



## Role of Garlic and Fenugreek during Gestation and Lactation: A Review

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### Abstract:

Nutrients plays important role in functioning and development of human body. A diet that is taken by organism should be a balanced diet, it must contain adequate amount of all the necessary nutrients required for healthy growth and developmental. Nutritional deficiency during pregnancy and lactation may cause different types of abnormalities during pre and postnatal development. Antioxidants may play very important role in abating side effects caused by free radicals generated during various metabolic processes especially during development as they are transferred through placenta to the fetus. There are few antioxidants, which also act as a lactating agent and have more importance during pregnancy and lactation. To assess the antioxidant activity of garlic and fenugreek which is also effective during gestation and lactation because their components can pass through placenta to fetus, all the previous information regarding in this connection are deliberated. Previously many studies have already been done on the nutritional importance of garlic and fenugreek in adults but information on developmental stages is very scanty. So to fulfill this lacuna the present study is focused on the effects of these antioxidants especially during pregnancy and lactation. These antioxidants can easily cross placenta and shows their beneficial effects on the development of the fetus. It can be concluded that garlic and fenugreek have favorable role not only in adults but also in the developing fetus due to their high antioxidant level and ability to pass the placenta.

**Keywords:** Antioxidants, Fenugreek, Garlic, Lactating agent, Nutrition

### 1.0 Introduction:

Pregnancy is associated with many physiological changes such as increased plasma volume, hematological, cardiovascular, renal and many more changes. All these physiological changes can be affected by malnutrition and it also induces many diseases which occur due to lack of nutrients intake during pregnancy like stillbirths, mental retardation of new born infants, fetal loss, cretinism etc. There are many synthetic vitamins and antioxidants but they all have many side effects if consumed in excess quantity. So they should be replaced by natural antioxidants like garlic and fenugreek etc, which exhibit productive effects on development because their components can easily pass through placenta to fetus. Garlic component SAC (S-Allyl Cysteine) has been shown to reduce oxidant load in cells involved in the carcinogenic process and also block NF-kB (Nuclear transcription Factor-kappa B) activation

because activation of NF-kB(Nuclear transcription Factor-kappa B) has now been linked with a variety of inflammatory diseases including cancer, atherosclerosis, myocardial infarction, diabetes, allergy, asthma, arthritis, crohn's disease (chronic inflammatory disease), multiple sclerosis, alzheimer's disease, osteoporosis, psoriasis, septic shock, and AIDS (Acquired Immunodeficiency syndrome) (Ide and Lau, 2001). This shows that it play very important role in development because sulfur compounds can easily cross placenta and pass to the fetus. Fenugreek components can also easily pass through mother milk to the fetus. In the present review we focused our attention on natural antioxidant such as garlic and fenugreek to evaluate their properties and their role during gestation and lactation. As components of these antioxidants especially garlic and fenugreek can easily cross placenta this became the future aspects to do study

on these antioxidant and observe their role in development of fetus.

## 2.0 Free radicals and their Formation in the Body:

The process by which the body breaks down and builds up molecules is called metabolism. During metabolism, atoms may lose electrons. This loss of electrons is called oxidation, because it is fueled by oxygen. Oxygen is indispensable for life under certain situations, have severe deleterious effects on the human body (Mohammed and Ibrahim, 2004). Our body cell uses oxygen to breakdown food products like carbohydrates, proteins, fats that provide us energy. The human body derives its energy from the utilization of nutrients and oxygen as fuel. Oxygen is also utilized to help the immune system, destroy foreign substances and combat diseases. The byproducts of this leads to development of some molecular agents that react with tissue in a process called oxidation. This process is a natural phenomenon of energy generation system and their products are free radicals have deleterious effect on human (Bagchi and Puri, 1998). Free radicals represents a class of highly reactive intermediate chemical entities whose reactivity is derived from the presence of unpaired electron in their structure, which are capable of independent existence for very brief interval of time. They react quickly with nearest stable molecule to capture electron in need to gain stability. These free radicals are unstable molecule because they contain unpaired electron, they want to become stable by either giving or taking an electron from other molecules.

Some ROS and RNS radicals are Singlet oxygen, Superoxide ( $O_2^-$ ), Hydroxyl ( $OH^\cdot$ ), Nitric Oxide ( $NO^\cdot$ ), Nitrous oxide ( $NO_2$ ), Hydrogen peroxide ( $H_2O_2$ ), Peroxide ( $O_2^{2\cdot}$ ). These formed ROS and RNS causes oxidative damage to nucleic acids, lipids, proteins (Smith *et al.*, 1992; Young and Woodside, 2001; Hensley and Floyd, 2002; Levine, 2002). Oxidative damage or Oxidative stress is a pathological condition in the body occurs due to ROS and RNS. It causes many diseases such as neurodegenerative (neurons in the brain are affected), cardiovascular (heart disease), pulmonary (lung disease), autoimmune, renal (immune system disease), gastrointestinal (gastrointestinal tract disease), cancers and many more (Agarwal and Prabakaran, 2005; Valko *et al.*, 2006; Pham Huy *et al.*, 2008).

