview on Inventions Related to Ginger Processing and Products for food and Pharmaceutical Applications

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: The rhizome of *Zingiber officinale* Roscoe (Zingiberaceae), commonly known as ginger, is one of the most widely used spice and condiment. The nonvolatile pungent compounds (namely gingerols, shogaols, paradols, and zinger- one) are some of the extensively studied phytochemicals and account for the antioxidant, anti-inflammatory, antiemetic, and gastro protective activities. This review a persuasive presentation of the current information regarding the patents that have been granted during the last decade related to the processing of ginger with an emphasis on the methods of extraction and mechanisms exploited for health claims for ginger-containing foods and pharmaceutical compositions. Further studies are required for the validation of the beneficial uses of ginger. Formulation for novel products and new usages may emerge in the years to come, basing on the revealed results of various studies.

: Anti-inflammatory, cancer, gingerol, pharmaceutical, processing, *Zingiber officinale.*

INTRODUCTION

Ginger rhizome (*Zingiber officinale* Roscoe) is most widely cultivated for use both as a spice and as a medicinal herb. It forms a part of the traditional medicinal practices of all the ginger-growing countries [1]. As a medicinal herb, ginger has long been used in China, India, Roman and Arab countries, for the management of various human ailments including headaches, colds, fever, nausea, and rheumatic disorders [2]. Indians consider it as *Mahaoushadha* (the great medicine). The refreshing pleasant aroma, biting taste and carminative property of ginger, make it an indispensable ingredient of food processing throughout the world. Fresh ginger, ginger powder from dry ginger, oleoresin and oil are used for this purpose. Moreover, it is considered as 'generally recognized as safe' (GRAS) by the Food and Drug Administration (FDA) of the United States.

Ginger is reported to contain numerous chemical constituents and these vary depending on the place of origin and whether the rhizomes are fresh or dry. Chemical constituents of ginger rhizomes include volatiles (camphene, -phellandrene, curcumene, cineole, geranyl acetate, terpineol, borneol, geraniol, limonene, -elemene, zingiberol, linalool, -zingiberene, -sesquiphellandrene, -bisabolene, zingiberenol and -Farnesene) and non-volatile pungent phytochemicals consisting of the biologically active components viz., gingerols, shogaols, paradols and zingerone [3, 4].

Over the years, ginger and its extracts have received increasing attention because of its pronounced antioxidant [5], anti-inflammatory [6], anti-diabetic [7] and anti-cancer activities [8-10]. Several studies have shown that ginger is more efficient at reducing nausea than vitamin B_6 [11, 12]; other studies compare ginger to placebo [13, 14] or to antiemetic prescription drugs [15]. Levine *et al*. [16] showed that administering high protein meals with ginger reduced the delayed nausea of chemotherapy and reduced the use of antiemetic medications.

Pharmacological investigations have revealed that ginger and its major pungent ingredients have chemopreventive and chemotherapeutic effects on a variety of cancer cell lines and on animal models [17, 18]. Due to all these properties, gin- ger has gained considerable attention in developed countries in recent years, especially for its use in the treatment of inflammatory conditions [9, 19] as well as in cancer cell lines [20].

In a recent study, [6]-shogaol was the strongest inhibitor of dibutyl phthalate-induced bronchial smooth muscle cells proliferation and migration [21]. The antimetastatis activities of 4-shogaol was evaluated [20] and found that 4-shogaol effectively inhibits the metastasis of breast cancer by decreasing NF- B and Snail, sequentially resulting in the reinforcement of Raf kinase inhibitor protein (RKIP) expression, inhibition of cell migration and invasion.

Weng *et al*., [22] observed that [6]-shogaol and [6]-gingerol exerted anti-invasive activity against hepatoma cells through regulation of MMP-9 and tissue inhibitor metalloproteinase protein (TIMP-1). [6]-shogaol further regulated urokinase-type plasminogen activity. Ling *et al*., [23] reported that shogaols of differing side chain lengths had an inhibitory effect on PMA-induced invasion of MDA-MB- 231 (ER-negative, p53 mutation, model of more advanced stage breast cancer) breast carcinoma cells, which was asso- ciated with a decrease in the extracellular secretion of matrix metalloproteinase-9 (MMP-9). [6]-shogaol was found to be

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potent inhibitor of MDA-MB-231 cell invasion, and the molecular mechanism involves the down-regulation of MMP-9 transcription by targeting the NF-kB activation cascade.

