

Cotton Seed oil: A Healthier Nutritional Alternative

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An Overview of Cooking Oils in India

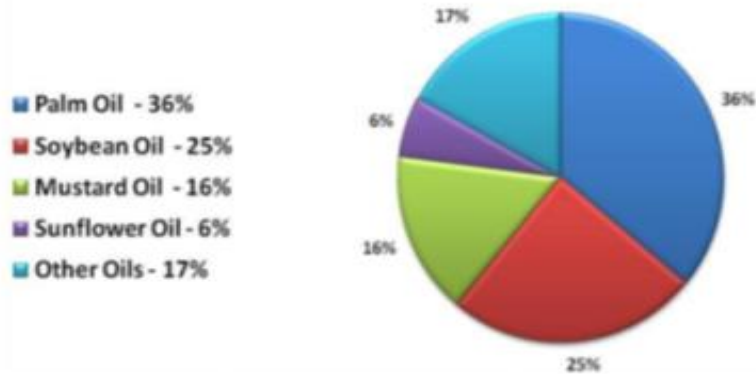


- Cooking oil is a vital and basic ingredient in any Indian dish, whether it is a serving of mixed greens or main course, oil is used for cooking and to add flavour to our food.
- However, picking the correct cooking oil can spare one from heart infections, cholesterol blockages, stoutness and processing issues. Some of the prominent cooking oils that can be used to prepare finger-licking dishes in the Indian cuisine.
- India has a wide range of oilseeds crops grown in its different agro climatic zones.
- Palm, Groundnut, mustard/rapeseed, sesame, safflower, linseed, nigerseed / castor seed are the major traditionally cultivated oilseeds
- Soyabean and Sunflower have also assumed importance in recent years.
- Palm, Soyabean, Sunflower and Rapeseed/Mustard together contribute about 85 percent of the country's oilseeds production.

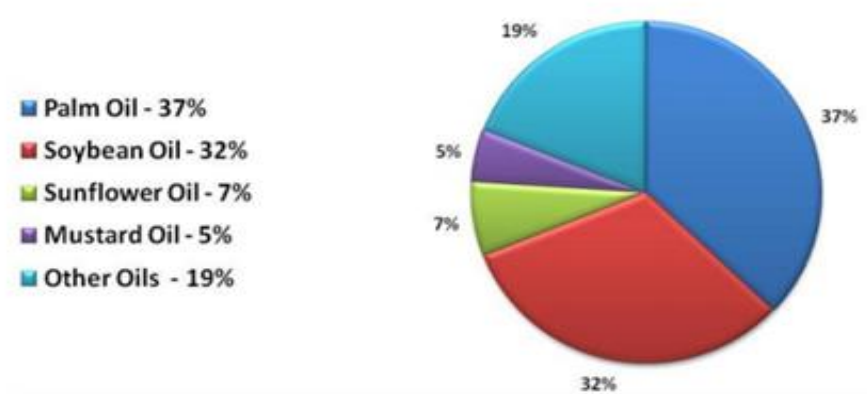
Zone wise oil Consumption Pattern



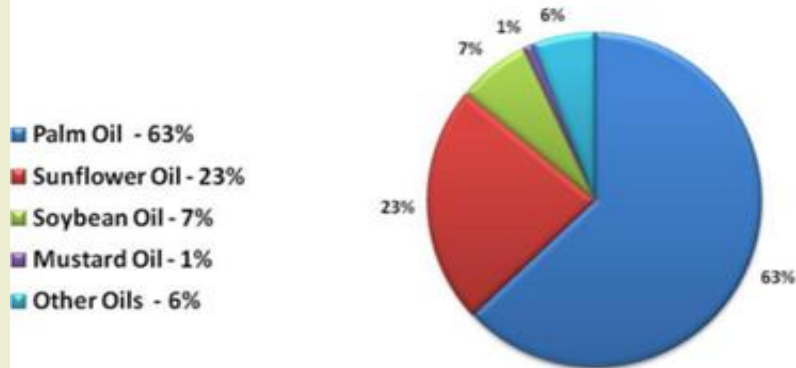
North India



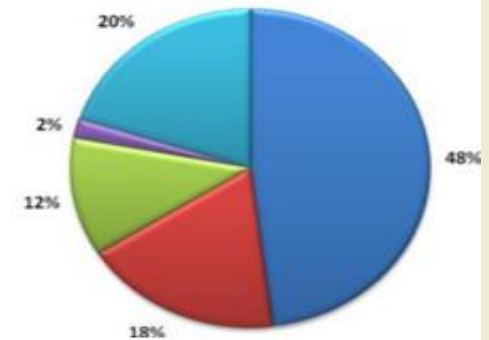
West India



South India



East India



Sources: GGN Research

- Among the non-conventional other type of oils, rice bran oil and cotton seed oil are the most important.

