Cultivation practice and disease management of *Zingiber officinale* Roscoe in Hosanagara, Shivamogga Karnataka, India

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ABSTRACT

Ginger (*Zingiber officinale)* is one of the hot aromatic spices of Zingiberaceae family. It's tender herbaceous, knobby perennial plant native to humid, partly-shaded habitats of Southeast Asia. Present work aimed to study cultivation practices, pest and diseases management in Hosanagara, Shivamogga Karnataka India. In the global market, India is the principal source for supply of spices. Ginger occurs in different forms such as fresh, dried, pickled, preserved, candied or crystallized and ground powdered forms. There are many varieties of ginger are grown in India and are named accordingly their locality few are Suprabha, Suruchi, Suravi, Himgiri, Mahima, Rejatha, Karthika, Athira and Aswathy. It is a good source of calcium phosphorus, iron and vitamins. Ginger is propagated by planting rootstock cuttings and harvesting is done simply by lifting the rhizomes from soil, cleansing and sun drying. Harmful diseases which may be reduce the quality and quantity of ginger production are rhizome rot, leaf spot, dry rot, bacterial and fungal wilt. These diseases are controlled by avoiding water logging, managing field hygiene and using good quality rhizome for sowing. The rhizome of ginger used as tonic to treat common ailments. Ginger is almost used in all the traditional medicine like Ayurvedic, Chinese and Unani, since ancient time to treat different diseases that include rheumatoid arthritis, sprains and muscular aches, sore throats, nausea, constipation, indigestion, fever and infectious diseases. Modern research has explored ginger's antioxidant, anti-inflammatory, antimicrobial and anticancer properties.

KEY WORLDS: Aromatic, cultivation, diseases, ginger, harvest, rhizome, spice, Shivamogga.

HIGHLIGHTS

Zingiber officinale is a common spice used in foods and beverages.
It is used in Ayurvedic, Unani and Chinese medicines since antiquity.
These validated health benefits strongly support its nutraceutical application.
Suprabha, Suruchi, Suravi, Himgiri, Mahima, Rejatha, Karthika, Athira and Aswathy.
Cultivation, harvesting, disease and management
Hosanagara, Shivamogga, Karnataka, India

INTRODUCTION

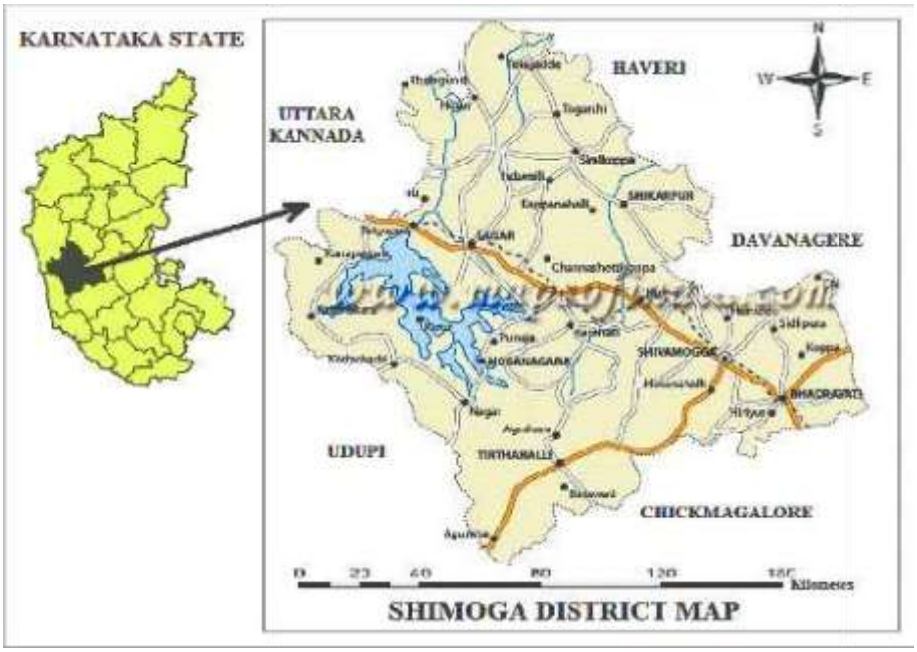
Ginger's generic name, *Zingiber*, is derived from the Greek *zingiberis*, which comes from the Sanskrit name of the spice, *singabera*. Its use in India and China has been known from ancient times. Ginger (*Zingiber officinale* Roscoe) is one of the hot spices belonging to Zingiberaceae family. An herbaceous perennial plant native to Southern Asia. Ginger rhizome is consumed as a spice in foods and beverages because of its characteristic pungency and piquant flavour. It is used in a variety of foods and also in carbonated drinks, in liquors and as a preserve in sugar syrup Murabba (B.H. Ali *et. al.* 2008; Srinivasan 2017). Ginger is an excellent source of several bioactive phenolics, including non-volatile pungent compounds such as gingerols, paradols,