Hsu *et al*., [24] employed human breast cancer MDA MB-231 (ER-negative, p53 mutation, model of more ad- vanced stage breast cancer) and MCF-7 (ER-positive, p53 wild type, model of early-stage breast cancer) cell lines to assess the molecular mechanisms responsible for the antipro- liferative effect of [6]-dehydrogingerdione (DGE) and found that DGE caused cell cycle arrest at G2/M phase and induced an apoptotic response. [6]-shogaol inhibited cell proliferation by inducing cells to autophagic cell death through AKT/mTOR inhibition in human non-small cell lung cancer A549 cells and hence can be a promising chemo preventive agent [25]. [6]-shogaol was also effective in inducing the apoptotic cell death of Mahlavu cells via an oxidative stress- mediated caspase dependent mechanism at >50 M concen- tration [26].

Moreover, the growing interest in nutraceutical compounds from ginger has led to efforts to find different extraction approaches for isolating/ identifying potential compounds possessing the above properties with an endeavour to develop and formulate new products for pharmaceutical usage.

PATENTS DURING THE LAST TWO DECADES

In fact, a number of patents have been granted/published on the extraction methods as well as on the processing and preparation of different forms of ginger that can be incorporated into foods and pharmaceutical compositions. Among them, a few selected patents that have been granted during the last decade, describing processes, product compositions and uses of ginger in various preparations are discussed un- der different headings.

Plant Design for Selected Products

Ginger cutting devices: Equipment was designed [27] for cutting of the irregularly shaped ginger roots, which comprises of a conveyor, an imaging means and a cutting device. The ginger roots were placed on the conveyor and cutting device was moved to the exact position with the help of the information provided by the image so as to obtain uni- form slices suitable for further processing.

Preparation of fresh ginger base: A method for the bulk preparation and individual distribution of fresh ginger base from a central location involves selecting fresh ginger root and comminuting it. A liquid mixture was prepared con- taining water, natural sweetener, edible acid, and salt. A predetermined amount of the comminuted ginger was then packed in a substantially airtight container. The comminuted ginger occupies more than ~ 90 percent of the internal volume of the container, which was later cooled to its freezing point. The container and the receptacle could be distributed from the central location to the site of intended use [28].

Methods for ginger extracts: A method [29] ascribed for obtaining an extract from ginger using butter as an ex- traction medium. The major fat-soluble components of gin- ger were extracted to produce a yellow liquid compound with dense consistency at ambient temperature, which was said to have therapeutic activity and hence can be used in food and for pharmaceutical purposes.

Method for large-scale production of shogaols (which are useful in foods, perfumes, drugs, quasi drugs, cosmetics) was reported for industrial use [30]. Extracts and components isolated from the plant genus *Zingiber*, particularly from the rhizome of ginger were described. The extracts possess activities with applications in many fields, including research reagents, pharmaceutical and nutraceutical product development, manufacture of improved high-value foods and feeds as well as production of alcohol from cereals, and waste treatment [31].

Ginger extracts were prepared and stabilized using chemical auxiliary agent (viz., polyvinylpyrrolidones). These preparations were stable up to 18 months. The invention also described solid galenic dosage forms such as capsules, and tablets, which contain the stable ginger extract preparations [32, 33]. Lim *et al*., [34] patented a method for preparation of extract from fresh ginger subjected to ultrasonic treatment at a frequency 20-30 kHz for 20-60 min. This extract con- tained higher soluble solids than the ginger extract obtained using conventional extraction methods. This extract exhib- ited antimicrobial properties.