Some Important Cooking Oils in India



- **Ghee** is presumed to be one of the best and healthy options available for cooking purpose in India. It improves the functioning of the brain and improves memory, helps in weight loss along with exercise, build up bone strength and energy level
- **Mustard oil** is often used as a stimulant to help digestion and circulation. Due to its antibacterial properties, this oil can help to protect the skin. Mustard oil also fights with germs and virus, good to prevent cold, coughs and skin problems.
- **Sunflower oil** is a source of vitamin E. The polyunsaturated (PUFA) helps in lowering cholesterol. Reduces free radicals cardiovascular risk, good for cancer patients, boost up immune system, helps in functioning of nervous system.
- **Olive oil** contains a good amount of antioxidants that reduces pain in the joints as well as lowers the risk of Parkinson's and Alzheimer's. This oil is known to have properties that assist in battling heart illnesses and diseases.
- **Rice bran oil** is rich in monounsaturated fatty acids and has cholesterol-lowering properties. Due to the presence of oryzanol, it is effective in reducing cholesterol.
- **Flaxseed oil** is a good cooking oil with richness of omega 3 fatty acids. Omega 3 fatty acid is beneficial for health and important in cure and prevention of Crohn's Disease and colitis.



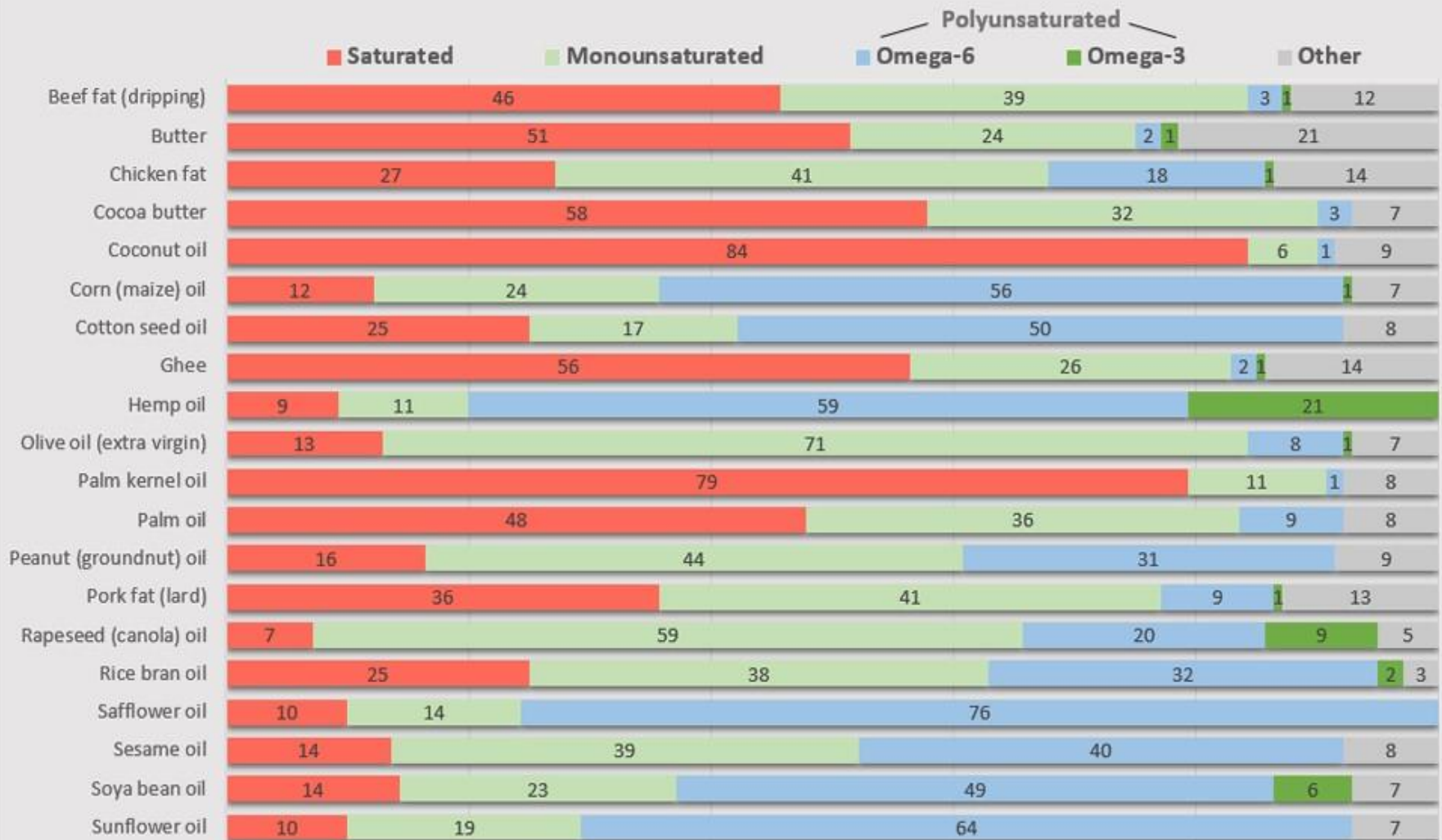
- **Groundnut oil** is high in mono-unsaturated (MUFA) and polyunsaturated (PUFA), helps in lowering low-density lipoprotein (LDL) cholesterol. Source of vitamin E, act as an antioxidant and protects the skin from acne or scars.
- **Palm oil** is a rich source of antioxidants, carotenes and Vitamin E. It is a good ingredient for cancer patients, and for those suffering from Alzheimer's, arthritis, atherosclerosis and anti-aging.
- **Sesame oil** is beneficial for diabetics and reduces the circulatory strain. It enhances oral cleanliness, dental wellbeing, counteracts the atherosclerosis, malignancy and battles misery.
- **Edible almond oil** is useful for Heart ailment and blood pressure. It can enhance good cholesterol levels and ensures protection against colon tumour.
- **Cashew oil** contains anti-bacterial properties that help our body build up the immune system. It can enhance the eye sight, lessening the irritation and cholesterol levels.
- **Canola oil** is cholesterol-free and is a good source of vitamins E and K, omega-3 fat and plant sterols, which helps in protecting your heart health.
- **Soybean oil** with high in poly-and monounsaturated fats and low in immersed fats. It additionally contains Omega 3 unsaturated fats