Especially oxidation of proteins is associated with a number of age related diseases including alzheimer's disease (it is a chronic neurodegenerative disease), rheumatoid arthritis (it is a chronic systemic inflammatory disorder in which joints are affected), amyotrophic lateral sclerosis (it is a neurodegenerative disorder that affects nerve cell in the brain), parkinson's disease (it is a central nervous system degenerative disorder), progeria disease (it is a genetic disorder that causes children to age rapidly), werner's syndrome (it is an adult progeria), systemic amyloidosis (in this occurs an accumulation of inappropriately folded proteins), muscular dystrophy (it is muscle disease in which weakness and degeneration of skeletal muscle occurs) and respiratory distress syndrome (it is a breathing disorder in which new born are mainly affected) (Smith *et al.*, 1991; Smith *et al.*, 1998). Detail mechanism of free radical formation and their neutralization activities are shown in Fig.1.

## 3.0 Antioxidants as a Free Radical Neutralizer:

An antioxidant is a molecule capable of slowing or preventing the oxidation of other molecules, they may protect cells from damage which is caused by unstable molecules known as free radicals. Antioxidants terminate chain reactions by removing free radical intermediates, and inhibit other oxidation reactions by being oxidized themselves or binding themselves with free radicals. Antioxidant neutralizes free radicals by donating an electron to free radicals or by breaking free radicals (Halliwell, 1995). They neutralize free radicals by using antioxidant defence system (ADS) against oxidative stress. Antioxidants are classified into four categories based on their function (Noguchi *et al.*, 2000).

- First Category includes preventing antioxidants,
- Second Category includes radical scavenging antioxidants,
- Third Category includes repair and denovo antioxidants,
- Fourth Category includes adaptation where signal for the production and action of free radical induces formation and transport of the appropriate antioxidant to the right side.

As known that free radicals want to stable free so they give up or take an electron from neighboring molecules during this process they destroy these

molecules which leads to various type of diseases. Antioxidant here play important role in preventing damage or oxidation of these molecules, ultimately preventing from diseases. On the basis of above classification of antioxidants most suitable and

natural antioxidant (garlic and fenugreek) are selected for the present study. As garlic has high ORAC value and fenugreek although have little ORAC value but have an unique lactating property (Fig.2, Fig. 3)

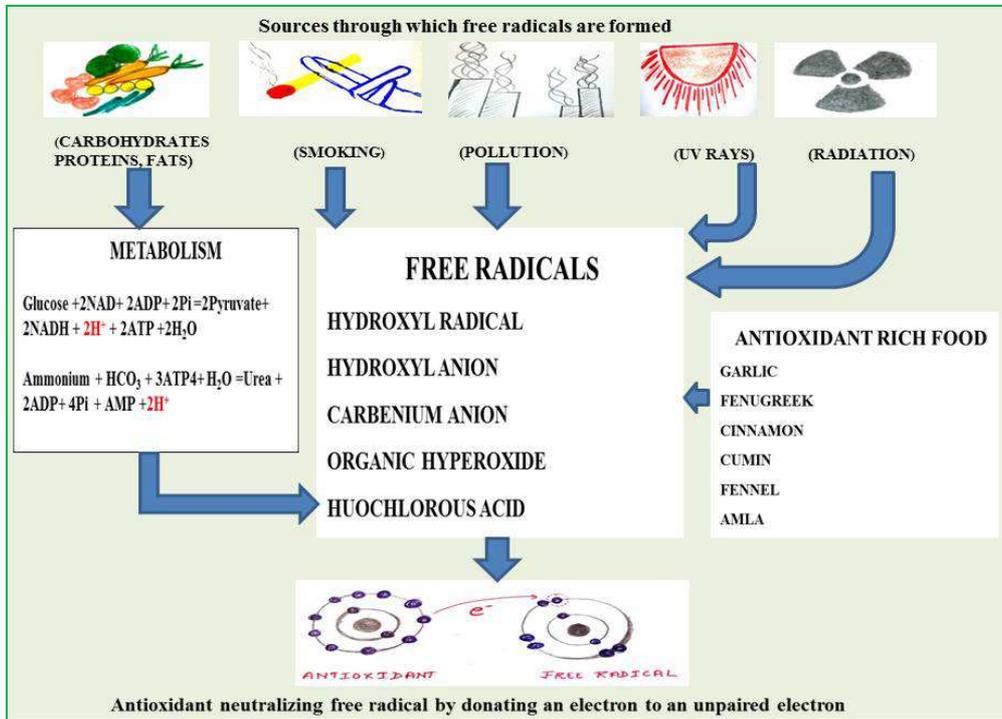


Fig 1: Antioxidant neutralizing free radical by donating an electron to an unpaired electron