Li *et al*., [35] developed a method to separate and purify [6]-gingerol from the extract of supercritical fluid extraction of ginger. A patent was assigned for the sequential extraction of ginger species to yield an essential oil fraction, a gingerol fraction, a phenolic fraction, and a polysaccharide fraction by Li and co-workers [36]. The gingerol composition com- prises of [6]-, [8]-, [10]-gingerol, [6]-shogaol, or combina- tions. Hawkins [37] invention relates to ginger rhizome ex- tracts and/or components isolated, which could be used in the treatment of infections caused by pathogenic micro-organisms including viruses, bacteria, protozoa and parasites.

A method for extracting gingerol from ginger with high efficiency was reported [38]. The method included microwave extraction of fresh ginger with 65-95% ethanol followed by dissolution in 30-40% ethanol and absorbing on to a macro porous resin column. The resin column was first eluted with water followed by 75% ethanol. The fractions were collected and concentrated. The extracting method was designed by orthogonal test, the obtained gingerol had stable quality and the method was suitable for industrial production due to its low cost. The optimum condition for extraction of phenolic fraction from ginger was reported using 80% ethanol, at 640W microwave power for 25s with the material to solvent ratio of 1:30 (w/v) [39]. Under this optimal condi- tion, the yield of phenolic fraction was 16.97 mg/g. Antioxi- dant experiments showed that the ginger extract exhibited a strong DPPH radical scavenging activity, reducing power and inhibition of lipid peroxidation activity, and antioxidant activity increased with increasing concentration.

Application for Food Use

Tenderisation of meat: Earlier reports showed that the ginger protease could be applied in the tenderisation of meat, and improve the quality of meat [40-42]. A method for improving tenderness and overall qualities of tough buffalo meat using plant proteolytic enzymes from *Z. officinale*

(ginger rhizome) and *Cucumis trigonus Roxb* (Kachri) was developed [43]. Ginger extract-treated meat samples received better scores for appearance, flavour, tenderness and overall acceptability. From these results, it was shown that ginger and cucumis could be used as an effective alternative to papain. Pitaya & Richard [44] investigated methods for stabilizing ginger protease during storage or enzyme fractionation.

Beverage formulation: Fermentation of fine ginger grains with yeasts resulted in the beverage having health- promoting effects [45]. An acidic beverage was formulated for pregnant women containing carbohydrates, essential vi- tamins (B_6, C & folic acid) and minerals (ammonium iron citrate, calcium gluconate, calcium lactate, magnesium car- bonate) along with ginger juice so as to maintain the good nutritional state of foetus [46].

Archer [47] formulated an organic, ergogenic and energy enhancing drink with a soothing effect. The isotonic soft drink comprised of extract from ginger, leaves of *Cym- bopogon citratus*, peppermint along with sugar or other sweeteners dissolved in purified water. A process for the manufacture of an improved herbal beverage prepared from mixture of extracts of ginger root (*Z. officinale*) along with China Root (*Smilax domingensis* Willd), Bejuco indio (*Gouania polygama*) and Pimento leaves (*Pimenta dioica* Merr) was described [48]. The beverage was both stable, relatively free from undesirable fermenting complexes. Original beverage formulation without ginger possessed sedative effect due to china root. Improved beverage with inclusion of ginger reduced sedative effect.

A process for producing the fermented milk drinks as well as foods involved culturing of animal milk using lactic acid bacteria in a medium containing its growth promoter (viz., selected from ginger extract, tea extract, green onion extract, oleic acid and derivatives) was reported [49]. These fermented milk drinks and foods can contain a large number of viable cells of lactic acid bacteria and sustain the activity (acid producing ability) at a high level.

Bakery products: Moisture adsorption characteristics of ginger bread was studied by Cervenka, *et al*., [50] and found that keeping the moisture content of gingerbreads below 12-15% dry basis (60-64% of RH) may ensure long shelf life during storage at room temperature. A powder composition for making ginger pudding was described by Kaneko *et al*. [51]. This composition contained ginger powder (1.6-4 wt. %), milk protein (31-62 wt. %), wheat protein (7-15 wt. %), calcium lactate (1.6-5.5 wt. %), carrageenan (0. 8-2. 4 wt. %) and lactic acid bacteria (0.4-1.6 wt. %). All the ingredients were mixed with cow milk and heated in a microwave oven.