Fatty acid content of different type of oil



Common Cooking Oils and Fats - Type of Fat Content (Approx. %)

For health choose oils and fats with low saturated (red) fat and a good mix of unsaturated (green and blue) fats



Indian Edible Oil Industry



- Edible oils constitute an important component of food expenditure in Indian households.
- Edible oil industry is one of the most important industries of agriculture sector in India.
- India is a leading player in the industry. And world's largest importer from Indonesia and Malaysia and third largest consumer.
- India is the 4th largest oil seed-producing country in the World after USA, China and Brazil with 38.6 million metric tons, derived from 40 million hectares.
- The per capita edible oil consumption is at 16 kgs, the total country's consumption stand much higher at about 21 million ton.

Status of Cotton Production



- Cotton has been important crop around since ancient times in India (3500 BC).
- India is second most cotton producing country after china with 26.1% of total world cotton production.
- It plays a vital role in Indian economy, as it accounts for 38% of the country's export as well as providing employment for more than one million people.

	Country	Cottonseed Production (metric tonnes)	% of World Total
1	China	12,320,000 m/t	26.2%
2	India	12,300,000 m/t	26.1%
3	United States of America	4,649,320 m/t	9.8%
4	Pakistan	4,442,697 m/t	9.4%
5	Brazil	2,669,161 m/t	5.6%

Cotton (*Gossypium hirsutum*, Malvaceae)

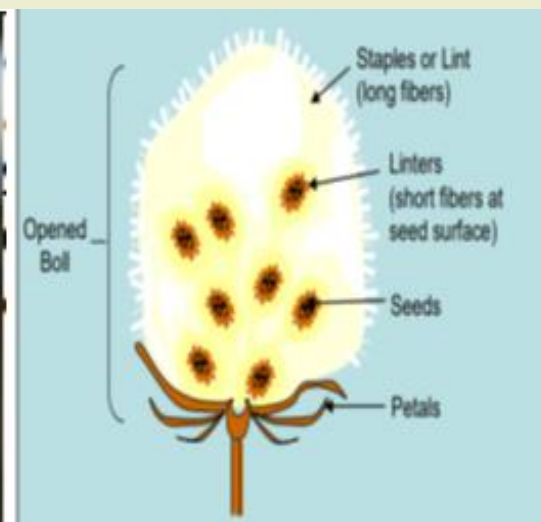
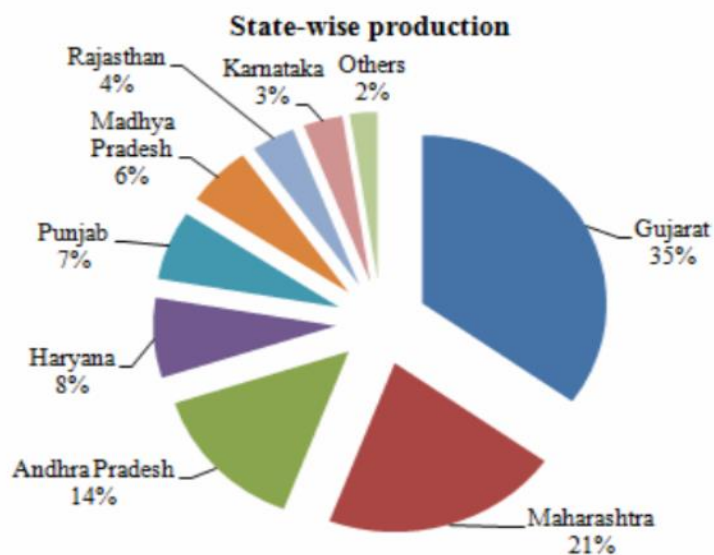
- Cotton widely grown for fiber
- The seeds used as a source of edible oil for thousands of years.
- Cotton seed contains a toxic compound, gossypol. A problem in utilizing the press cake.
- David Wesson's process of purification with caustic soda, steam and fuller's earth removed much of the gossypol.
- Shortening was first made by hydrogenation of cottonseed oil.



