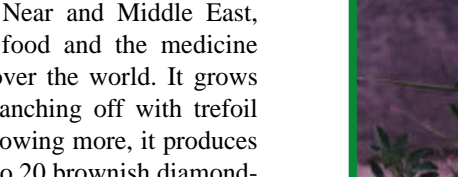


# FENUGREEK

[Air Green]



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## About Fenugreek

### Familiar Food

Fenugreek, *Trigonella foenum-graecum*, is an annual legume native to the Mediterranean region. From ancient days, it has been grown in the Near and Middle East, Africa, and India and used for food and the medicine purposes. Today it is grown all over the world. It grows straight up to 60cm in height branching off with trifoliate leaves and little white flowers. Growing more, it produces sickle shaped pods containing 10 to 20 brownish diamond-shaped seeds which have a diameter of 3 to 4mm and a deep groove in the middle.

In the Near and Middle East, Africa, and India, they eat it in many ways. They eat beansprouts and grown-up fenugreek. It has the same constitution as a soybean, and they feed it to cattle. However, fenugreek is mostly used as beans for curry spice and also used for Indian popular condiment, "chutney". Traditionally, fenugreek has been used in folk medicine for tonic, nutrition, appetizer, and antifebrile. Especially in India and the Near and Middle East, they have the custom that women in the lactation period eat fenugreek because fenugreek is thought to increase their milk. Recently, in Europe and America, many women eat them as health food to enlarge their breasts. Because it is said that steroid saponin contained in fenugreek testa is a precursor of female hormone and it is turned into female hormone in the body that enlarges breast and increases milk.

### Folk usage of fenugreek

Fenugreek is eaten in various ways in Africa, Middle-East, India and China such as sprouts, vegetable, mixed in bread and spice of curry. Fenugreek is harvested as feed in USA and Canada because fenugreek has protein similar to soybeans.

Fenugreek was used as folk medicine such as tonic, nutritious supplement, aperient, and antifebrile. As fenugreek has a galactagogue function, it is recommended for nursing women to eat during nursing terms in Middle East. Recently fenugreek supplement is sold for the purpose of breast enlargement. This is mean why steroid saponin contained in fenugreek testa is a precursor of women's hormone and changes to women's hormone in the body and acts for breast enlargement and galactagogue function.



### The usage of Fenugreek seed

Fenugreek seed is used as spice in curry and other foods and as fenugreek is legume, it is suitable for feed for cattle. In most cases, whole seeds were used and seeds separated into testa and albumen were not. When separated into testa and albumen, fenugreek has completely different functions.

Fenugreek seed consists of 75% testa and 25% albumen, the testa contains fragrance essential oil, saponin, and protein and functions as spice. On the other hand, albumen consists of 80% water soluble substance and 20% water insoluble substance. Water soluble substance is galactomannan. It is called viscous polysaccharide and viscous polymer. Galactomannan itself has no taste and no smell.

Composition of fenugreek seed	
Protein	26%
Water-soluble polysaccharide (galactomannan)	20%
Hemi-cellulose and cellulose	24.5%
Water	9%
Fat (fenugreek oil)	7%
Lignin	2.5%
Saponin	8-10%

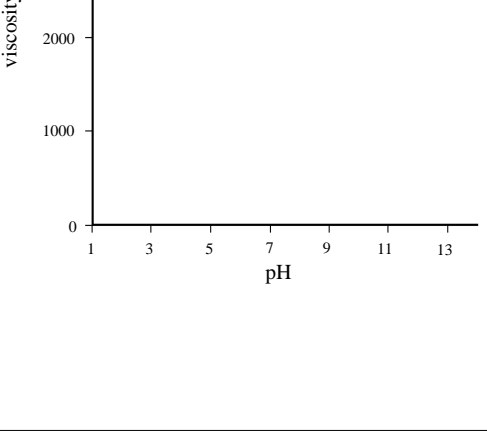
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## Fenugreek galactomannan

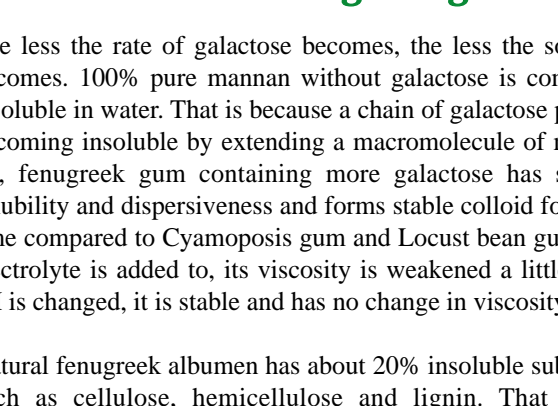
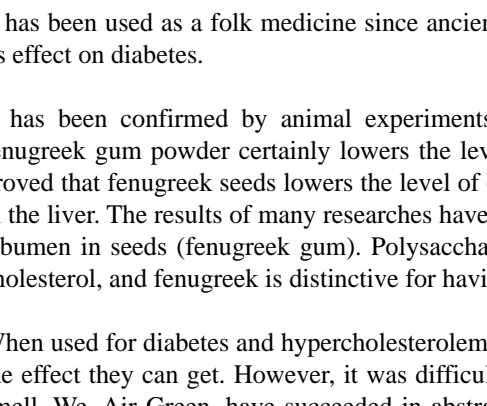
Why does only fenugreek galactomannan have blood sugar reducing function?