shogaols, and zingerones. Ginger is also used in traditional oriental medicine (Ayurvedic, Chinese, and Unani systems of medicine) since antiquity (>2500 years) to treat different diseases that include rheumatoid arthritis, sprains and muscular aches, sore throats, nausea, constipation and indigestion, fever, infectious diseases, and helminthiasis (Chrubasik *et al*. 2013; Srinivasan 2017). It is particularly valued in medicine as a carminative and stimulant to the gastrointestinal tract (Zhang *et. al*. 2013; Srinivasan 2017). Ginger is known to increase the motility of the gastrointestinal tract and has antibacterial, antiviral, analgesic, and antipyretic properties (Patel *et. al*. 2001. The efficacy of ginger rhizomes as a phytomedicine in the context of its use as a broad-spectrum antiemetic has been reviewed by Chrubasik *et. al*. 2013; Prakash *et. al.* Srinivasan 2017). Ginger is abundant in active constituents, such as phenolic and terpene compounds (Prasad and Tyagi 2015; Mao *et. al.* 2019). The phenolic compounds in ginger are mainly gingerols, shogaols, and paradols. In fresh ginger, gingerols are the major polyphenols, such as 6-gingerol, 8-gingerol, and 10-gingerol. With heat treatment or long-time storage, gingerols can be transformed into corresponding shogaols. After hydrogenation, shogaols can be transformed into paradols (Stoner 2013; Mao *et. al*. 2019). There are also many other phenolic compounds in ginger, such as quercetin, zingerone, gingerenone-A, and 6-dehydrogingerdione (Fang *et. al.* 2017; Schadich *et. al*. 2016; Mao *et. al*. 2019). Terpene components in ginger, such as β-bisabolene, zingiberene, β-sesquiphellandrene, α-curcumene, and α-farnesene, which are considered to be the main constituents of ginger essential oils Besides these, polysaccharides, lipids, organic acids, and raw fibers are also present in ginger (Prasad and Tyagi 2015; Yeh *et. al* 2016; Mao *et. al*. 2019). Ginger occurs in different forms such as fresh, dried, pickled, preserved, candied or crystallized and ground powdered forms. It is a stifling plant with a long growing season and the seed is pre sprouted indoors early in the year to ensure a harvest before the weather turn cold. In the global market, India is the principal source for supply of spices, even though there are a number of other countries like Indonesia, Malaysia, Pakistan, Australia, Spain, Egypt and Tanzania were produce and export ginger to the international market. Almost all the states in India are growing ginger but the leading states are Meghalaya, Mizoram, Arunachal Pradesh and Sikkim contributes about 65% in India's total production. It is a good source of calcium phosphorus, iron and vitamins. The rhizome of ginger used as tonic to treat common ailments. There are many varieties of ginger rhizome. There are many varieties of ginger are grown in India and these are named accordingly their locality few are Suprabha, Suruchi, Suravi, Himgiri, Mahima, Rejatha, Karthika, Athira and Aswathy. Ginger is propagated by planting rootstock cuttings and has been under this type of cultivation for so long that it no longer goes to seed. Harvesting is done simply by lifting the rhizomes from the soil, cleansing them, and drying them in the sun. Present work aimed to study cultivation practices, pests and diseases management in Shivamogga Karnataka.

MATERIALS AND METHODS

STUDY AREA:

The field work was carried out in Chandaladimba village of Hosanagara, Taluk Shivamogga District. It is a part of "Malnad region" of Karnataka. It lies between Latitudes 13° 27' and 14° 39' north and between the longitudes 74° 38' and 76° 04' east at mean altitude of 585 meters above the sea level. The average rain falls ranges from 3000-8000mm. It lies 13.9743° north and 75.5997° east. Agriculture field is about 1.5 hectare in this village.