Cotton Seed Production



- Cotton is produced in more than 12 states in India
- Gujarat is the largest cotton producing state in India with a production of 125 Lakh Bales.
- Gujarat is the perfect place for growing cotton.
- Temperature, soil, availability of water & fertilizer, and the labour charge- everything goes in favour of cotton cultivation

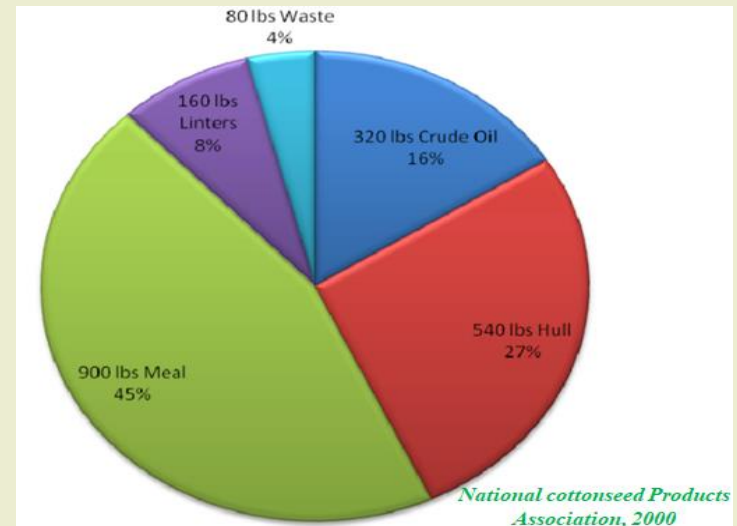


Open ball of *Gossypium hirsutum*(L) and a diagram to shows the various constituents and their relative positions(R); LaForest, 2008

Cotton Seed Oil is a good Nutritive Source



- All elements of cotton seed as it is often considered as "Golden Goose".
- Cottonseed contains linters, kernels and hulls which are used in various consumer products, delicious food and nutritious feed for animals.
- The kernel contains oil, protein, carbohydrate and other constituents such as vitamins, lecithin, sterols etc.
- Leftover endosperm after oil extraction is a rich source of protein and is used as a feed for animals or fertilizer for plants. They are considered as cost effective animal feed.



Cottonseed products yield/ton of seed crushed

Cottonseed oil - Significance



- Cotton seed oil, falls under the vegetable oil, has been a part of the American diet for well over a century and considered as one of the most popular oils in kitchens.
- Cotton seed oil mostly extracted from *Gossypium hirsutum* and *Gossypium herbaceum*, that are also grown for cotton fiber and animal feed.
- Cottonseed oil is extracted from cottonseed kernel which are by-products of cotton fibre production
- It has a mild, nut like taste and is clear with a light golden colour.
- Refined and deodorised cottonseed oil is considered as one of the purest cooking medium available.

Cotton seed oil fatty acid composition



- Fats and oils are made up of triglycerides, three molecules of fatty acids joined to a glycerol molecule.
- The chain length of the fatty acids and their organization on the glycerol backbone vary greatly, although in most of the edible oils it is with 16 and 18 carbons.
- Fats and oils are a combination of fatty acids, both saturated (C14:0, 16:0, etc.) and unsaturated (C 18:1, 18:2, 18:3).

FATTY ACID	COTTONSEED COOKING OIL	*PARTIALLY HYDROGENATED
Myristic (14:0)	0.8	0.9
Palmitic (16:0)	24.4	22.5
Palmitoleic (16:1)	0.4	0
Stearic (18:0)	2.2	5.5
Oleic (18: 1)	17.2	50.0
Linoleic (18:2)	55.0	20.3
Linolenic (18:3)	0.3	0.3
SUMMARY		
% Saturates	27	29
% Monounsaturates	18	50
% Polyunsaturates	55	21

Cottonseed Oil Quality



- Most of the fatty acids in this type of oil are polyunsaturated, with the majority of them being the “good” fat linoleic acid.
- Cottonseed oil is among the most unsaturated oils, others being safflower, corn, soybean, rapeseed and sunflower seed oils.
- Cottonseed oil has a ratio of 2: 1 of polyunsaturated to saturated fatty acids and generally consists of 65-70% unsaturated fatty acids including 18-24% monounsaturated (oleic) and 42-52% polyunsaturated (linoleic) and 26-35% saturated (palmitic and stearic).
- The saturated fatty acids content make it a relatively stable vegetable oil without partial hydrogenation, hence also called as "naturally hydrogenated" oil.