Guar gum and locust bean gum are the same viscous polysaccharide whose main ingredient is galactomannan. In a study of comparing the blood sugar lowering function of galactomannans, only fenugreek galactomannan achieves a remarkable result. Guar gum has a little function and locust bean gum has no function. This study concluded the difference of the functions as follows. When hydrolyzing galactomannan to mono sugar, the ratio of galactose to mannose for fenugreek is 1:1, but for Cyamopsis gum, it is 1:2, and for Locust bean gum, it is 1:4. This means that one mannose molecular bonds to one galactose molecular in fenugreek gum. This study also indicates that fenugreek gum is more effective than guar gum and locust bean gum in the function of reducing serum cholesterol and serum lipid.

### Salinity tolerance in purified fenugreek gum



### Viscosity change of purified fenugreek gum by pH



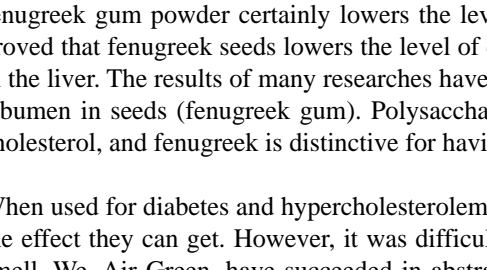
### The attribute of fenugreek gum

The less the rate of galactose becomes, the less the solubility becomes. 100% pure mannan without galactose is completely insoluble in water. That is because a chain of galactose prevents becoming insoluble by extending a macromolecule of mannan. So, fenugreek gum containing more galactose has superior solubility and dispersiveness and forms stable colloid for a long time compared to Cyamopsis gum and Locust bean gum. If an electrolyte is added to, its viscosity is weakened a little, but if pH is changed, it is stable and has no change in viscosity.

Natural fenugreek albumen has about 20% insoluble substances such as cellulose, hemicellulose and lignin. That is why fenugreek gum is said to have less viscosity than guar gum and locust bean gum. However, purified gum powder that contains more than 80% galactomannan has almost the same viscosity as guar gum.

Galactose is hydrophilic and mannan is hydrophobic. This means that fenugreek gum is surface-active, in other words, an emulsifier that mixes water and oil. It dissolves oil into water, increases viscosity, and forms aqueous colloids. That moderately disperses oil particles and prevents from sticking to each other, therefore it can maintain the state of oil dispersion. This kind of material is called a stabilizer. Fenugreek galactomannan works as a gum and an emulsifier, so that it can be used as a stabilizer for food.

### Viscosity comparison of 4 kinds of gum



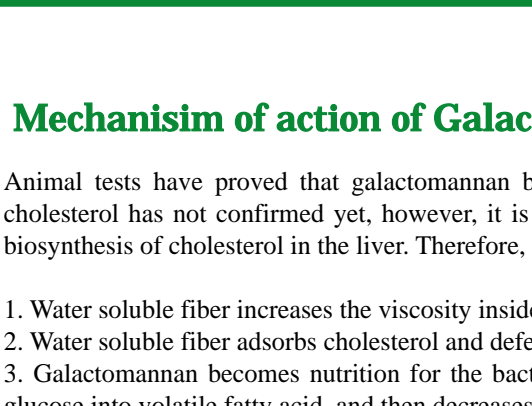
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## Fenugreek's medicinal virtues

It has been used as a folk medicine since ancient days, and the reason why it has recently attract particular attention is its effect on diabetes.

It has been confirmed by animal experiments and clinical tests on humans that ingesting the food compounded fenugreek gum powder certainly lowers the level of sugar in the blood for the past few years. Moreover, it has been proved that fenugreek seeds lowers the level of cholesterol and fat in the blood and restrains biosynthesis of cholesterol in the liver. The results of many researches have discovered that these effects are caused by galactomannan contained in albumen in seeds (fenugreek gum). Polysaccharide, or dietary fiber, generally has the effect of lowering the level of cholesterol, and fenugreek is distinctive for having the effect of lowering the level of sugar in the blood as well.