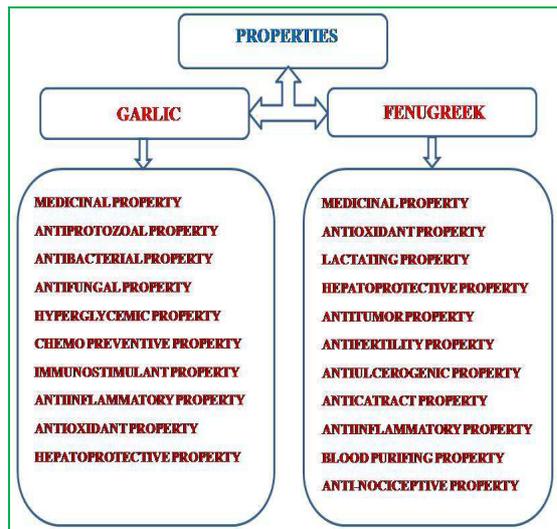


Fig. 2: Showing the different properties of Garlic and Fenugreek

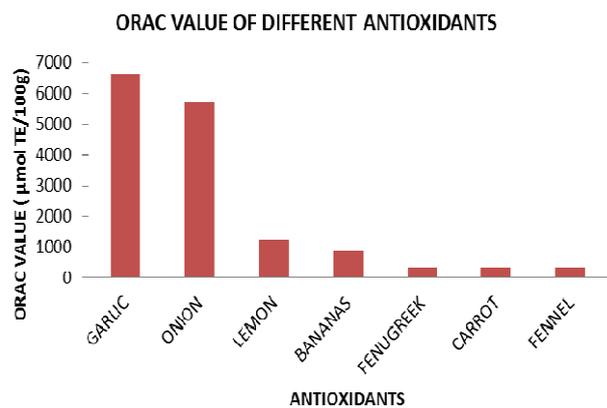


Fig. 3: Showing the ORAC (Oxygen Radical Absorbance Capacity) Or Antioxidant level of different antioxidants

#### 4.0 Garlic:

Garlic (*Allium sativum*) belonging to family alliaceae contains enzyme allinase, peroxidase, myrosinase and many more. The name “*allium sativum*” is derived from the celtic word “all” and the Latin word “*sativum*”, “all” meaning burning or stinging and “*sativum*” meaning planted or cultivated. Position of garlic in plant kingdom classification system is shown in table 1. The main thiosulfate in garlic is allicin. Allicin is considered as the major scavenging and antioxidant compound present in garlic (Chung, 2006; Sharma *et al.*, 2010). Alliin is converted into allicin with the help of enzyme allinase during crushing of garlic clove (Elmore, 1994). Allicin is very important sulfur containing compound present in the garlic as sulfur compounds can cross placenta and pass to the fetus so it plays very important role in development (Hidiroglou and Knipfel, 1981).

Researchers have worked on garlic supplementation to hypercholesterolemic pregnant rats and they evaluated the severe effects of hypercholesterolemia on pregnant rats and their offsprings (El-Sayyad *et al.*, 2010). Researchers have also worked on nano silver plus garlic and their results shown a significant increase in silver level in two groups including nano-silver and nano-silver plus garlic groups comparing to other ones and a significant decrease in silver level in nano-silver plus garlic group comparing to nano-silver treated group (Lale Ataei, 2014). This shows transfer of some

components of garlic through placenta in the offsprings which means garlic play important role in gestation and lactation.

**Table 1:** Shows position of fenugreek in plant kingdom classification system

S. No.	Kingdom	Plantae
1	Class	Lilopsida
2	Order	Liliales
3	Family	Liliaceae
4	Genus	<i>Allium</i>
5	Species	<i>Sativum</i>

#### 4.1 Nutritional Composition of Garlic:

Garlic has carbohydrates, proteins, fats, vitamins, sulfur compounds, enzymes and trace metals. Researchers have worked on transfer of amino acid and fats especially omega-3- fatty acid across the placenta (Schneider *et al.*, 1979; Moe 1995; Jones *et al.*, 2014). Similarly study was also done on sulfur compounds and minerals especially selenium and folate transfer across the placenta, as sulfur compounds are the main components of garlic so their transfer is very important (Husain and Mughal, 1992; Nandakumaran *et al.*, 2003; Zhao *et al.*, 2009). These show the transfer of garlic components through placenta during gestation and lactation. Because of this nutritional composition it shows numbers of different properties. Details of all these materials are given in table 2