Cottonseed Oil - Nutritional Aspects



- Linoleic acid is the major polyunsaturated fatty acid found in cottonseed oil.
- With three times as much unsaturated as saturated fatty acid, cottonseed oil is considered as a healthy vegetable oil and is one of the few oils advised for reducing saturated fat intake.
- Cottonseed oil is described by scientists as being "**naturally hydrogenated**" because of the levels of oleic, palmitic, and stearic acids in it. This renders it a stable frying oil without the need for additional processing that could lead to the formation of trans fatty acids.
- When it is partially hydrogenated, its monounsaturated fatty acids actually increase. When hydrogenated to a typical Iodine Value of about 80, its fatty acid profile changes to 50% monounsaturated, 21 % polyunsaturated, and 29% saturates all well within health guidelines.

Cottonseed Oil Major Benefits



- Cottonseed oil's major benefits includes, its high level of antioxidants - Tocopherols that contribute to its long life on the shelf.
- The high level of natural antioxidants in fried products, preserve their freshness and creating longer shelf life. Cottonseed oil is rich in Tocopherols.
- Several different tocopherols having vitamin E activity has been found in various edible oils; the most active and abundant one is a - tocopherol. The below table gives a clear idea about cottonseed oil's superior quality in terms of total a - tocopherol equivalent over the most of edible oils.

Oil Type	Total mg/100g	a-Tocopheral equivalent
Canola	66	23
Corn	104	33
Cotton Seed	65	38
Olive	13	12
Palm	26	8
Peanut	13	9
Rapeseed	67	24
Soyabean	104	17
Sunflower	65	62

Tocopheral Content in Various Edible Oils

(Source: The National Cottonseed Products Association -Guide to Edible Oils.)

Cotton seed oil extraction

- Cotton seed oil is extracted from the seeds of cotton.
- It is essentially a by-product of the cotton industry along with cottonseed meal, hulls and linters.
- Over 10-15% of a cotton farmers income is expected to come from these by-products, making them considerably valuable products in cotton processing operations.
- Its production process involves pressing and extraction of oil from the cotton seeds followed by purification and refinement.
- The refinement of the oil is the key step as it helps in removing gossypol, a naturally occurring toxin that protects the cotton plant from damage.

Cottonseed oil as “Heart Oil”

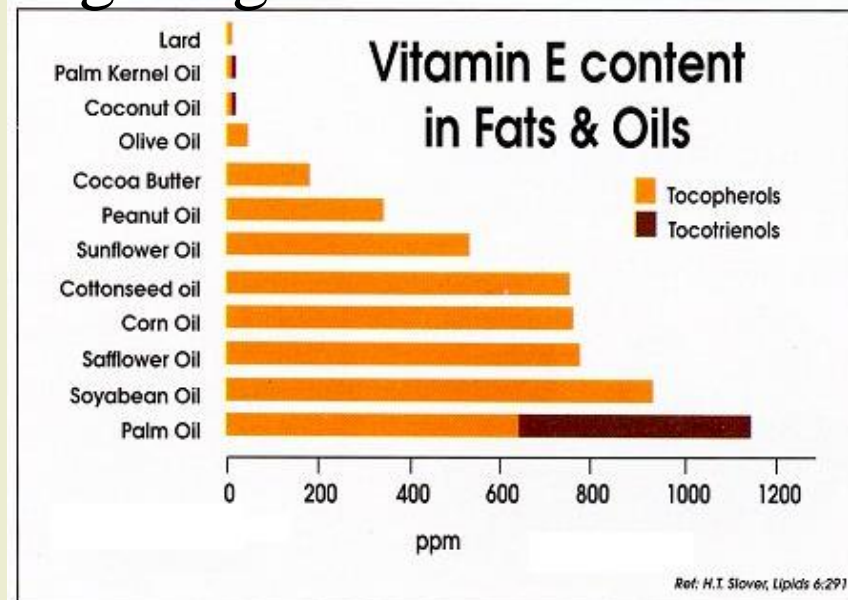


- Cottonseed oil is cholesterol free, as it extracted from plants which make it's a great choice to reduce the cholesterol level.
- The better part of cottonseed oil's fat composition is polyunsaturated and monounsaturated fat.
- It contains sufficient saturated fatty acids (palmitic, stearic, myristic) as well as enough unsaturates (oleic , linoleic, and linolenic usually) to make it a heart healthy oil and helping the body to act against the harmful activities of the LDL cholesterol.
- The presence of linoleic acid gives the body the much needed supply of mono and poly-saturated fats which help to reduce the chances of heart issues like stroke, clogged arterial condition, and heart attacks.