Baby foods: Production of infant foods containing ginger, which can be used to reduce gastrointestinal reflux are described [52]. The foods may contain a ginger puree and one or more fruits or vegetables. A baby-food composition comprised of blanched ginger puree (0.1-0.5%) together with one or more fruits or vegetables at suitable levels. The ginger component of the baby-food composition of the present invention contains an amount, sufficient for diminishing gastroesophageal reflux.

Soup mix: A process for the preparation of ready to use chicken soup mix was disclosed [53] wherein the preparation of dehydrated chicken soup mix involved pressure cooking of chicken meat along with ginger, garlic, onion followed by separation of liquid extract from cooked meat. The cooked meat was blended with starch and spices, addition of liquid extract to the mix to make slurry and finally drying of slurry to obtain powder. The resultant powder was mixed with milk powder, salt, monosodium glutamate (MSG), ascorbic acid, pepper powder and sugar. The product was sensorily highly acceptable and microbiologically safe.

Condiment: A simple method for manufacturing *Z. officinale* condiment through cooking in vegetable oil has been developed [54], wherein the *Z. officinale* granules are cooked in vegetable oil to obtain golden-coloured granules which can be stored for long time. Sudo [55] developed a method for the production of grated ginger wherein the raw ginger with the outer skin was cooked with oil and then pasted, ster- ilized to inactivate the thermo- resistant bacteria.

Pharmaceutical Compositions for Anti-inflammation

Wu *et al*. [56] reported a method of preparing a product potent in anti-inflammation or in anti-platelet aggregation from rhizomes of *Z. officinale.* The extracts were prepared by extraction of ginger rhizomes with an organic solvent (such as ethyl ether, acetone, methanol and ethanol) or su- percritical CO_2, or by steam distillation of ginger rhizomes. The crude extract was subjected to reverse phase chromatog- raphy to obtain the fractions containing shogaols, gingerols and/or dehydrogingerdione and monitored by HPLC.

A pharmaceutical composition mainly comprising of ginger, *Fructus jujubae, Radix astragali, Radix glycyrrhizae, Ramulus cinnamomi*, and green tea mainly effective against Type I allergy was reported by Zhang & Fu [57]. A dietary supplement composition comprising water/alcohol extract of ginger, *Strobilanthes cusia, Panax pseudo-ginseng, Eucommia ulmoides, Momordicae grosvenori*, licorice root, and *Allium fistulosum* was described for ameliorating inflammatory changes in influenza process [58].

A process for preparing a ginger fraction which can be used as such or combined with drugs for inhibiting human cytochrome P450 (CYP) enzymes (cytochrome P450 3A4, CYP3A4) for positively influencing the oral bioavailability and pharmacokinetics of active substances was reported [59-62]. Kim [63] reported the invention related to the use of compounds isolated from turmeric, gingko and ginger, and synthetic chemical analogues for the treatment of a beta-amyloid protein-induced disease.

A pharmaceutical composition containing ginger extract was developed for inhibiting human drug transporters for positively influencing the oral bioavailability and pharmacokinetics of active substances [64]. A formulation containing ginger extract and bisabolol or an extract containing bisabolol was formulated for treating or eliminating irritation and/or inflammation reducing effect on endodermal tissue of the respiratory as well as gastrointestinal tract. The ratio of bisabolol and ginger was adjusted such that the irritation and inflammation-reducing action of the constituents was increased synergistically [65]. A composition comprising of

gingerol and anthocyanidin from red ginger extract along with glucosamine and/or its salt for inhibiting of inflamma- tion was described [66]. The defatted red ginger was ex- tracted with hydrous ethanol followed by removal of ethanol to obtain dried extract.

Pharmaceutical Compositions for Treatment of Ulcer

Ginger juice along with honey was incorporated in tooth- paste [67], to remove the mouth smell, to prevent oral ulcera- tion and to diminish inflammation, promote regeneration of the skin tissues. Potential antiulcer compounds from ginger rhizome, which has many uses in both herbal, and food for- mulations were prepared [68, 69]. The invention also gives information regarding the extraction of water soluble anti- oxidant and pectic polysaccharide fractions having antiulcer property exhibits H^+, K^+-ATPase inhibition and hence can be used in the treatment of gastric cancer caused by stress or acid, or *Helicobacter pylori* induced ulcer etc.