**Table 2:** Shows the nutritional composition of garlic (136 gm)

Composition	Form
Calories (850 kJ)	From Carbohydrate (724 kJ), From Fat (23.9 kJ), From Protein (100 kJ)
Carbohydrates (45.0g)	Sugar (1.4g), Dietary Fiber (2.9g)
Protein (8.6g)	Tryptophan (89.8mg), Threonine (214mg), Isoleucine (295mg), Tyrosine (110mg), Valine (396mg), Arginine (862mg), Histidine (154mg), Alanine (180mg), Aspartic acid (665mg), Glutamic acid (1095mg), Glycine (272mg), Proline (136mg), Serine (258mg), Leucine (419mg), Lysine (371mg), Methionine (103mg), Cystine (88.4mg), Phenylalanine (249mg)
Fat (0.7g)	Saturated Fat (0.1g), Monounsaturated Fat (0.0g), Polyunsaturated Fat (0.3g), Total Omega-3 fatty acids (27.2mg), Total Omega-6 fatty acids (311 mg)
Vitamins	Thiamine (B <sub>1</sub> ), Riboflavin (B <sub>2</sub> ), Niacin (B <sub>3</sub> ), Pantothenic Acid (B <sub>5</sub> ) Vitamin (B <sub>6</sub> ), Folate (B <sub>9</sub> ), Vitamin C
Sulfur Compounds	Aliin, Allicin, Ajoine, Allylpropyl disulfide, Diallyl trisulfide, S- allylcysteine, Vinylidihines, S-allylmercaptocysteine
Enzymes	Allinase, Peroxidase, Myrosinase
Minerals	Calcium, Iron, Magnesium, Phosphorus, Potassium, Sodium, Zinc, Copper, Manganese, Selenium, Fluoride

Sources: Nutritional Facts and Analysis

**4.2 Different Properties of Garlic:**

Garlic is a perennial herb cultivated throughout India. It is commonly used as a food ingredient and also used as a spice in many different countries. Garlic has many beneficial properties for animals and mankind's such as medicinal, antimicrobial, antifungal, antiviral, antiprotozoal, antioxidants and so many other properties of garlic are reviewed by (Bayan *et al.*, 2014). Detail account of all these properties of garlic is given below in table 3.

**4.3 Medicinal Property of Garlic:**

Garlic is used in treatment of heart disease, headaches, tumors which show it exhibit medicinal properties (Agarwal, 1996). Garlic shows many medicinal properties such as approximately 30% of all cardiovascular disease patients use garlic supplements as a medicine in its treatment (Yeh,

and Yeh 2006). Garlic also possesses anti-inflammatory property to suppress nuclear factor kappa B activation pathway (Aggarwal and Shishodia, 2004). Garlic possesses steroid saponin (Kravets *et al.*, 1990). This steroid saponin reduces plasma cholesterol level because it inhibits the intestinal absorption of cholesterol (Sauvaire *et al.*, 1991). Garlic helps in prevention of cancer (Setiawan *et al.*, 2005; Galeone *et al.*, 2006; Islam *et al.*, 2011). Diallyl sulfide, a thioether found in garlic, has been linked to the prevention of cancer. The organosulfur compound ajoene, a constituent of garlic, has shown to induce apoptosis in a leukemic cell line (Dirsc *et al.*, 2002; Aggarwal and Shishodia, 2004). Allicor (garlic tablets) is effective for preventing non-specific acute respiratory infections especially in children (Andrianova *et al.*, 2003).

**Table 3:** Different properties of garlic

Properties	Uses	Compound	References
Medicinal Property	In curing cardiovascular disease	S-containing compound	Yeh and Yeh, 2006
Antiprotozoal Property	Against <i>Entamoeba histolica</i>	Allicin	Reuter <i>et al.</i> , 1996
Antibacterial Property	Against Heliobacter	Allicin	O' Gara <i>et al.</i> , 2000
	Against Myobacterium	Allicin	Delaha and Garagusi, 1985
Antifungal Property	Against Aspergillus	Ajoene	Hitoko <i>et al.</i> , 1980
Hyperglycemic Property	High doses of garlic can lower elevated blood sugars	Allicin	Kasuga <i>et al.</i> , 1999
Antineoplastic/ Chemopreventive Property	In Cancer prevention	Diallyl sulfide	Galeone <i>et al.</i> , 2006
Immunostimulant Property	Garlic extracts serve as efficient immunostimulant	Allicin	Morioka <i>et al.</i> , 1993
Antiinflammatory Property	Help to resolve inflammation associated with IBD (Inflammatory Bowel Disease)	Allicin	Tsai <i>et al.</i> , 2005
	Suppress nuclear factor kappa B activation pathway	Allicin	Agarwal and Shishodia, 2004
Antioxidant Property	Inhibit lipid per oxidation in liver cells	Allyl cysteine, Alliin, Allicin, and Allyl disulfide	Wang <i>et al.</i> , 1988
	Cure oxidant mediated brain cell damage that is implicated in Alzheimer's disease	Allyl cysteine, Alliin, Allicin, and Allyl disulfide	Borek <i>et al.</i> , 2001
Hepatoprotective Property	Curative effect of garlic on alcoholic liver disease patients	Allicin	Mirunalinis <i>et al.</i> , 2010