Cotton seed oil as antioxidant



- Cotton seed oil has high concentration of vitamin E.
- Cottonseed oil is a more efficient delivery vehicle for heart-healthy Vitamin E than other vegetable oils.
- Since cotton seed oils is rich source of vitamin which is like antioxidant, is important in fighting free radicals and essential for good health.
- It can be used in rotation with other oils such as canola oil, sunflower oil, groundnut oil, etc. as a part of healthy diet.



Health benefits of Cotton seed oil



- Due to the vitamin E content of the oil, it's one of the most effective oils to prevent the signs of aging.
- Cotton seed oil helps to protect and fight off the free radicals that harm skin.
- Cotton seed oil helps to strengthen hair and promotes growth. It also help to mitigate less hair loss as well.
- Due to the high amount of linoleic acid, vitamin E and antioxidants, it is very useful in wound or cut.
- The healing process is sped way up in the presence of this oil and even it prevents the presence of scarring.
- It can be apply either directly on wound or along with some coconut or jojoba oil.

Memory and Cognition Benefits

- The nutrients found in cottonseed oil contribute to a healthy brain and great nerve function.
- Vitamin E, the most plentiful vitamin by far in this nutrient-rich oil, helps the nervous system to repair the fatty sheaths that encase neurons to ensure the swift, faithful delivery of signals sent along the body's natural fiber-optic system.

Cardiovascular Benefits

- Cottonseed oil has a number of related cardiovascular benefits.
- This all-purpose Vitamin E helps blood vessels to repair themselves, and slows the progression of cardiovascular disease.

Helps in Regulating Weight

- The higher nutrition content in Cotton seed oil has been seen to enhance weight loss as it does not contain trans fats which are difficult for the body to burn.
- Moreover, it is loaded with good fat elements like mono and polysaturated fats which are easily broken down by the body.

Helps Prevent Cancers

- Cotton seed oil help to safe guard the human body from numerous illnesses including cancers too.
- The antioxidant levels found in cottonseed oil have been linked to lower levels of prostate tissue growth, which can reduce prostate enlargement and reduce the risk of prostate cancer.

Ointments & Dust Control Production

- Cotton seed oils being totally edible oil help in formulation of certain ointments like Neosporin whose base is made of cotton seed oil
- It is wonderful in making certain ointments in hospitals to prevent bed sores too.
- It is also an essential ingredient in making dust control sprays too due to the edibility of this oil.

Reduces Inflammation

- Monounsaturated fats have been proven to reduce inflammation throughout the body.
- Regular use of this oil can relieve chronic symptoms of arthritis, gout, headaches and joint disorders.

Genetic Engineering in Improving Cotton Seed Production

High-Oleic and High-Stearic Cottonseed Oils: Nutritionally Improved Cooking Oils through Post Transcriptional Gene Silencing (PTGS)

Gene technology and plant breeding are combining to provide powerful means for modifying the composition of oilseeds to improve their nutritional value and application as food oil. Major alterations in the proportions of individual fatty acids have been achieved in a range of oilseeds using conventional selection, induced mutation and, more recently, post-transcriptional gene silencing (PTGS).

In particular, a number of high-oleic oils have been developed in order to provide high stability for cooking oils. These oils can replace the current widespread use of saturated fats and hydrogenated oils that contribute significantly to increased risk of cardiovascular disease due to the effect of saturated and trans-fatty acids on elevating LDL cholesterol in the bloodstream.

Similarly, oils with increased stearic acid content are being developed to enable the production of solid fats without the need for hydrogenation. Recently applied hpRNA-mediated PTGS in cotton to down-regulate key fatty acid desaturase genes and develop nutritionally-improved high-oleic (HO) and high-stearic (HS) cottonseed oils (CSOs). Silencing of the ghFAD2-1 12-desaturase gene raised oleic acid content from 13% to 78% and silencing of the ghSAD-1 9-desaturase gene, substantially increased stearic acid from the normal level of 2% to as high as 40%. Additionally, palmitic acid was significantly lowered from 26% to 15% in both HO and HS lines. Intercrossing the HS and HO lines resulted in a wide range of unique intermediate combinations of palmitic, stearic, oleic and linoleic contents, and these are currently being evaluated.

Oil Metabolic engineering

Main objectives are

- Increase content of “healthy” fatty acids and reduce unhealthy’ fatty acids.
- Improve oil stability to expand applications and reduce the need for hydrogenation.
- Expand the repertoire of fatty acids through exploitation of genetic diversity and enzyme engineering.