When used for diabetes and hypercholesterolemia, it has been proved that the more fenugreek seeds they take, the more the effect they can get. However, it was difficult to take much seed powder because it has a bitter taste and a peculiar smell. We, Air Green, has succeeded in abstracting only albumen from seeds containing 25% of albumen, and then produced fenugreek gum powder. It has no taste and no smell because it does not contain testa which has a bitter taste and a peculiar smell, so everyone can eat it. We have also succeeded in purifying gum powder and abstracting only fenugreek galactomannan without taste and smell.



### Intake of Fenugreek Gum

There is no limit for the intake because fenugreek gum is harmless. According to clinical tests, 1.25g of gum (5g in seeds) is enough to lower the blood sugar level and cholesterol. There is a case that 7.25g of gum (30g in seeds) are taken for therapeutic purposes. Generally, it is thought to be effective to take approximately 6g in gum powder or approximately 5g in refined gum powder whose galactomannan content is more than 80%. It is confirmed by animal experiments that administration of the amount equivalent to 120g per day for human does no harm.

### Other effects by fenugreek gum

Because fenugreek galactomannan is dietary fiber, it has an effect as bulk cathartic, so that it works well as constipation. Moreover, it lowers not only cholesterol but also blood fat such as triglyceride. In various experiments designed to determine the effect of lowering blood sugar, weight loss is also observed. This indicates that long-term intake of fenugreek gum loses weight, so you can make diet foods by compounding it into various foods.

## Mechanism of action of Galactomannan

Animal tests have proved that galactomannan blocks intestinal absorption of glucose. The block of absorption of cholesterol has not confirmed yet, however, it is true that it lowers the level of cholesterol in blood and also lowers biosynthesis of cholesterol in the liver. Therefore, some hypotheses are framed as follows.

1. Water soluble fiber increases the viscosity inside the intestine and then inhibit absorption of glucose and cholesterol.
2. Water soluble fiber adsorbs cholesterol and defecates as feces.
3. Galactomannan becomes nutrition for the bacteria in the intestine. When the bacteria proliferate, they decompose glucose into volatile fatty acid, and then decreases glucose absorption. The fatty acid is absorbed into blood and inhibits biosynthesis of cholesterol.
4. Galactomannan influences intestine walls to generate hormones and enzymes and they influence biosynthesis of cholesterol in liver.

However, the mechanism has not been fully understood yet.

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## Fenugreek testa

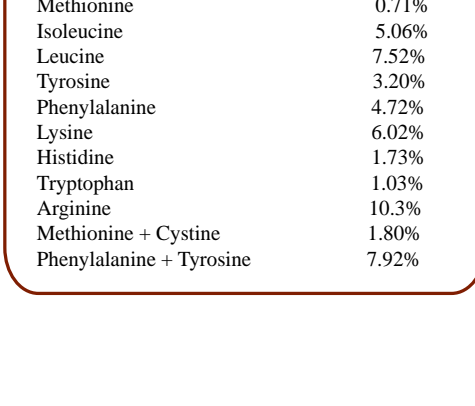
Fenugreek seed has different composition in testa and albumen. The testa contains steroidal saponin like diosgenin and yamogenin, and fragrant essential oil and protein.

## Fenugreek essential oil and fenugreek oleoresin

### Natural surfactant

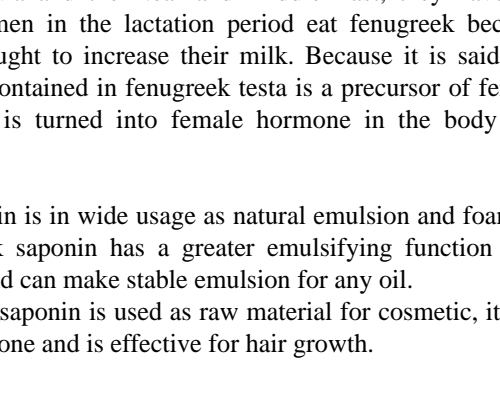
### Fenugreek saponins

Fenugreek has two kinds of saponins, furostanol type and spirostanol type. Most of saponins are furostanol type called diosgenin and yamogenin. Fenugreek testa that contains 10-15% of saponin. Especially, diosgenin is a precursor of progesterone of corpus luteum hormone and raw material for female hormone and steroid hormone. It is said that fenugreek saponin has the function of increasing appetite, the function decreasing cholesterol (making insoluble compounds), anticarcinogenic function, antiviral function. These functions are thought to relate with surfactant function, but have not been fully resolved yet.



The compositions of fenugreek protein	
Methionine	0.71%
Isoleucine	5.06%
Leucine	7.52%
Tyrosine	3.20%
Phenylalanine	4.72%
Lysine	6.02%
Histidine	1.73%
Tryptophan	1.03%
Arginine	10.3%
Methionine + Cystine	1.80%
Phenylalanine + Tyrosine	7.92%

### Furostanol-type saponins



Especially in India and the Near and Middle East, they have the custom that women in the lactation period eat fenugreek because fenugreek is thought to increase their milk. Because it is said that steroid saponin contained in fenugreek testa is a precursor of female hormone and it is turned into female hormone in the body that increases milk.