Pharmaceutical Compositions for Treatment of Cancer

A composition comprising of a synergistic mixture of ginger, boswellia extract, salts of glucosamine, and curcumi- noids optionally containing bromelain, chondroitin, methyl- sulphonylmethane, resveratrol, extracts of white willow and quercetin was formulated. This composition was capable of controlling inflammatory conditions, preventing and curing cancer in mammals [70]. Newmark *et al*., [71, 72] reported a composition, which comprises of supercritical extracts of ginger, rosemary, turmeric, oregano along with therapeuti- cally effective amounts of hydroalcoholic extracts of ginger, holy basil, turmeric, *Scutellaria baicalensis*, rosemary, green tea, huzhang, Chinese goldthread, and barberry for treating tumorigenesis of glioblastoma as well as prostate and oral cancer.

Pharmaceutical Compositions for Relief from Pain

A method was disclosed [73] for treating degenerative musculoskeletal disease such as rheumatoid arthritis and osteoarthritis in animals. The composition comprised of ex- tracts of *Z.officinale* rhizomes (5-15%), *Withania somnifera* roots (30-50%), *Boswellia serrata* (30-50%), turmeric rhi- zomes (1-15%), and gum exudates in a predetermined pro- portion relative to each other with or without other biologi- cally active inorganic ingredients (zinc sulphate). This com- position could be administered typically enterally, in a con- venient dosage form. Kelly & Perry [74] disclosed an herbal composition that can be used to relieve pain in migraines and headaches. It included ginger root extract along with white willow bark extract, kava kava root extract, feverfew extract, guarana extract, and vitamin B_6. It may be combined with liposomes and can be applied sublingually for rapid, effec- tive pain relief.

An herbal ointment mixture comprising of ginger oil (2.4%), clove oil (3.2%), wintergreen oil (4.9%), peppermint oil (4.9%), along with ginger root powder (1.4%), cayenne powder (1.4%) and petroleum jelly (81.8%) was formulated for soothing aches and pains [75]. An herbal composition that aids in the relief of symptoms caused by edema, cyano- sis, blood stasis, neuropathy and related conditions was re- ported [76]. This composition included ginger essential oil, cayenne extract, myrrh essential oil, frankincense essential oil, cinnamon essential oil, and powdered saffron in carrier oil, preferably safflower oil. This herbal composition can be applied on the exterior surfaces of the human body using massage strokes in the direction of venous blood flow.

Vad's [77] invention related to enhanced pain control and shortened onset of pain control effect in arthritis by ingesting a composition comprising ginger, glucosamine and chon- droitin sulfate or methylsulfonylmethane, all at a level of daily dosage required. An organic composition was formu- lated for treating and/or preventing certain physical ailments such as pain in a person. This composition comprised of ef- fective amounts of powdered ginger, turmeric, cumin, fen- nel, cinnamon, red pepper flakes, chia seed, celery seed, and hibiscus petals [78].

Pharmaceutical Compositions for Treatment of Diseases of Skin and Appendages

A formulation consisting of compounds from ginger and bisabolol was formulated. The composition was selected in such a way that both components function synergistically to reduce skin irritation [79]. A method for treating dyshidrosis and dry skin disorders, comprising topical administration of a herbal formulation comprising of ginger, black walnut, wormwood, turmeric, garlic, licorice, chamomile, clove, nutmeg combined with aloe vera and niacin was disclosed [80]. Synergistic antioxidant effect exhibited by a mixture of herb extracts- licorice, ginger, kudzu, sophora and thyme, which can be used for skin care preparations are described [81].

A new class of anti-infective agents were extracted from ginger, pepper, and other plant species containing vanillyl and piperidine ring structures typical of the pungent princi- ples found in the plant. The role of these structures, their attached hydrocarbon groups, and other agents found with the plant extract was demonstrated in the topical treatment of dermatophyte infections, tissue injuries, and abnormal pro- liferations of keratin [82]. The water-soluble ginger extract was obtained by extracting the ginger root with water or an- hydrous alcohol. Ginger extract causes less skin irritation because of being substantially free of gingerols, and pos- sesses excellent body-hair growth inhibiting effects, so that it is useful as a hair growth inhibitor [83].

