
International Journal of Advanced Multidisciplinary Research (IJAMR)

ISSN: 2393-8870

www.ijarm.com

Review Article

Role of *Emblica officinalis* and *Foeniculum vulgare* during pregnancy and lactation: A Review

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Abstract

Nutrition and nourishment is the supply of food required by organisms and cells to stay alive. Nutrition is the key for development and maintaining good health. Having nutritional knowledge and making smart choices in food, not only helps to achieve optimum health but also avoiding obesity, illness and today's most prevalent chronic diseases. Antioxidants provide protection against the harmful effects of free radicals and neutralize them. Lactating agents increase the milk secretion as they transferred to foetus through placenta. Lactating women requires substantial nutrients for child nourishment. *Emblica officinalis* (Amla) and *Foeniculum vulgare* (Fennel) are good antioxidants and have lactating properties so they are beneficial to improve health of young ones when their mothers are fed with these plant products during pregnancy and lactation. Amla and fennel both herbs have plenty of pharmaceutical and therapeutic properties. These properties may also cooperative during pregnancy and lactation. Many studies are already performed on animal models which reported that these properties enhance the growth and development of young-ones during gestation and lactation. But the exact role of these herbs during pre and postnatal development is not thoroughly studied. The present review is focused to evaluate out the beneficial role of these herbs during pregnancy and lactation.

Keywords

Emblica officinalis,
Foeniculum vulgare,
pregnancy,
lactation,
free radical,
placenta

Introduction

Every year all over world so many children are born with low birth weight. More than one third of children death are due to malnutrition of pregnant women and young ones (Black *et al.*, 2008). So nutrition is necessary to avoid adverse birth outcomes. For proper growth and development of baby, proper diet is must. Proper diet includes supplements like micronutrients, macronutrients, vitamins, minerals, antioxidants, lactating agents etc. Mother's health and nutritional status critically impact the fetal development and even the development of mammary glands (Heerwagen *et al.*, 2010; Dabelea and Crume, 2011). Pregnancy increased metabolic demands due to changes in women's physiology and requirements of growing foetus (Broughton Pipkin, 2007). This kind of metabolic demands imbalance the normal ROS (Reactive oxygen species) and free radicals generation. So during pregnancy and lactation more antioxidants are required to neutralize the adverse effects of ROS and free radicals. There are so many natural antioxidants available in the nature like Amla, Garlic, Cinnamon etc. which are able to neutralize the adverse effects.

of these ROS and free radicals without causing any side effects.

Nutrition during lactation is of great importance because nutritional status of mother affects the quality of breast milk (Ministry of Health, 2006). During lactation proper diet is required for the mother to produce the milk. There are many lactating agents available in nature like Fennel, Fenugreek, Cumin etc. which are able to improve the quality and quantity of milk, when we add these agents in the diet of lactating female then the milk production increases.

A Pregnant woman needs extra iron and folic acid, because folic acid reduces the risk of neural tube defects. Iron is required for the growth of the baby, blood cells development and for haemoglobin (Hb) synthesis to transport oxygen. Maternal iron prevents low infant birth weight, and also the problem of maternal zinc deficiency which increases the risk of low infant birth weight, preterm delivery, malformations,

post-term delivery and pregnancy hypertension (Szostak-Wegierek, 2000).

Fetal growth and development basically dependent on the hormonal, nutritional and metabolic environment which is provided by the mother (Tzanetakou *et al.*, 2011). A pregnant woman needs the entire nutritional supplement because diet taking by mother affects the foetus, as the nutrients present in the diet passes through placenta to foetus. In the present review we select *Emblica officinalis* and *Foeniculum vulgare* after assembling extensive literature and reaching at a conclusion that these plants have plenty of anti-oxidative properties which are also beneficial during pregnancy and lactation.

Amla

Emblica officinalis relishes in Ayurveda for medicinal properties. According to ancient Indian mythology, it is the first tree to be created in the universe. The species is native to India and also grows in tropical and subtropical areas

including Pakistan, Uzbekistan, South East, Srilanka, Asia, Malaysia and China (Khan, 2009). It is commonly known as Indian gooseberry or Amla and euphorbiaceous plant (Verma and Gupta, 2004).