Fenugreek saponin is in wide usage as natural emulsion and foaming agent. Fenugreek saponin has a greater emulsifying function than other saponins and can make stable emulsion for any oil. When fenugreek saponin is used as raw material for cosmetic, it also acts female hormone and is effective for hair growth.

### Fenugreek Protein

Fenugreek seed contains approximate 32% of crude protein. Most of protein is contained in the testa. The testa is made of approximate 42% of crude protein and it is a good source of protein. Fenugreek protein is digestible and the ratio is over 90% and its composition is similar to other amino acids like soybean. It contains much lysine and a little sulfurous amino acid. Galactomannan is also contained in testa it elutes with protein. The difficulty of separating protein from galactomannan makes it hard to extract fenugreek protein. So, it is one idea to use the testa as the feed for cattle.

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## Fenugreek Products by Air Green

We, Air Green, is the first company in the world that developed and succeeded in manufacturing purified albumen powder containing high ratio of galactomannan from the seed.

Air Green also manufactures fenugreek oil, oleoresin and saponin extracted from the seed.

The standard of purified fenugreek gum powder		
Description	Gum powder A	Gum powder B
		light yellow or white powder with a slight grain smell.
<b>Identification</b>		
(1)	The water solution has viscosity. (Gum A,B)	
(2)	The water solution become gel. (Gum A,B)	
(3)	The water solution do not have smell and bitter taste. (Gum A)	
<b>Purity test</b>		
(1) Acid insoluble matter	Not more than 3%	Not more than 5%
(2) Water insoluble matter	Not more than 3%	Not more than 5%
(3) Heavy metal	Not more than 20ppm (Gum A,B)	Not more than 3%
(4) Arsenic	Not more than 2ppm (Gum A,B)	Not more than 3%
<b>Loss on drying</b>	Not more than 10.0% (Gum A,B)	
<b>Viscosity: (1w/% solution)</b>	Not less than 3000mPa.s	Not less than 1000mPa.s
<b>Particle size</b>	Not more than 100 mesh ( 150 micro m )	
<b>Nutritional test</b>		
(1) Protein	Not more than 5% (Gum A,B)	
(2) Starch	Not detective (Gum A,B)	
(3) Fat	Not more than 1.0% (Gum A,B)	
(4) Dietary fiber	Not more than 80%	Not more than 70%
(5) Caloric	Not more than 1kcal/g (Gum A,B)	
<b>Assay</b>		
(1) Galactomannan	Not less than 80%	Not less than 60%
<b>Microbial test</b>		
(1) General Bacteria		
bacteria	Not more than 3x10 <sup>6</sup>	(Gum A,B)
Fungi	Not more than 3x10 <sup>4</sup>	(Gum A,B)
(2) E. Coli	Not detective (Gum A,B)	

### Fenugreek Gum Powder A

Gum A is the most highly purified gum powder containing not less than 80 percent of galactomannan. We recommend gum powder A when you use it as solution. Purified gum powder is easy to melt in water at room temperature and becomes a slight milk white and half translucent gel form easily. It tastes like the cereal, but has hardly any taste and smell. It has the highest viscosity and forms stable gel.

### Fenugreek Gum Powder B

Gum B is produced as a byproduct of purifying gum and contains 60-80% of galactomannan. it has a little curry smell because of less purification. When dissolved in water, the solution takes on light yellow color. Therefore it is suitable for using as ingredient of health supplement in tablet and capsule forms without dissolving. The price of Gum B is lower than Gum A.

### Fenugreek Testa

The purpose of this product is to intake steroidal saponin. Especially diosgenin is a precursor of progesterone and changed into progesterone in the body. Then it has the function to increase milk production and enlarge breast. Fenugreek testa powder is sold as health supplement in the form of tablet or capsule in US and other countries.

### Fenugreek Oil

Fenugreek oil is essential oil from the testa, it has curry fragrance and can be used as flavor of curry in foods.

### Fenugreek Oleoresin

Oleoresin is the resin in fenugreek testa and contains much essential oil and is used for flavor in food. When added to syrup, the syrup has maple syrup flavor. When added to butter, the butter flavor increases. It is also used for tobacco fragrance and, of cause, increases curry flavor.

### Fenugreek Saponin

Fenugreek saponin is used as emulsion and foaming agents and becomes the raw material of female hormone. The usage for cosmetic raw materials has attracted considerable attention. Fenugreek saponin is a female hormone precursor and changes into female hormone in the body. When formulated in hair cosmetics, and fenugreek hormone is absorbed through the skin and acts female hormone and works for hair growth.

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