Pharmaceutical Compositions for Prostate Health and Fertility in Men

An herbal composition which can help promote prostate health in men was prepared from ginger, green tea, pumpkin seed oil, urtica root extracts, selenium, watermelon and rosemary. The composition contained therapeutically effec- tive amounts of supercritical extracts of ginger, rosemary, green tea, pumpkin seed oil, urtica, watermelon along with selenium. This herbal composition reported to control urine flow and promote normal prostate cell growth, and anti- aging constituents that inactivate free radicals, thereby pro- viding antioxidant benefits [84]. A composition comprising of aqueous ginger rhizome extract (5-21 wt. %), aqueous extracts of radish seeds (20-35 wt. %), aqueous celery seeds extract (20-35 wt. %) and aqueous black seeds extract (4-9

wt. %) was formulated and administration of composition was said to enhance fertility in a male individual [85].

Pharmaceutical Compositions for Hormonal Imbalance in Women

An herbal composition which can be used to alleviate the symptoms associated with hormonal imbalance in women contained supercritical extracts of ginger, rosemary and evening primrose oil and supercritical extracts of black cohosh, dong quai, schizandra berry, and chaste tree berry was reported. The herbal composition can be administered orally, topically or parenterally. In addition to promoting hormonal balance, the herbal composition also promotes normal bone growth by inhibiting the 5-lipoxygenase enzyme and sustains warmth and normal fluids for healthy sexual functioning [86].

Pharmaceutical Compositions for Menstrual Syndrome in Women

Fasano [87] invented an herbal composition for women for the treatment of premenstrual syndrome, premenopausal symptoms, menopausal symptoms and postmenopausal symptoms in the tablet form. The composition includes the combination of ginger root, sage leaf, red raspberry leaf, bayberry bark, capsicum pepper, damiana leaf, licorice root, vaierian root, black cohosh root, red clover extract and kudzu root. A soft gelatin capsule or tablet containing evening primrose oil along with calcium, magnesium, vitamin B_6, vitamin B_{12}, St. John's wort, ginger oleoresin and *Gymnema sylvestre* was prepared and orally administered for the treatment of pre-menstrual syndrome [88].

Pharmaceutical Compositions for Antimicrobial Infections

Suzuki [89] invented an agent for the treatment of infections, which was effective against virus infections, fungal infections, etc, which comprised the active ingredient at least one member selected from the group consisting of aconite-alkaloids, aconite tuber and an extract thereof, gingerol and analogues thereof, and rhizomes of ginger and a substance there from. Bok *et al*., [90] invention described a health-improving spice composition, comprising ginger (0.2 to 10%), garlic (1 to 30%), onion (10 to 50%), jujube (5 to 40%), and citrus peel (10 to 50%) or an extract thereof with naringin/hesperidin (1 to 20%). A composition for treating symptoms such as common cold, sore throat, congestion, laryngitis and mucous membrane inflammation was disclosed [91]. The composition included ingredients from ginger powder (30-150mg/g composition), turmeric extract (5- 20 mg/g composition), horse radish root powder (25-75mg/g composition) along with a pharmaceutically acceptable carrier for oral administration.

A method of treating a patient suffering from a disease associated with *Trichophyton mentagrophytes* or *Pityrosporum ovale* by applying topically an anti-fungal pharmaceutical composition prepared from *Z. officinale* was described [92]. An anti-microbial composition containing ginger root powder (30-150mg), green tea extract (5-20mg), turmeric extract (5-20mg) along with a carrier was reported [93]. Inventors claimed that this composition could be used for reducing, treating or preventing symptoms of microbial infection in patients.

Ginger, as one of the major ingredient in various forms (viz., raw, powder, extract) was incorporated in different pharmaceutical compositions that may be used in the treatment of wide array of ailments including arthritis, rheumatism, sprains, muscular aches, pains, sore throats, cramps, constipation, indigestion, vomiting, hypertension, dementia, fever, infectious diseases. However, inventions were carefully selected based on the various aspects related to ginger processing and products for food and pharmaceutical applications and are summarised in Table **1**.