Enzymes to be manipulated

- Fatty acid synthase:- *KASI, KASII, KASIII*
- Thioesterases - produce medium chain FAs by removing acyl group.
- Elongases - produce 20:1 and 22:1 FAs from oleate
- Desaturases- introduce double bonds into FA chain.
- *Stearoyl-ACP $\Delta 9$ -desaturase*:- in the plastid stroma that converts stearate into oleate.
- *$\Delta 12$ -desaturase, $\Delta 15$ -desaturase*
- Acyltransferases - incorporate FAs into DAG and TAG.
- Hydroxylases - incorporate hydroxyl groups in the FA chain.

Table 15.1: Influence of chain length and the number of double bonds on the melting point of fatty acids

Fatty acid	Chain length: double bonds	Melting point
Lauric acid	12:0	40°C
Stearic acid	18:0	70°C
Oleic acid	18:1	13°C
Linoleic acid	18:2	-5°C
Linolenic acid	18:3	-11°C

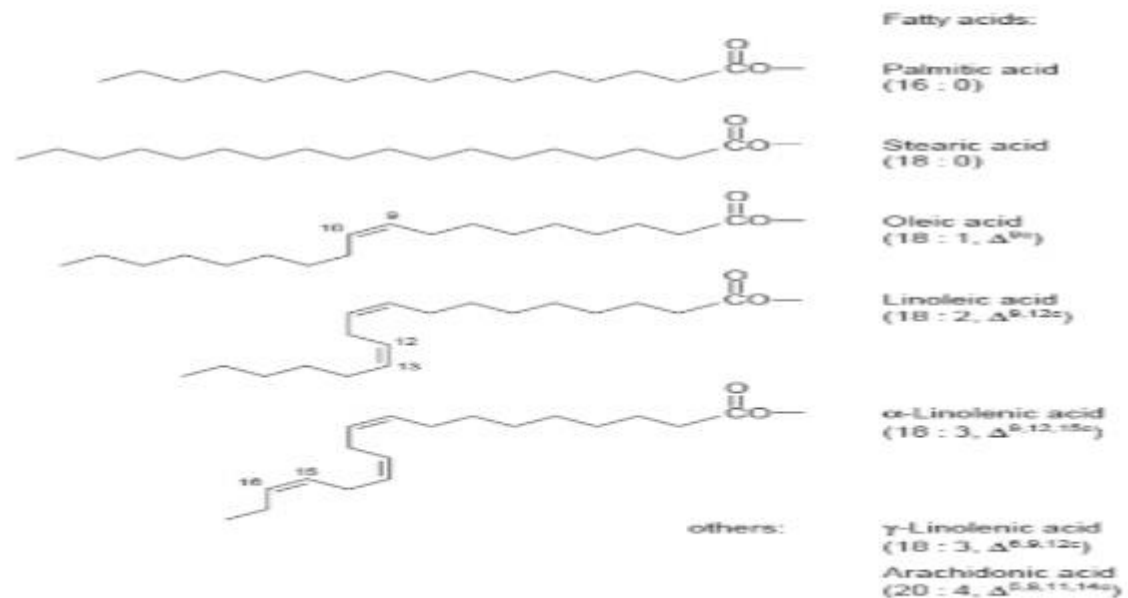


Table 15.1: Influence of chain length and the number of double bonds on the melting point of fatty acids

Improvement of properties of oils

- Cooking oils generally contain a higher proportion of mono-unsaturated FAs (oleic acid).
- Margarines and spreads are often rich in saturated fatty acids (e.g. palmitic and stearic acids).
- Other oils, such as salad oils, contain more polyunsaturated FAs (e.g. linoleic and α -linolenic acids).
- Production of oils for specific applications has been achieved by mixing of various plant oils.
- Partial hydrogenation

(Ascherio.,2006).

Development of Gossypol free Cotton Seed through Transgenic Technology

The annual world-wide cottonseed yield could supply the dietary protein needs of some 240-350 million people, but presence of Gossypol is a major deterrent. Ruminant animals could tolerate the Gossypol, but it is toxic to non-ruminants.

If Gossypol were not present, cottonseed oil could be made more economically and cottonseed meal could be processed for food and feed. The use of glandless cotton could produce Gossypol free cottonseed, but then insect infestation would be a big menace.

To keep Gossypol in plant but away from seed Ow (2000) proposed engineering the seed specific breakdown of Gossypol. He reasoned that Gossypol in cottonseed, like all organic matter must get recycled into the basic building blocks and that would mean there should be microbial enzymes that breakdown this compound. He identified an enzyme that could degrade the Gossypol, which ultimately led to the gene and construct for expression in plants. His group has been able to produce transgenics in which size and density of Gossypol containing glands were reduced in leaves and they have to further concentrate there work on getting the gene expressed in seeds, which would be the ultimate goal.