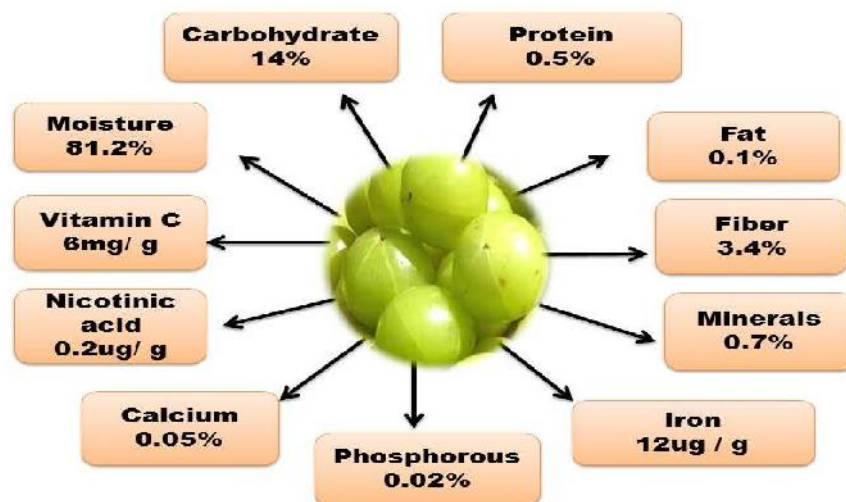
Composition of Amla

Amla is extremely nutritious and dietary source of vitamin C (Ghosal *et al.*, 1996), amino acids and minerals. It contains higher amount of flavonoid like quercetin (Patel and Goyal, 2011), alkaloids, phyllantine, gallic acid, glutamic acid, chebulinic acid, chebulagic acid, ellagotanin, ellagic acid and kaempferol (El-Desouky *et al.*, 2008). The seed oil of *Emblica Officinalis* is rich in unsaturated fatty acids. The main polyunsaturated fatty acid (PUFA) present in it is linoleic acid or omega-6 and Oleic acid or omega-9 is also found as major fatty acid (Arora *et al.*, 2011). All these components and its nutritional value are summarised in fig 1 and table 1.

Table 1 showing chemical compounds of Amla

S. no	Category	Chemical compounds	References
1.	Hydrolysable Tannins	Emblicanin A and B, Pedunculagin, Chebulinic acid, Chebulagic acid, Ellagotanin	Bhattacharya <i>et al.</i> , 2002; El-Desouky <i>et al.</i> , 2008
2.	Alkaloids	Phyllantine, Phyllemblin	Zhang <i>et al.</i> , 2003; Yi-Fei <i>et al.</i> , 2009
3	Phenolic compounds	Gallic acid, Ellagic acid, Methyl galate	Rehman <i>et al.</i> , 2007; El-Desouky <i>et al.</i> , 2008
4.	Amino acids	Glutamic acid, Proline, Aspartic acid, Alanine, Cysteine, Lysine	Krishnaveni and Mirunalini 2010
5.	carbohydrates	Pectin	Dasaroju and Gottumukkala, 2014
6.	Flavonoids	Quercetin, Kaempferol	El-Desouky <i>et al.</i> , 2008; Patel and Goyal, 2011
7.	Organic acid	Citric acid (vitamin C),	Jain and Khurdiya, 2004; Scartezini 2006
8.	Minerals	Phosphorous, Calcium, Iron, Nicotinic acid	Dasaroju and Gottumukkala, 2014