Miscellaneous

Raissen [138] used herbs and herbal extracts and/or oils in breath odor control generally by aiding the digestive proc- ess. The said composition contained ginger, licorice, chamomile, parsley seed oil, and sunflower seed oil in a de- livery system which was intended to be ingested and swal- lowed whole for delivery of the ingredients to the stomach and/or lower in the digestive tract. An herbal formulation comprised of ginger root, peppermint leaf, fenugreek seed, fennel seed along with a mixture of Chinese herbs and meth- ylsulfonylmethane for soothing intestinal bowel was reported [139].

An herbal pharmaceutical composition comprising of ginger rhizome, scutellaria root, coptis rhizome, rhubarb root, and dry powders of ginseng root (or American ginseng) was formulated and it was reported to be effective for pre- vention of development of cardiovascular diseases [140]. A composition comprising of gingerol (0.5-78%, w/w), a silymarin (0.6-96%, w/w), a catechin (1-98%, w/w), along with vitamin B_1 (0.04-88%, w/w), vitamin B_6 (0.06-88%, w/w), vitamin B_{12} ($7x10^{-7}$-12%, w/w) was reported for the prevention and treatment of symptoms (for example, a hangover) associated with ethyl alcohol consumption [141].

A ginger flavoured liquid seasoning developed [142] using ginger extract along with grated onion and radish grains. A composition useful as a substitute for table salt was reported [143]. The salt substitute contained calcium chlo- ride (10 wt. %), a potassium citrate (20 wt. %), citric acid (30 wt. %), rice flour (30 wt. %), ginger oil (5 wt. %) and one or more flavorants.

An herbal tablet comprising effective amounts of ginger, green tea, caffeine, cocoa, calcium, yerba mate, hawthorne berry, parsley leaf marshmallow root, fennel seed, astragalus root, licorice root, suma, cinnamon, celery seed, and alfalfa leaf useful for promoting weight loss was reported [144]. A method for treatment of cachexia involving the step of administering, to a human or animal, a composition including ingredients obtainable from ginger, turmeric, green tea, and, optionally, horseradish was described [145]. Methods of treating, inhibiting, and/or abatement of cognitive decline and Alzheimer's disease with a derivative of ginger oil were provided [146]. A method for reducing odor of excreta of animals by feeding with a composition comprising of ginger (0.1- 5%, of the total weight of the composition) or fiber together with another odor reducing agent has been

Table 1. Summary of the Selected Patents Describing Processes, Product Compositions and Uses of Ginger