Habit of *Zingiber*

Rhizome of *Zingiber*

METHODOLOGY

The study was conducted during cultivation period of March to July (2023). Interact with formers in those grows ginger crop. Interaction is about crop yield, Diseases causing to it, how to prevent the diseases, maintenance of ginger and its medicinal value.

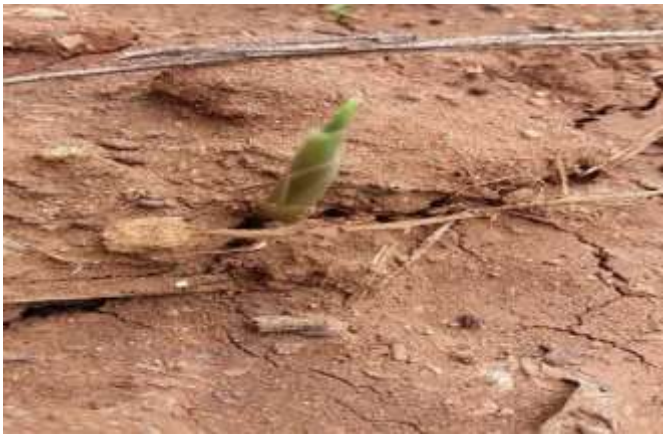
RESULTS AND DISCUSSION

The health benefits of the pungent spice ginger rhizomes are being increasingly understood and experimentally validated in recent decades.

GINGER CULTIVATION PRACTICE;

Planting;

Planting is done between the February to April depending on rainfall. The rhizomes are planted in 2-3 rows of the beds and covered with soil. The spacing between the plants is 15 centimetres. During planting, each seed is broken into 2-4 sprouts. Heavy weed growth has been influenced by heavy rainfall. After a month, the beds are weeded and disposed off.



Planting of ginger

MULCHING OF GINGER;

After planting, the beds are covered with mulches. The mulches consisting of forest litters, grass, straw and plant residues up to 8-10 cm thick. Mulching protects seedlings from rain, prevents weed growth and keeps soil soft and moist and accelerates growth. Mulches are prepared by putting grasses in cattle shed for a few days and it mixes with cattle dung and urine. Mulching increases germination, weed growth and soft rot.

Mulching of ginger

PLANTING GINGER IN CONTAINERS;

Well drained and soilless media in containers can be used. Better to use good quality and low salt coir's (Coconut fiber) has been used. Bendable grow bags or large pots can be used for rhizomes to grow up and enough room for filling. For planting, the bag has been filled with soilless media mixed with fertilizer, gypsum. It has been covered with media approximately 2 inches.

TEMPERATURE;

Ginger enjoys morning sun light and stippled shade. It can be grown in temperature not exceeding 32.5 c in summer.

IRRIGATION;

Drip irrigation can be applied to maintain moisture to the ginger form improved heavy day aloes good drainage. Enough water is watered to the plants to keep the soil moist evenly. Water should not be stagnated.

Irrigation of ginger

FERTILIZERS AND MANURES;

Organic and inorganic fertilizers have been used. Compost is preferable liquid fertilizer is preferable for rhizome. Fertilizing with seaweeds and fish emulsion for every 6-8 weeks give best results. At planting time, mild and balanced fertilizer has been used at each hilling. The compost has been used, but restrict to add materials that decomposes actively. The decomposed materials use the soil nutrients and may causes heating of soil. Poultry based on manure has been used. Ginger takes more nitrogen to support the growth of the leaf. Potassium has been added after the rhizome formation in the month of August and September respectively. The recommended dosage for ginger is 75klgms of Nitrogen, 50klgms of Phosphorous pentoxide, 50klgms of Potassium dioxide, 6klgms of Zinc and 30gms of Zinc sulphate per hectare.

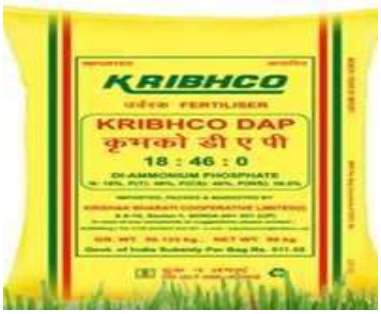
SEAWEED FERTILIZER GRANULES:

Seaweed fertilized Granules are the growth promoter. It used 25 kg per Hectare. It used regularly with other fertilizer.