Figure 1 shows the nutritional composition of amla according to their percentage



Properties of Amla beneficial during Pregnancy

Unani, Ayurveda, Siddha Tibetan, Sri Lankan, and Chinese systems of medicine consume Amla for variety of diseases (Udupa, 1985; Bhandari and Kamdod, 2012). In India it is noted that as high as 40-80% and nearly 4-16% of maternal deaths are due to anemia. Demand of iron during pregnancy is markedly increased and simultaneously pregnancy reduces the erythropoietic function of bone marrow. About 2-4.8mg iron required daily for a pregnant women and she must consume 20-48mg of dietary iron every day. While normal vegetarian food does not supply more than 10-15mg. Iron pills added once in a day only from 16 weeks of pregnancy causes multiple side effects, but if the amla churna is added with iron pills it raises its absorption and decreases the side effects (Benjwal, 2013). Iron deficiency is common during pregnancy which cause anemia. Anemia raises foetal, neonatal and maternal mortality and morbidity (Srivastuki, 2012). Pregnant women require adequate iron for a variety of reasons because iron help to make new blood cells to carry the nutrients and oxygen to the fetus during pregnancy (Benjwal, 2013). According to Harris *et al.* (1992) Iron transport across the placenta is carried in maternal blood bound to transferrin receptor (Tf). So it was proved that Amla fulfil the extra iron deficiency during pregnancy without any side effects.

Amla is rich source of vitamin C or ascorbic acids. The placental transport of ascorbic acid is carried by a sodium-dependent mechanism (Rybakowski *et al.*, 1995). Ascorbic acid associated with fertility for many years and may have evolutionary significance (Millar, 1992). It is reported that administration of vitamin C (1000mg/day) reduced the incidence of preeclampsia in women who were at risk (Chappell *et al.*, 2002). Gallic acid is a major polyphenol, found in triphala and been reported as suppressor of the growth of cancer cells (Kaur *et al.*, 2005). Polyphenols help in transport of some compounds like glucose, vitamin, thiamine and folic acids at the placental barrier (Martel *et al.*, 2010). Polyphenolic compounds are widely distributed throughout the plant kingdom and form integral part of human diet (Lindsay, 2000; Manach *et al.*, 2004). These all compounds play important role during pregnancy.

It is also examined by a number of authors that it possesses anti-oxidative, hypoglycaemic, antiviral, antibacterial, antifungal and antimicrobial properties. Apart from this it is cardio protective, immunostimulant, anti-inflammatory, anticancer, hepatoprotective, gastro-protective and dermoprotective. All these properties are summarised in fig 2 table 2.

On the basis of above available literature we can say that Amla possess so many properties which are beneficial during pregnancy. Its compounds are able to neutralize the adverse effects of free radicals and also accomplish the mineral deficiency in pregnant women.

Fennel

Foeniculum vulgare commonly known as fennel or saunf, is biennial medicinal plant belonging to the family apiaceae (Umbelliferae). It is well known to Indian, Chinese, Egyptian and Greek civilizations for medicinal purposes and human consumption (Abelsoud, 2010). Fennel is a medicinal plant or herb which has many protecting properties against various diseases. It is widely used in Egyptian traditional medicine for dealing several diseases (Hanan *et al.*, 2013).

Composition of Fennel

Fennel seeds are source of numerous nutrients, i.e. minerals (Özcan *et al.*, 2008), sugars (Cataldi *et al.*, 1998), essential fatty acids (Vardavas *et al.*, 2006; Barros *et al.*, 2009), vital vitamins, fibres and protein. They are also rich in flavonoids and essential oil (Das *et al.*, 2013). The major constituents of essential oil are anethole, estragole and fenchone (Mimica-Dukic *et al.*, 2003; Ruberto *et al.*, 2000; Abed, 2007). These all compounds and their nutritional values are summarized in fig 3 and table 3.

Properties of Fennel beneficial during Pregnancy

Fennel has many biological activities. Essential oil present in Fennel possesses carminative, stimulant activities and spasmolytic actions on the smooth muscles of animals (Khan *et al.*, 2009). The major constituents of essential oil are anethole, estragole and fenchone (Mimica-Dukic *et al.*, 2003; Ruberto *et al.*, 2000; Abed, 2007). Anethole is H₂S generating compound which is used in the treatment of pre-eclampsia or fetal growth restriction in pregnant females (Ahmed and wang, 2014). Schröder-van der Elst *et al.* (1998), shows that flavonoid crosses the placenta and enter in the fetal tissues. The concentration of flavonoids in fetal tissues is higher than in maternal tissue, thus it shows there is transfer of flavonoids to foetus. *Foeniculum vulgare* contains high amount of flavonoids that also affects the endocrine system and hormone function which promotes the flow of milk or lactel secretion (Sayed *et al.*, 2007).