Patent Number	Inventors	Title	Year	Description
JP	N. Yasumoto Y. Kawahara A. Hashimoto Y. Takeuchi [94]	Ginger enzyme preparation and production thereof	1992	Ginger enzyme formulation prepared using ginger enzyme extract along with sugars, amino acids, carboxylic acids or their salts as a stabilizing agent for meat-softening and preservation over a long period.
JP	F. Takeda [95]	Preparation of crushed raw ginger	1995	A preparation of crushed raw ginger was reported and contains the following steps: skinning of raw ginger, optional cutting of the skinned ginger to a proper size, crushing and sealing in a vessel and later stored at -5 to -40°C in frozen state. This had stability for 10 days.
EP	M. Scaloni [96]	A procedure for the preparation of a ginger-root infusion to desensitize teeth and gums and infusion prepared according to said procedure.	1995	Ginger-root infusion for mouthwash or as an additive to toothpaste, ointment, wax was prepared and useful for desensitizing teeth and gums to temperature changes.
JP	K. Hirasa S. Motohashi T. Ine [97]	Production of grated ginger product	1996	A grated ginger composition comprising raw ginger or frozen ginger containing acetic acid (to maintain pH 3 - 4.5) was heat- treated at 48-60°C for 0.5 hour to two days and packed into a container, sealed and heat-treated.
US	B. Patwardhan [73]	Method of treating musculoskeletal disease and a novel composition therefore.	1996	A method for treating degenerative musculoskeletal disease (such as rheumatoid arthritis and osteoarthritis in animals) was reported. The composition contains extracts of ginger, *Withania somnifera* roots, *Boswellia serrata*, turmeric rhizomes, and gum exudates.
JP	S. Iwahata M. Noguchi Y. Ito [98]	Ginger-flavored composition and ginger-tasted food	1998	A ginger-flavored composition possessing refreshing flavour included ginger extract along with one or more extracts obtained from pepper, cardamom, ajowan, beefsteak plant, nutmeg, rosemary, oregano, lemon, lemongrass, Japanese pepper, savory, celery, thyme, marjoram, lime and orange.
JP	M. Kake [99]	Production of ginger decoction	1999	Improved ginger decoction powder containing ginger extract, sugar, starch, glucose, raw sugar, arrow root starch, epigallocatechin gallate and cyclodextrin was prepared using selected processing steps such as pasting, extraction, and sterilisation.
JP	J. Yoshifuji N. Kojima M. Fujii [100]	Ginger food improved in taste of ginger	2000	Ginger food with improved ginger taste was prepared using alternate sweetener viz., sucralose as taste-improving agent was reported.
US	F. Suzuki [89]	Agent for the treatment of infections.	2000	An agent for the treatment of infections (viz., virus, fungal infections, etc.) comprising from the group consisting of aconite-alkaloids, aconite tuber, gingerol from ginger rhizomes.

(Table 1) Contd….

Patent Number	Inventors	Title	Year	Description
US	J.J. Staggs [82]	Therapeutic uses of pungent botanicals and their related compounds.	2000	A new class of anti-infective agents was extracted from ginger, pepper, and other plant species containing vanillyl and piperidine ring structures. The role of these structures was demonstrated in the topical treatment of dermatophyte infections, tissue injuries, and abnormal proliferations of keratin.
US	R.C. Theuer [52]	Ginger containing baby-food preparation and methods therefore.	2000	A baby-food composition comprised of blanched ginger puree together with one or more fruits or vegetables at suitable levels was reported, which can be used to reduce gastrointestinal reflux.
US20010046523	T. Newmark P. Schulick [101]	Ginger -based herbal composition for promoting health and methods of using same	2001	An herbal composition containing supercritical extract of ginger and rosemary to promote stomach, liver and intestinal health; reduce inflammation; support blood platelet health and cardiovascular function; and provide antioxidant benefits was reported.
US	T.S. Wu S.C. Kuo C.M. Teng F.N. Ko [56]	Method of preparing an extract potent in anti-inflammation and anti-platelet aggregation from *Zingiber officinale* and pharmaceutical compositions containing said extract.	2001	A method of preparing a product potent in anti-inflammation or in anti-platelet aggregation from rhizomes of *Z. officinale* was reported.
US	T. Newmark P. Schulick [84]	Composition for promoting prostate health containing selenium and herbal extracts.	2001	An herbal composition was prepared using ginger, green tea, pumpkin seed oil, urtica root extracts, selenium, watermelon and rosemary for promoting prostate health in men.
US	T. Newmark P. Schulick [86]	Herbal composition for promoting hormonal balance in women and methods of using same.	2001	An herbal composition containing supercritical extracts of ginger, rosemary and evening primrose oil and supercritical extracts of black cohosh, dong quai, schizandra berry, and chaste tree berry was reported for the treatment of symptoms associated with hormonal imbalance in women.
US	G.J. Kelly A. Perry [74]	Herbal composition to relieve pain.	2001	An herbal composition containing ginger root extract along with white willow bark extract, kava kava root extract, feverfew extract, guarana extract, and vitamin B_6 was reported that can be used to relieve pain in migraines and headaches.
US	S.H. Bok T.S. Jeong K.H. Bae Y.B. Park M.S. Choi Y.K. Kwon B.H. Hyun Y.K. Choi C.H. Lee S.S. Moon [90]	Health-improving spice composition.	2002	A health-improving spice composition comprising of ginger, garlic, onion, jujube, and citrus peel or an extract thereof with naringin/hesperidin was reported.

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