NPK FERTILIZER;

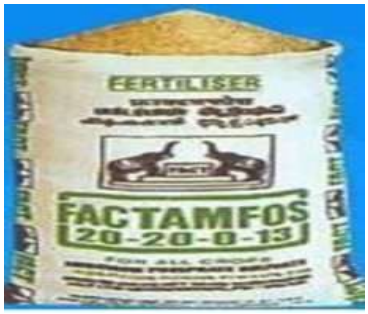
It used after 60 days. Pouring this NPK fertilizer 50Kg per hectare, Fertilizer is added to soils to increase plant productivity. A common type of fertilizer is called NPK Fertilizer because of its ingredients: nitrogen (N), Phosphorus (P) and Potassium (K).

KRIBHCODAP;



These fertilize used 25 kilo grams per Hectare. Hindalco produces Diammonium phosphate (DAP) fertilizer. It is the most popular phosphatic fertilizer because of its high nutrient content and good physical properties. The composition of DAP is 18% Nitrogen and P20546%.

FACTAMFOS FERTILIZER:



These fertilize used 50kilo grams per hectare. It contains essential micro nutrients zinc at 0.5% in addition to major nutrients Nitrogen and Phosphorus and secondary nutrient sulphur. It is mainly suitable for all crops and soils with Zinc deficiency.

HILLING GINGER

We need to check the base of the Ginger shoot after 4 to 6 weeks. After observing the bright pink color at the stem base, hill the plant with 4 inches of soil and fertilizers have to be applied.
Hilling and fertilizing have been done for every 2 to 4 weeks, repeat the hilling process.

HARVESTING OF GINGER

Harvesting has been done by the demand of the market. Ginger takes 8-9 months to attain maturity for harvesting. Rhizomes have been harvested for baby ginger by loosing the soil approximately 12 inches from the base of the plant with a shovel or with a garden fork. Then grasp the stems near the ground and entire plant has been pulled from the container by the stalks. The rhizome which is left in the ground forms a thick brown skin the harvested yield depends on fertility, water hilling, weeds and temperature. Seed harvesting ratio ranges from 1:8 to 1:12 approximately.

PESTS AND DISEASES MANAGEMENT IN GINGER

SOFT ROT DISEASE

Symptoms

The infection starts at the collar region of the pseudo stem and progresses upwards as well as downwards. Affected pseudo stem becomes water soaked and the rotting spreads to the rhizome resulting in soft rot. At a later stage root infection is also noticed.

Foliar symptoms appear as light yellowing of the tips of lower leaves which gradually spreads to the leaf blades. In early stages, the middle portion of the leaves remain green while the margins become yellow. The yellowing spreads to all leaves of the plant from the lower region upwards and is followed by drooping, withering and drying of pseudo stems.

Survival and spread: The fungus is soil-borne can survive in two ways: (a) in diseased rhizomes kept for seed, and (b) through resting structures like chlamado spores and oospores that reach the soil from infected rhizomes.

The fungus multiplies with buildup of soil moisture with the onset of south west monsoon. Younger sprouts are the most susceptible to the pathogen.

Nematode infestation aggravates rhizome rot disease.

A high temperature above 30° C and high soil moisture are the important predisposing factors.

Water logging in the field due to poor drainage increases the intensity of the disease.

Management:

Avoid water logging. At the time of sowing, treat the rhizome with Bordeaux mixture (1%) and again with Trichoderma @8-10-gm/litre water.

Remove the badly affected plants and drench around the infected plants, after slightly removing of soil with Bordeaux mixture (1%) or copper oxychloride @ 2g/1 litters of water.

BACTERIAL WILT

Symptoms

Water-soaked spots appear at the collar region of the pseudo stem and progresses both sides upwards and downwards.

The first conspicuous symptom is mild drooping and curling of leaf margins of the lower leaves which spread upwards.

Diseased plant and rhizome

Yellowing starts from the lowermost leaves and gradually progresses to the upper leaves.

In the advanced stage, severe yellowing and wilting symptoms occurs.

The vascular tissues of the affected pseudo stems show dark streaks.

The affected pseudo stem and rhizome when pressed gently extrudes milky ooze from the vascular strands. Ultimately rhizomes get rotted.

Survival and spread

Bacterial wilt is a soil and seed borne disease that occurs during south west monsoon.