Development of the mammary glands with reproductive maturity and the demand of the offspring for milk are coordinated by endocrine system (Neville *et al.*, 2002). Galactogogues or lactogogues are the compounds which initiate and maintain the milk production (Penagos Tabares *et al.*, 2014). During development the intensity of reproductive hormones, progesterone, estrogen, oxytocin, prolactin and placental lactogen alter and act directly on the mammary glands to synchronize milk release to the offspring according to their needs (Neville *et al.*, 2002). Milk has been recognized as dynamic nutrient system helping neonatal growth of mammals (Melnik *et al.*, 2013).

Table 2 showing various properties of Amla fruit

S.no	Properties	Components	Mechanism	Reference
1.	Anticancer	Aqueous/methanolic fruit extract and polyphenols of <i>Emblica officinalis</i> .	<i>In vitro</i> apoptosis, <i>In vitro</i> invasiveness, Inhibition of nf k- cell	Ngamkitidechakul <i>et al.</i> , 2010; Baliga and Dsouza, 2011; Aggarwal and Shishodia, 2004
2.	Hepato-protective	Vitamin C, Gallic acid, Flavonoids, Tannins and Phyllanthin.	By enzymatic antioxidants defence system (SOD, CAT, and GPx)	Reddy <i>et al.</i> , 2009; Sharma <i>et al.</i> , 2009
3.	Cardio-protective	Emblicanin A, B, Ascorbic acid, Polyphenols, Ellagic acid	Prevents ischemia- reperfusion induced oxidative stress and inhibit oxidation of DNA	Bhattacharya <i>et al.</i> , 2002; Pandey and Govind, 2011
4.	Anti-inflammatory	Methanolic extract of fruit	Reduced inflammation by carrageenan induced rat paw edema method	Golechha <i>et al.</i> , 2014
5.	Immuno-stimulant	Vitamin C (ascorbic acid)	Improve natural killer cell activity and antibody dependent cellular toxicity	Suresh and Vasudevan, 1994
6.	Antioxidant	Flavonoids, Phenolic compound, Tannin and Vitamin C	Free radical scavenging activity Increases the level of GSH, antioxidant capacity, and activities of antioxidant enzyme (SOD, CAT, GSH peroxidase and GSH reductase)	Prakash <i>et al.</i> , 2012 Shivnanjappa and Joshi, 2012
7.	Anti-microbial	Ethanollic extract	Inhibiting the adhesion of candida albicans to human buccal epithelium cells.	Thaweboon and Thaweboon, 2011
8.	Gastro-protective	Fruit extracts	By inhibited the development of gastric lesions	Al-Rehaily <i>et al.</i> , 2002
9.	Hypo-lipidemic	Flavonoids	Attenuating oxidative stress	Yokozawa <i>et al.</i> , 2007a
10.	Nephro-protective	Fruit extract	Reduced the elevated levels of serum creatinine and urea nitrogen, thiobarbituric acid reactive substance level of serum	Yokozawa <i>et al.</i> , 2007b
11.	Metabolic syndrome	Polyphenol	Metabolic syndrome is attenuated by polyphenol rich fraction of amla	Kim <i>et al.</i> , 2010
12.	Osteoporosis	Fruit extract	Triggering programme cell death of human primary osteoclasts	Penolazzi <i>et al.</i> , 2008
13.	Dermo-protective and ageing	Fruit extract and Vitamin C	Stimulated fibroblast proliference and induced production of pro collagen	Fujii <i>et al.</i> , 2008