#### **4.4 Antimicrobial, Antifungal, Antiviral, Antiprotozoal Property of Garlic:**

The steroid saponins present in garlic possess many pharmacological properties which include antifungal, antiviral, antiprotozoal and antibacterial (Lacaille-Dubois and Wagner, 1996). Such an extract of garlic is effective against a host of protozoa including *Entamoeba histolica*, *Trypanonomas*, *leptomonas*, *Leishmania*, *Opalina ranarum* (Reuter *et al.*, 1996), *Candida albicans* (Lemar *et al.*, 2002). Hence it shows antiprotozoal property. Garlic has been proven as effective against gram positive, gram negative, acid fast and many more bacteria. These include *Clostridium*, *Mycobacterium*, *Pseudomonas*, *Proteus*, *Staphylococcus aureus*, *Micrococcus*, *Bacillus subtilis*, and *Helicobacter* (O'Gara *et al.*, 2000). Hence it possesses antibacterial activity. Garlic is effective against *Candida*, *Torulopsis*, *Trichophyton*, *Cryptococcus*, *Trichosporon*, *Epidermphyton*, *Rhodotorula* and also against *Cryptococcal meningitis* (Lal *et al.*, 2003). Ajoene activity against *Aspergillus* is observed (Yoshida *et al.*, 1987). Hence it shows antifungal activity. Very little work has been done to investigate its antiviral properties. Garlic extract shows *in vitro* activity against influenza A and B, Cytomegalovirus, Herpes simplex virus 1 and 2, viral pneumonia, Rhinovirus, HIV (Human Immunodeficiency Virus) and rotavirus (Tsai *et al.*, 1985). According to Shoji *et al.* (1993) allyl alcohol and diallyl disulfide have also proven effective against HIV (Human Immunodeficiency Virus) infected cells.

#### **4.5 Antioxidant Property of Garlic:**

It is well demonstrated that patient who experience increase in reactive oxygen species and these ROS induces stress on their liver function which may be protected by garlic ingestion (Sabayan *et al.*, 2007). Aged garlic has shown to reverse oxidant effects of nicotine toxicity in rat (Sener *et al.*, 2005). Aged garlic protect against oxidative damage by inhibiting lipid peroxidation in liver cells (Wang *et al.*, 1998). Garlic also confers phyto estrogenic effects to counter bone loss. Oil extract of garlic promotes intestinal transference of calcium by modulating the activities of both intestinal alkaline phosphatase and calcium activated ATPase. Furthermore garlic oil supplement do recovery in serum estrogen titer in bilaterally ovariectomized rat which was found to be persistently associated with enhanced calcium

transference and better preservation of bone mineral content (Mukherjee *et al.*, 2006). Garlic is a treatment strategy in both post-menopausal and pre-mature menopausal women. Because of its antioxidant property it has become a potent herb for conducting research. Apart from the properties discussed above the most remarkable and unique property of garlic is that it can be use safely in children.

#### **4.6 Hepatoprotection by Garlic:**

It is curative on alcoholic liver diseased patient by significantly increasing the activity of free radical scavaging enzymes such as SOD (Superoxide dismutase), CAT (Catalase), GPx (Glutathione peroxidase) (Borek, 2001). Albumin protein is a key biomarker for monitoring liver function. Its concentration decreases in alcoholic patients. An increase in serum protein concentration is observed in alcoholic patient treated with raw garlic treated. Garlic prevented liver damage (Yang *et al.*, 2001; Nencini *et al.*, 2010), which is considered to induced with oxygen radical injury and lipid peroxidation. Treatment with aged garlic extract appeared to enhance the recovery from CCl<sub>4</sub> (Carbon Tetrachloride) and acetaminophenol hepatotoxicity induced in rats (Borek, 2001). Glutathione is a compound necessary for liver detoxification. It has been hypothesized that garlic organosulfur compounds may be able to prevent glutathione depletion. Patients who experience increases in reactive oxygen species-induced stress on liver function may be protected by garlic ingestion (Sabayan *et al.*, 2007). So, it is concluded that garlic plays important role in protection of liver from various type of injuries.

#### **4.8 Role of Garlic in Hematology:**

Garlic favorably altered blood lipid concentration in normocholesterolemic subjects (Bordia, 1981). One half to one clove of garlic per day reduces hypercholesterolemiaby less 10% of the initial value or less 0.59 milli mol/L (Warshafsky *et al.*, 1993). It inhibits platelet aggregation and also increases fibrinogen activity because of the presence of allicin which breakdown to ajoenes, allyl methyl trisulfide, vinylidithins and other sulfur compounds (Kendler, 1987; Kleijnen *et al.*, 1989; Nishimura and Ariga, 1994). Garlic extract also inhibits vascular calcification in high blood cholesterol human

patients (Durak *et al.*, 2004). Garlic contain sulfur rich compound called polysulfides, these polysulfides are converted into hydrogen sulfide inside our RBC's, and this is how it controls blood pressure. This hydrogen sulfide helps in controlling our blood pressure by triggering dilation of our blood pressure. According to Olaniyan *et al.* (2013) Leucocytes count is known to increase sharply when infection occur which were made normal by garlic feeding. Similar results are observed in our initial experiments in which number of leucocytes increased in comparison to control group of Swiss mice in the group feed with antioxidant garlic in their diet, although there is no morphological alterations observed in white blood cells. These results shows that garlic also preserve the basic components of blood and fight against infections.