The bacteria are spread through soil, water, infected or contaminated rhizomes.

The bacteria enter the plant through wounds made in the roots during transplanting, through agricultural equipment's, nematodes and insects.

Favourable conditions: Relatively high soil moisture and soil temperature

Disease, occurs during south west monsoon.

LEAF SPOT

Symptoms

The disease starts as water-soaked spot and later turns as a white spot surrounded by dark brown margins and yellow halo. The lesions enlarge and adjacent lesions coalesce to form necrotic areas.

Survival and spread: Spread through wind and rain splashes.

Favourable conditions: Disease is soil-borne; Noticed on the leaves from July to October; high humidity and temperature.

Diseased plant with leaf spot

Management

Spray Bordeaux mixture (1%) 3-4 times at 15 days interval with the initiation of the disease. Good control is achieved by growing the crop under partial shade.

STORAGE ROT

Symptoms

Initially, disease appear as light yellowing of the tips of lower leaves which gradually spreads down to the leaf blade and leaf sheath along the margin.

The middle portion of the lamina remains green while the margins become yellow.

The yellowing spreads to all the leaves of plant from bottom upwards and is followed by drooping, withering and drying.

The collar region of the pseudo-stem shows pale translucent brown color which becomes water soaked, due to destruction of parenchymatous tissues.

The infected plants can be easily pulled out from the rhizomes, the infection from the collar spreads to the rhizome gradually.

Survival and spread: The fungus have been reported to be carried in seed-pieces or soils which are the source of primary infection.

Secondary infection occurs by conidia

Favourable conditions: High rainfall and poor drained soil favour in development of disease.

FUSARIUM WILT YELLOW DISEASE

Symptoms

The infected plants remain yellow and stunted in growth.
The yellowing start from lower leaves. From infection to total collapse is gradual.
Infected plants produce shrivelled tubers and brown ground tissue.
Survival and spread: Infected seed pieces and soil are source of primary inoculum.
Resting spores i.e. chlamado spores present in soil are source of secondary infection.
Favourable conditions: High rainfall and poor drained soil favour in development of disease.

Diseased plant

SHEATH BLIGHT / LEAF BLIGHT

Symptoms

The lesions are usually observed on the leaf sheaths although leaf blades may also be affected. Initially, lesions are small, ellipsoid or ovoid, and greenish-grey and usually develop near the water line in lowland fields. Under favourable conditions, they enlarge and may coalesce to form bigger lesions with irregular outline and greyish-white centre with dark brown borders.
The presence of several large spots on a leaf sheath usually causes the death of the whole leaf.
Survival and spread: Fungus survives in the soil for many years in the form of sclerotia and spreads through soil & infected rhizomes
favourable conditions: The pathogen prefers warm wet weather and outbreaks typically occur in the early summer months most symptoms of the pathogen do not occur until late summer.

DRY ROT

Symptoms

Discoloration of rhizome surface by fungal mycelia accompanied by dry rotting.

Survival and spread: Soil and infected rhizome pieces are source of primary inoculum.

The fungus also produces resting structures (Chlamydospores) in the decomposing tissues of infected rhizomes. Therefore, tissues from infected crops remaining in the field serve as a reservoir of the fungus.

Favourable conditions: The pathogen is known to prefer warm wet weather, coupled with high soil moisture.

Management:

Soil application of mustard oil cake at the rate of 40 kg/ha before sowing in furrows can check the nematode problem.

Hot water treatment (51OC for 10 min) followed by seed treatment with Bordeaux mixture (1%) effectively checks the problem.

BACTERIAL WILT OR PREM ROG

Symptoms

The affected clumps and drench the soil with copper symptoms, it is the most serious disease and the symptoms can be noticed form July-August. The leaf margins of the affected plant turn bronze and curl backward. The whole plants wilt and die. The base of the infected pseudo stem and the rhizome emit foul smell. When the suspected pseudo stem is cut and immersed in a glass of clean water, milky exudates will ooze out from the cut end. Typical symptom is the wilting observed during afternoon in young seedlings.

Management

Seed contamination is the major source of infection. Hence, procure only healthy rhizome from disease free area. Treat the seed with Streptomycin (20g/100 litre water). Remove oxychloride 0.2%.