Table 3 Chemical compounds of fennel

S. no.	Category	Chemical compounds	Reference
1.	Essential oil	Trans-anethole, Fenchone, Estragol, Alpha-phellandrene	Piccaglia and Marotti, 2001
2.	Phenols and Phenolic glycosides	Quercetin, 3-o- galactoside, Kaempferol-3-0-glucoside, Rosmarinic acid	Parejo <i>et al.</i> , 2004
3.	Flavonoids	Acacetin, Kaempferol, Naringenin, isorhamnetin	Harborne and Boardley, 1984
4.	Minerals	Potassium, Sodium, Iron, Phosphorous	Trichopoulou <i>et al.</i> , 2000
5.	Vitamin	Thiamine, Riboflavin, Niacin, Vitamin C	Badgujar <i>et al.</i> , 2014

Figure 2 diagrammatical representations of the properties of amla

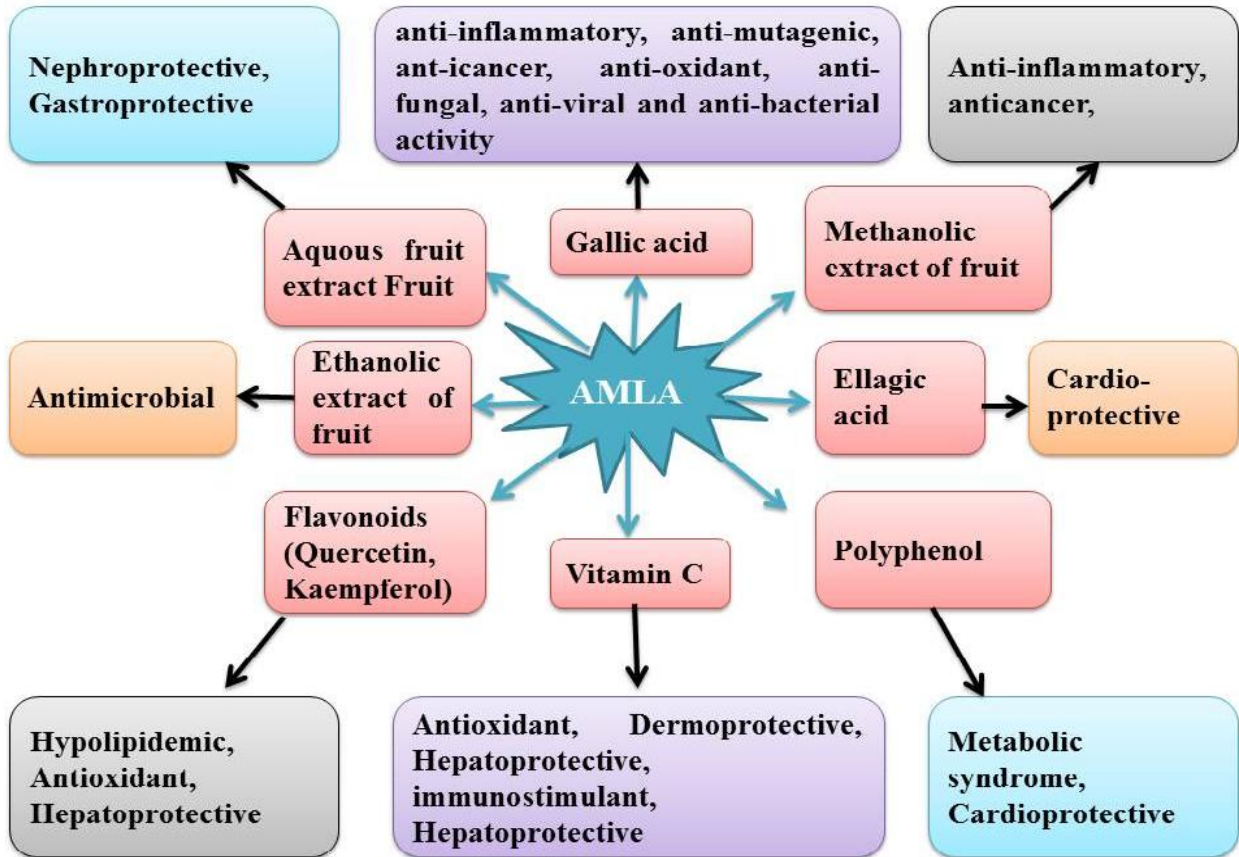


Figure 3 shows the nutritional values of fennel according to their percentage contribution.