**4.9 Role of Garlic on BMI (Body Mass Index):**

Alliin a most potent substance found in garlic shows to not only lower blood pressure, insulin and triglyceride levels in laboratory animals fed a sugar rich diet, but also prevent weight gain. Therefore many researchers concluded that allicin may be of practical value of weight control. The long term feeding (4 weeks) of raw and boiled garlic extract to albino rats resulted weight loss (Shashikanth *et al.*, 1986). Similar results are observed in our initial experiments in which Body weight decreased in comparison to control group of Swiss albino mice in the group feed with antioxidant garlic in their diet.

These results show that antioxidant garlic help in controlling weight. It is a weight controlling appetizer.

**5.0 Fenugreek:**

Fenugreek (*Trigonella foenum graecum*) is an annual leguminous herb that belongs to the family Fabaceae which is found as a wild plant and also cultivated in northern India. It is in the list of one of the most ancient herbs known (Thomas *et al.*, 2011). Fenugreek is a Greek hayseed is originated in the Mediterranean, Southern Europe and Western Asia (Altuntas *et al.*, 2005) which is used since ancient time (NIH, 2012). Hippocrates considered it a soothing herb. Fenugreek seeds contain 50% fiber, 30% soluble fiber and 20% insoluble fiber (Basch *et al.*, 2003). Position of fenugreek in plant kingdom classification system is shown in table 4. A list of the medicinal species of genus *Trigonella* according to Mehrafarin *et al.* (2011) are given in table 5.

**Table 4:** Shows position of fenugreek in plant kingdom classification system

S. No.	Kingdom	Plantae
1	Class	Magnoliopsida
2	Order	Fabales
3	Family	Fabaceae
4	Genus	<i>Trigonella</i>
5	Species	<i>foenum-graecum</i>

**Table 5:** Shows the species of genus *Trigonella* with medicinal properties (Mehrafarin *et al.*, 2011)

Genus	Species
<i>Trigonella</i>	<i>T. foenum-graecum</i> , <i>T. balansae</i> , <i>T. corniculata</i> , <i>T. maritime</i> , <i>T. occulta</i> , <i>T. polycerata</i> , <i>T. calliceras</i> , <i>T. cretica</i> , <i>T. caerulea</i> , <i>T. lilacina</i> , <i>T. radiata</i> , <i>T. spinos</i> , <i>T. spicata</i>

**Table 6:** Shows the nutritional composition of fenugreek (11gm)

Composition	Form
Calories (149 KJ)	From Carbohydrate (87.5 kJ), From Fat (24.7 kJ), From Protein (36.8 kJ)
Carbohydrates (6.4g)	Dietary fiber (2.7g)
Protein (2.5g)	Tryptophan (43.0mg), Threonine (98.8mg), Isoleucine (137mg), Leucine (193mg), Lysine (185mg), Methionine (37.2mg), Cystine (40.6mg), Phenylalanine (120mg), Tyrosine (84.0mg), Valine (121mg), Arginine (271mg), Histidine (73.5mg), Alanine (112mg), Aspartic acid (298mg), Glutamic acid (439mg), Glycine (144mg), Proline (132mg), Serine (134mg)
Fat (0.7g)	Saturated fat (0.1g), Polyunsaturated Fat (0.3g)
Vitamins	Vitamin A, Vitamin B <sub>6</sub> , Vitamin B <sub>12</sub> , Vitamin C, Vitamin D, Vitamin E (Alpha Tocopherol), Vitamin K, Thiamin, Riboflavin, Niacin, Folate, Pantothenic Acid, Choline, Betaine
Minerals	Calcium, Iron, Magnesium, Phosphorus, Potassium, Sodium, Zinc, Copper, Manganese, Selenium, Fluoride