INTEGRATED PEST AND DISEASE MANAGEMENT FOR GINGER

Field hygiene is more important to manage the pests and diseases. Avoid water stagnation, provide adequate drainage, remove weeds periodically, apply only well rooted FYM compost 25 tone/ha and thoroughly incorporate it in the soil, apply dolomite @ 2 t/ha before sowing to increase soil pH, sow ginger in raised beds of at least 25-30 cm height and provide mulching with leaves and twigs of Chilaune (*Schima wallichii*) or Banmara (*Eupatorium sp*) or utis (*Alnus nepalensis*) or mustard oil cake 5 to 10 tone/ha and follow crop rotation of 2 to 4 years depending on the incidence and severity of the diseases. Soil application of biocontrol agents like *T. harzianum and P. fluorescence* during planting time gives effective control of diseases.

Use good quality rhizome for sowing. Procure disease free seeds from disease free area.

Before sowing, treat the rhizome in hot water (51ºC for 10min) and again in solution of Bordeaux mixture 1% for 15 min. Add Streptocyclin (20g/100 per litre of water) if bacterial wilt is also a problem. Dry the rhizome in shade and then sow. If cut rhizome are to be planted, they should be treated after cutting.

Treat rhizome with bio-inoculant *Pseudomonas fluorescens* and *Trichoderma harzianum* followed by soil application 60 days after planting to reduce rhizome rot.

Once the diseases are spotted in the field, remove the affected clumps and drench the soil with Bordeaux mixture 1% at 15 days interval.

Diseased plants should be identified while the crop is in field. Rhizomes from such plants should not be selected for the seed purpose

Mechanical collection and destruction of grubs, weevils, larvae and adult beetle periodically will reduce the incidence of insect pests. If white grub is predominant, apply Nimbicidin.

It has been observed that diseases spread fast after mother rhizome (mau) extraction. Hence, drench the soil with fungicide immediately after mau extraction and again this practice has to be followed keeping into consideration the cost-benefit ratio of mau extraction and disease incidence.

CONCLUSION

According to our study there is a 200 to 250 Quintal of ginger production per year in 1.5 Hectare. Diseases of ginger crop due to both biotic and abiotic factors which include virus, bacteria, fungus and nematodes. Biotic factors, bacteria are most important, causes wilt and soft rot. Fungus is the next major pathogen causes rhizome rot, soft rot, yellows disease, dry rot, storage rot, leaf spot, fungal and bacterial wilt. These diseases are controlled by avoiding water logging. Managing field hygiene, using good quality rhizome for sowing. Chemical constituents of ginger: The ginger rhizome contains 60–70% carbohydrates, 3–8% crude fiber, 9% protein, 8% ash, 3–6% fatty oil and 2–3% volatile oil. The characteristic flavour of ginger is due to zingerone, shogaols, gingerols, and volatile (essential) oils that comprise up to 3% of ginger on fresh weight basis. The volatile fragrant essential oil of ginger contains mainly sesquiterpenoids, with α-zingiberene (30–70%) as the main component, smaller amounts of other sesquiterpenoids: β-sesquiphellandrene. Recently, ginger has been widely investigated for its anticancer properties against different cancer types, such as breast, cervical, colorectal, and prostate cancer. The potential mechanisms of action involve the inhibition of proliferation and the induction of apoptosis in cancer. Several signaling pathways are involved in the anticancer mechanisms of 6-gingerol. Cyclin-dependent kinase; Phosphoinositide 3-kinase; Adenosine monophosphate-activated protein kinase; Bax: Bcl-2-protein; B-cell lymphoma 2. Ginger controls many diseases like common cold, diarrhoea, trichomonas and prevents stomach ulcers. Manages arthritis like headaches, menstrual cramps, headaches, stimulates circulation, etc. Hence ginger is an important herb which counts for both food and medicine. Ginger forming needs best cultivation practice and disease management in rural areas for the higher production in all over the India and world in future.

CONFLICT OF INTEREST STATEMENT

We declare that we have no conflict of interest.