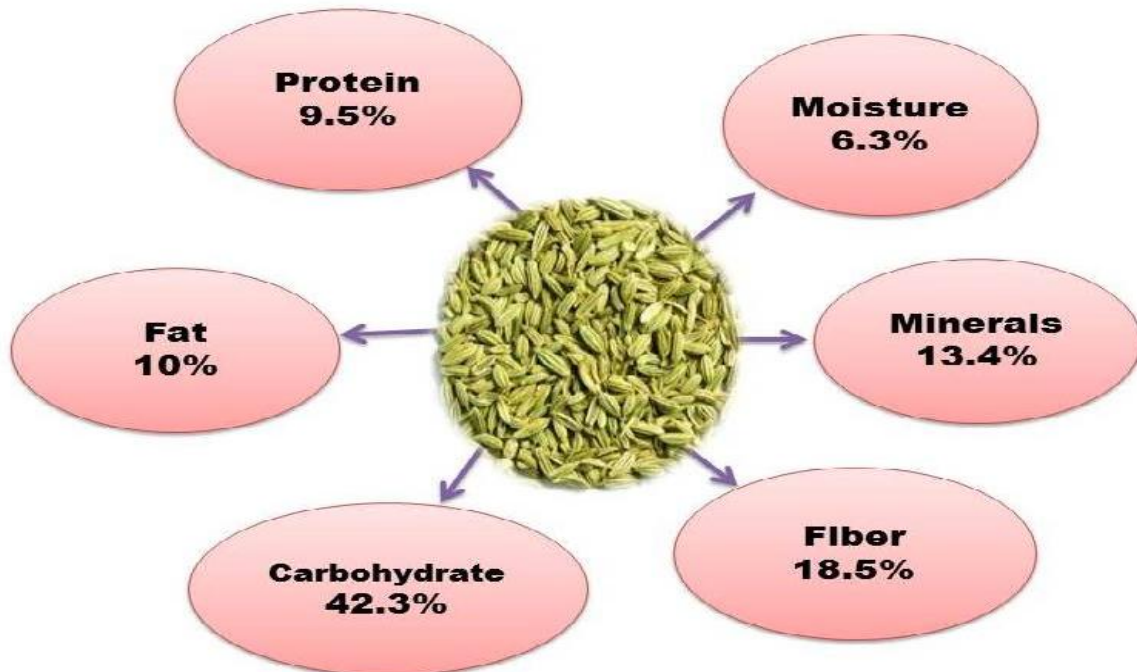
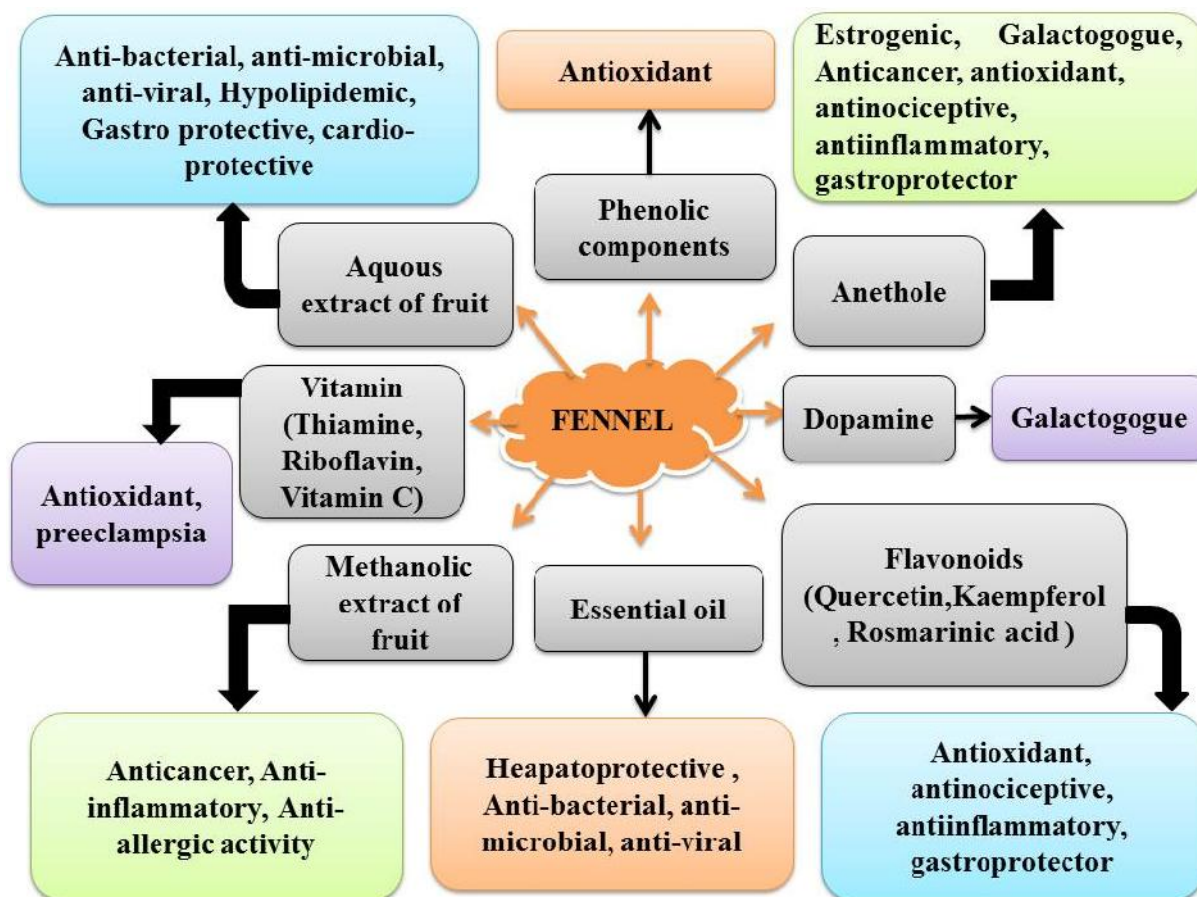