Source: Nutritional Facts and Analysis

**Table 7:** Shows the different properties of fenugreek

Properties	Uses	References
Medicinal Property	Help in reducing gastric mucosa and gastric lesions	Dixit <i>et al.</i> , 2005
Antioxidant Property	Reduce lipid per oxidation and enzyme leakage	Thirunavukkarasu <i>et al.</i> , 2003
Lactating Property	Stimulate growth hormone release	Mohammed and Basiouni, 2005
Hepatoprotective Property	Prevent ethanol induced abnormalities Lower hepatic steatosis Leaves and seeds of fenugreek show gastro and hepatoprotective application	Kaviarasan and Anuraddha, 2007 Raju and Bird, 2006 Blank, 1996
Antitumor Property	Tumor cell growth was inhibited	Shabbeer <i>et al.</i> , 2011
Antifertility Property	Shows antifertility effect in male and female	Kassem <i>et al.</i> , 2006
Antiulcerogenic Property	Aqueous extract of fenugreek seed shows prevention against ulcer	Suja <i>et al.</i> , 2002
Anticataract Property	Seed shows anticataract property in sodium selenic-induced cataract in rats	Gupta <i>et al.</i> , 2010
Antiinflammatory Property Blood Purifying Property Anti-nociceptive Property	Alkaloids in extract of fenugreek has been reported to produce anti-inflammatory property Seeds and leaves of fenugreek are one of the important blood purifying agent Seeds and leaves of fenugreek are important pain reducing agent	Ahmadiani <i>et al.</i> , 2001 Sowmya and Rajyalakshmi, 1999 Naidu <i>et al.</i> , 2011

**5.1 Nutritional Composition of Fenugreek:**

Fenugreek has some nutritional compounds such as carbohydrates, proteins, fats, vitamins and trace metals. Srinivasan (2006) reported that fenugreek seeds are a rich source of vitamin C,  $\beta$ -carotene 2.3 mg, thiamine, riboflavin, nicotinic acid and folic acid. Researchers have worked on transfer of amino acid and fatty acid across the placenta (Schneider *et al.*, 1979; Jones *et al.*, 2014). Fatty acid transfer is highly directional from mother to fetus (Jumpsen and Clandinin, 1995). Similarly minerals are also transferred across the placenta (Husain and Mughal, 1992). They reported the transfer of fenugreek components through placenta during gestation and lactation. Details of these compounds are given in the table 6.

**5.2 Different Properties of Fenugreek:**

Fenugreek has important medicinal, antioxidant, lactating and hepatoprotective, antitumor, antifertility, anticataract, blood purifying, anti-nociceptive properties and many more which are given below in table 7.

**5.3 Medicinal Property of Fenugreek:**

It showed many benefits such as appetite stimulating, inducing labour, lactation promoting

(Galactogue), reducing menstrual discomfort, minimizing symptoms of menopause, reducing cardiovascular risk, treating renal insufficiency (Sharma *et al.*, 1990). Moreover, it is well demonstrated that glucose and cholesterol level in blood plasma decreases with increasing fenugreek in diet (Hamodi, 2006) because 4-Hydroxyisoleucine an amino acid in fenugreek seeds increased insulin release in human and rat therefore it is an anti-diabetic (Sauvarie *et al.*, 1998). Administration of aqueous extract of fenugreek seeds and its gel fraction in ethanol-induced gastric ulcer in rats elaborated its cytoprotective actions by its anti-secretory activity thereby preventing gastric mucosa and reducing gastric lesions (Rababah *et al.*, 2003; Dixit *et al.*, 2005). Presence of alkaloids in fenugreek seeds extract has been reported to produce anti-inflammatory property (Ahmadiani *et al.*, 2001). Studies have been done on beneficial hypoglycemic effects of fenugreek seeds in diabetic rats (Raju *et al.*, 2001; Vats *et al.*, 2002; Mondal *et al.*, 2004). Fenugreek also shows anticataract property in sodium selenic-induced cataract in rats by restoring levels of antioxidant enzymes such as glutathione, superoxide dismutase, catalase and also by inhibiting lipid per oxidation (Gupta *et al.*, 2010).

#### **5.4 Fenugreek and Breastfeeding:**

Fenugreek is a natural means to increase milk supply. All over the world fenugreek seeds are consumed by women's during postnatal period to facilitate the lactation (NIH, 2012). It is a galactagogue (milk producing agent), its consumption during pregnancy increases milk production in pregnant women. Therefore it is important herb in pregnancy and lactation (Shinde, 2012). Exact mechanism is not well understood that show fenugreek seeds increase the milk production but it is believed that seeds of fenugreek contain the precursor of hormone that increases the milk production. Jensen, (2012) also believed that fenugreek stimulates the sweat production and breast is (mammary glands) are the modified sweat glands so it is stimulate the milk production. So, ultimately fenugreek stimulates milk production.

A study of (K. Huggins, personal communication, July 1, 2013) on 1200 breast feeding women's showed increase in the milk production within 24-72 hours in the fenugreek fed mothers. The milk production is continuing when stimulated at appropriate level and no side effects were observed in mother and their sucklings. Huggins has found fenugreek to be a potent stimulator of breast milk production that appears safe for the mother and baby which is in reference with Hillervik *et al.* (1991). The purpose of this study was to determine the role of fenugreek requirement during gestation and lactation.

A study on doses of fenugreek required for increasing milk supply. The suggested dose of fenugreek to increase milk supply is 7 to 14. 500mg capsules per day which is much higher than the labeled instructions of one capsule 3 times a day (Gabay, 2002). It was well demonstrated that by giving fenugreek extract to Saudi goat from Zumri breed in a dose of 60 g/day for 7 weeks leads to increase in milk production by stimulating growth hormone release (Mohammed and Basiouni, 2005).