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REFERENCES

1. Ali *et al.* Some phytochemical, pharmacological and toxicological properties of ginger (*Zingiber officinale* Roscoe): A review of recent research. Food Chem. Toxicol. 2008.
2. Chrubasik *et al. Zingibers rhizome*: a comprehensive review on the ginger effect and efficacy profiles. Phytomedicine. 2005.
3. M. Zhang *et al.* Edible ginger-derived nanoparticles: a novel therapeutic approach for the prevention and treatment of inflammatory bowel disease and colitis-associated cancer. Biomaterials. 2016)

4. Platel *et al.* Studies on the influence of dietary spices on food transit time in experimental rats Nutr. Res. 2001.
5. Prakash *et al.* Enhanced intestinal uptake of iron, zinc and calcium in rats fed pungent spice principles-piperine, capsaicin and ginger (*Zingiber officinale*) J. Trace Elem. Med. Biol. 2013.
6. Krishnapura Srinivasan. Ginger rhizomes (*Zingiber officinale*): A spice with multiple health beneficial potentials. Pharma Nutrition. 2017. 5(1);18-28.
7. Mao *et. al.* Bioactive Compounds and Bioactivities of Ginger (*Zingiber officinale* Roscoe). Foods. 2019. 8(6):185
8. Prasad S., Tyagi A.K. Ginger and its constituents: role in prevention and treatment of gastrointestinal cancer. Gastroent. Res. Pract. 2015:142979.
9. Fang *et. al*. Ginger oleoresin alleviated gamma-ray irradiation-induced reactive oxygen species via the Nrf2 protective response in human mesenchymal stem cells. Oxid. Med. Cell. Longev. 2017:148029415.
10. Schadich et. al. Effects of ginger phenylpropanoids and quercetin on Nrf2-ARE pathway in human BJ fibroblasts and HaCaT keratinocytes. Biomed Res. Int. 2016:2173275.
11. Yeh *et. al.* Bioactive components analysis of two various gingers (Zingiber officinale Roscoe) and antioxidant effect of ginger extracts. LWT-Food Sci. Tech. 2014. 55. 329–334.
12. Stoner G.D. Ginger: Is it ready for prime time? Cancer Prev. Res. 2013. 6. 257–262.
13. Zhang *et.al.* Edible ginger-derived nanoparticles: A novel therapeutic approach for the prevention and treatment of inflammatory bowel disease and colitis-associated cancer. Biomaterials. 2016. 101. 321–340.
14. Saha et. al. 6-Shogaol from dried ginger inhibits growth of prostate cancer cells both in vitro and in vivo through inhibition of STAT3 and NF-kappa B signaling. Cancer Prev. Res. 2014. 7.627–638. 58.
15. El-Ashmawy N.E., Khedr N.F., El-Bahrawy H.A., Mansour H.E.A. Ginger extract adjuvant to doxorubicin in mammary carcinoma: study of some molecular mechanisms. Eur. J. Nutr. 2018. 57.981–989.
16. Liu C., Kao C., Tseng Y., Lo Y., Chen C. Ginger phytochemicals inhibit cell growth and modulate drug resistance factors in docetaxel resistant prostate cancer cell. Molecules. 2017. 22. 1477.
17. Tahir *et. al.* Combined ginger extract & Gelam honey modulate Ras/ERK and PI3K/AKT pathway genes in colon cancer HT29 cells. Nutr. J. 2015. 14:31.
18. T. Baratha Dewanarayana, Wijitapure Wimalaratana. “Challenges and prospect of ginger farming in Sri Lanka with special reference to Plogahawela Spectariat Division”. Journal of Buisness, 2018. 17(3).
19. Eva Bryer, CNM, MSN. A Literature Review of the effectiveness of Ginger in Alleviating Mild to moderate and Vomiting of Pregnancy. Journal of Midwifery and Women’s Health. 2015.
20. Rohini Terry, Phd, Paul Posadzki, Leal k. “The Use of Ginger for the Treatment of Pain: A Systematic Review of Clinical. 2011.
21. Joseph Masabniand Stepphen King. “Easy Gardening”Texas & M Agrilife Extensions Service. 2012.
22. H Rahman R Karuppaiyan, K Kishore and Denzongpa. Traditional practice of Ginger cultivation in Northeast India. Indian Journal of Traditional knowledge. 2008. 8 (1).
23. Jayashree E, Kandiannan k, Prasath D, Rashid Pervez, “ICAR- Indian Institute of Species Research”. 2015.
24. Krishi Vigyan Kendra, Workha. “Package of Practices for Cultivation of Ginger”. 2016.
25. M.S.Nishina, D.M.Sato, W.t.Nishijinm. “Ginger Root Production in Hawaii” 2015.