Table 4 Showing properties of fennel

S. No	Properties	Components	Mechanism	Reference
1.	Antioxidant	Phenolic components, Ethanolic and water extract	Free radical scavenging activity	Parejo <i>et al.</i> , 2004 Diaz-Maroto <i>et al.</i> , 2005
2.	Hepato-protective	Essential oil	By decreasing the level of serum AST, ALT, ACP, and Bilurubin	Ozbek <i>et al.</i> , 2003;
3.	Anti-allergic activity	Methanolic extract	Inhibitory effect on DNFB- (2,4-dinitrofluorobenzene-) induced delayed type hypersensitivity	Choi and Hwang, 2004
4.	Anxiolytic activity	Ethanolic extract of fruit	Extract produced skeletal muscle relaxant	Naga Kishore <i>et al.</i> , 2012
5.	Gastro-protective	Aquous extract of fruit	Aquous extract reduced ethanol induced gastric damage. <i>Foeniculum vulgare</i> decrease malondialdehyde level which increases the nitrite, nitrate, ascorbic acid, retinol and beta carotene level	Ozbek <i>et al.</i> , 2003; Choi and Hwang, 2004; Birdane <i>et al.</i> , 2007; Naga Kishore <i>et al.</i> , 2012
6.	Cardio-protective	Aquous extract of leaves	Aquous extract of fennel produced significant dose related reduction in arterial blood pressure without affecting heart rate	Abdul-Ghani and Amin, 1988
7.	Anti-inflammatory	Methanolic extract of	Three protocol- 1.Carrageenan paw edema 2.Archidonic acid induced ear edema 3.Formaldehyde induced arthritis	Choi and Hwang, 2004
8.	Estrogenic properties	Anethole essential oil	Promote mensuration, milk secretion,	Malini <i>et al.</i> , 1985; Albert-Puleo, 1980
9.	Anti-bacterial, anti-microbial, anti-viral	Essential oil, aquous extract of fennel	Inhibit the growth of bacteria, virus, and microbes	Parejo <i>et al.</i> , 2004; Duško <i>et al.</i> , 2006; Kaur and Arora, 2009
10.	Galactogogue	Anethole, dopamine	Anethole compete with dopamine at appropriate receptor site and influence milk secretion	Albert-Puleo, 1980
11.	Anti-mutagenic	Fennel extract	DNA repair system	Ebeed <i>et al.</i> , 2010; Tripathi <i>et al.</i> , 2013
12.	Anti-cancer	Anethole, Methanolic extract	Anethole increase survival time, reduced tumor weight and cytoprotection activity	Al-Harbi <i>et al.</i> , 1995; Pradhan <i>et al.</i> , 2008
13	Hypolipidemic	Aquous extract of Fennel	Significant reduction of plasmalipid level i.e. cholesterol, triglyceride, LDC-cholesterol, apolipoprotein- etc.	Oulmouden <i>et al.</i> , 2011