#### **5.5 Problems in Processing of Fenugreek Seeds:**

Fenugreek seeds are full of nutrient. During processing of fenugreek seeds many problems occur some of them are as follows. Firstly, as pH is increased during processing of fenugreek seeds this leads to decrease in antioxidant property of seeds (Ruby *et al.*, 2005). Secondly, during drying of fenugreek seeds at high temperature beta- carotene and ascorbic acid content of seeds is lost (Sharma *et al.*, 1990).

#### **5.6 Antioxidant Property of Fenugreek:**

Fenugreek bears potential of a powerful antioxidant (Rababah *et al.*, 2003; Dixit *et al.*, 2005). The nutrients present in fenugreek especially flavonoids and polyphenols present in it are responsible for making them powerful antioxidant. Dietary fenugreek seed has been shown to counter the increased lipid peroxidation and alterations in the content of circulating antioxidant molecules alloxan-diabetic rats (Ravikumar and Anuradha, 1999). This shows that fenugreek seeds possess an encouraging antioxidant property. When fenugreek is fed *in vivo* and *in vitro* to ethanoal-induced toxic rats in them along with antioxidant property it also reduced lipid peroxidation and enzyme leakage (Thirunavukkarasu *et al.*, 2003). It is well demonstrated as medicinal herb in animal growth and health.

#### **5.7 Hepatoprotection by Fenugreek:**

Fenugreek essential oil hepatoprotective activity is studied using carbon tetrachloride-induced liver fibrosis model in rats (Hanefi *et al.*, 2004). Fenugreek decreased the levels of serum aspartate aminotransferase, alkaline phosphatase, Bilirubin and alanine aminotransferase (Khosla *et al.*, 1995). Ethanol-induced abnormalities in the rat liver can be prevented by ethanolic extract of *Trigonella foenum-graecum* seeds (Kaviarasan and Anuradha, 2007; Thirunavukkarasu *et al.*, 2003).

#### **5.8 Role of Fenugreek in Hematology:**

Fenugreek (*Trigonella foenum graecum*) seeds are high in soluble fibre, which helps lower blood sugar by slowing down digestion and absorption of carbohydrates. This suggests that they may be effective in treating people with diabetes hence maintaining blood sugar (Basch *et al.*, 2003; Omoruyi, 2008). It was also reported that fenugreek seeds increase the bone marrow cell counts indicating its stimulatory effect especially on blood cells (Bin-Hafeez *et al.*, 2003). Similarly in our own study conducted on mice we have also observed small elevation in number of white blood cells in animals is fed with fenugreek in their diet.

### 5.9 Role of Fenugreek on BMI (Body Mass Index):

Obesity is one of the major risk factor for various disease and mortality. Obesity may be defined as abnormal growth of adipose tissue (Weiser *et al.*, 1997). Some researchers indicated that fenugreek seed extract supplementation results in reducing the body weight and adipose tissue (Handa, 2005; Geetha, 2011). These results show that fenugreek helps in controlling body weight. Similar results are observed in our initial experiments conducted on Swiss mice in which body weight decreased in in the group feed with fenugreek in comparison to control group. The probable mechanism of fenugreek decreasing the total body and adipose tissue weight may be that firstly fenugreek seeds contain a high proportion (40%) of soluble fiber. Secondly, fenugreek flushes out the carbohydrates from the body before they enter the blood stream resulting in weight loss. This fiber forms a gelatinous structure (similar to gaurgum) which may have effects on slowing the digestion and absorption of food from the intestine and create a sense of fullness in the abdomen, thus suppresses appetite and promotes weight loss. It can be concluded that this plant is effective on blood lipids and sugar and on some bacterial strains. Antioxidant activity of fenugreek provides protection to the body by inhibiting the entrance of many causative agents of diseases. It decrease body fats and also effective on obesity. Moreover, the fenugreek saponins are implicated for the body weight gain when supplemented to rats for hypercholestemia. Compared with diabetic group, rats treated with *Trigonella foenum-graecum* extract had an increase in body weight and a decrease in kidney/body weight ratio.

### 6.0 Conclusions:

On the basis of above literature and our initial findings we can conclude that all the micro and macronutrient are required during gestation and lactation in adequate amount. Malnutrition during pregnancy may create many types of deleterious effects on development. Few antioxidants especially garlic, fenugreek, cinnamon, amla, fennel, cumin etc play important role during gestation and lactation, as they also act as lactating agents along with their other properties. The roles of natural antioxidants are more promising as they do not impose any side effects on development. Garlic plays important role during gestation as it is capable of ameliorating

many stressful effects generated during this period and also in controlling body weight and increasing number of leukocytes. Fenugreek also presents a pivotal role as antioxidant and lactating agent during gestation and lactation, it also control the body weight. Further studies are required to evaluate the effect of various combination diets and natural antioxidants which may be beneficial during gestation and lactation with very diminutive side effects.

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