Figure 4 shows the chemical compounds of fennel and their properties



It also possesses several properties like antifungal, antibacterial, antioxidant, antithrombotic hepatoprotective, gastrointestinal, oestrogenic, anti-mutagenic, anti-inflammatory etc. All these properties are summarised in fig 4 table 4.

On the basis of above various studies in this field, we can say that fennel seeds possess so many properties and it is beneficial during pregnancy and lactation. It possesses antioxidant and lactating properties. Its compounds are able to neutralize the adverse effects of free radicals and enhance milk secretion and improve the quality of milk in lactating women which are necessary for the nourishment of young ones.

Inadequate supplies of essential vitamins and micronutrients can be injurious to the health of pregnant women and children (King, 2003). Lack of trace element during pregnancy resulted into mortality and morbidity in new born child (Srivastava *et al.*, 2002). As iron deficiency causes preterm delivery, perinatal mortality and low birth weight (Rooney, 1992), calcium and magnesium deficiency cause hypertension (Maine, 2000). Scarcities of antioxidants, and micronutrients such as selenium, copper, zinc and manganese can cause poor pregnancy results with foetal growth restriction (Fall *et al.*, 2003), preeclampsia

(Rumbold *et al.*, 2005, 2008) and increase the risk of diseases at the time of maturity, including cardiovascular disease and type 2 diabetes (Bellamy *et al.*, 2007; Vikse *et al.*, 2008; Lykke *et al.*, 2009; Staff *et al.*, 2010). It is postulated that there is competition for nutrients between mother and her foetus during gestation period (Naeye, 1981; Baker *et al.*, 2009) so balance diet is must to avoid adverse effects of malnutrition.

Conclusion

On the basis of studies discussed above in this article, effort has been taken to collect and compile the detailed account of various properties of *Embllica officinalis* and *Foeniculum vulgure* which are also beneficial during pregnancy and lactation. During this period women need extra energy not only for her but also for growing foetus because pregnancy is period when rate of metabolic activity is increased. During these stressful period possibilities to generate ROS and free radicals increases which cause various metabolic disorders. To avoid side effects of free radicals during pregnancy women should take products with plenty of antioxidants and little deleterious impact. Amla fruit and fennel seeds are versatile plant products with overflowing pharmaceutical and therapeutic properties.

It is the ancient medicinal plant mentioned in Ayurveda with potential effects for various ailments. These plant products possess several properties like anti-oxidative, antibacterial, antiviral, hypolipidemic, nephro-protective, anticancer, gastroprotective and galactogogue as lactating agent. All these properties contribute to safe pregnancy and boost postnatal growth. Pregnant women must include herbal plant products in their diet to avoid adverse effects of free radicals and ROS. In our own initial study performed in Swiss mice on effects of different combinations of diet on development of pups, we also found improvement in health status of pups when their mothers are feed with these plants products during pregnancy and lactation. The reports and results discussed in the present review are not enough to conclude any concrete inference in this direction. More detailed studies are needed to fulfil this lacuna in our understanding related to this problem.

Acknowledgments

We are obliged to our department for providing all the basic necessary facilities required in this work. One of us (Neelam Jain) is thankful to DST, New Delhi for providing the financial support.

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