Thing to be consider when Choosing Best Oil for Deep Frying



1. Smoke point

- The temperature at which oil begins to break down and produces harmful elements is called the smoke point and should be avoided.
- Oils with high smoke points enable to cook food at high temperatures and allowing the food to get ready faster as well as absorbing less oil which is the best for your waistline and health.

2. Stability

- The oil should not react with oxygen. Stable deep frying oils contain highly saturated fats.
- As a result, monounsaturated & saturated oils are the best way to go.
- The double bonds in the polyunsaturated fats will react with oxygen under high heat to produce harmful compounds.

3. Calories

- Deep frying adds lots of calories to food compared to other cooking methods.
- The batter used (like flour) and the oil that sticks to the food contribute to the extra calories. For example:

Deep-fried chicken wing: 11 grams of fat and 159 calories

Roasted chicken wing: 7 grams of fat and 99 calories

Cotton seed Oil is one of the best oils for deep frying



- Cotton oil is a good option when choosing best oil for deep frying.
- It has a high smoke point of 420°F. This means that it is stable under high temperatures.
- Cottonseed Oil is neutral in taste. It means it will taste like whichever ingredient it is added to. Sometimes, the oil added to the food tends to change the flavor. But this problem never occurs when cooking with Cottonseed oil. This fact makes it more useful in the kitchen.
- The shelf life of food containing it is quite long. This is due to the high amount of Tocopherols in it.
- It is considerably cheaper than other organic oils like olive oil and canola oil.

Cotton seed oil in processed food



- Cottonseed oil has properties that make it a very desirable oil for development of *trans*-free products.
- Gained importance in food preparations due to its neutral taste and higher smoke point (about 232⁰C) compared to other cooking oils.
- Ideal for baking and deep-frying of food items as it is known to enhance the flavour of fresh foods instead of hiding them, unlike some other oils.
- High level of antioxidants- tocopherols; contribute to its long life on the shelf with preserving their freshness.
- Ideal ingredient of salad dressings and processed foods include potato chips & French fries, baked goods, cereals, mayonnaise, oriental dishes and spicy foods.

Other Benefits of Cotton Seed oil



- Cotton seed oil is also used in several personal care or cosmetic products such as soaps, cosmetics stabilizer, creams, lotions, moisturizer and detergents.
- Untreated cottonseed oil, consists of gossypol, a toxin present in cotton, is used as an insecticide.
- Used in making of rubber and explosives.
- It's a popular ingredient in margarines, icings, and whipped toppings, as it helps to form beta prime crystal, which promotes the ideal texture and creamy appearance of shortenings and spreads.
- It is also popularly used as a form of biofuel.

Organic Cotton seed oil



- Organic cotton seed also available in the market which makes it easy for the people who prefer it over other oils to use in their kitchen.
- Organic cottonseed oil derived from the seeds of the cotton plant produced by organic farming.
- It is primarily used in the preparation and cooking of foods.
- Rajhans 1, Buranda 1, Chandan and Kundan bred are non-GMO, untreated and particularly suitable for organic farming.
- Global organic cotton production is not even 1% of the total production.
- Organic cotton is produced in 18 countries including India, Turkey, China, Tanzania and America.

Global Outlook of Cottonseed Oil Market



- Geographically, the global cottonseed oil market can be divided by major regions which include North & Latin America, Western & Eastern, Asia Pacific excluding Japan, Japan & Middle East and Africa.
- Both on the production and consumption side, the market is heavily dominated by India and China.
- India doesn't import any notable amounts of this oil.
- These countries produced & consumed over 55% of the total cottonseed oil made during the 2015-2016 period.
- This dominance by Asia countries is largely attributed to large amount of cotton cultivation in the region and the high domestic demand for low-priced cooking oil.

Market Dynamics of Cottonseed Oil



- The edible oil market is a highly competitive space occupied by numerous types of oils.
- The presence of many substitute products such as olive oil, almond oil, sunflower oil, is regarded as a reason for the fluctuations observed in cottonseed oil retail demand and market values.

key advantage in this scenario

- ✓ Industrial use of cottonseed oils.
- The product is widely used in various food and beverage products.
- ✓ Rich source of antioxidant- tocopherol.

Market Dynamics of Cottonseed Oil



- ✓ The other advantages enjoyed by cotton seed oil are a low relative price and easy availability in cotton producing regions.
- With the increasing public understanding of the composition of such oils, the fat and nutrient profiles of cooking oils become very important.
- Given the relatively high fraction of saturated fats in cottonseed oil, this becomes a significant constraining factor for the market.
- Growing Awareness among consumers about health benefits will boost the cottonseed oil market in the coming years.

Future Thrusts In Cotton Seed Oil Industry

Several studies have been made on seed oil content related to variability, heterosis, combining ability and gene action, correlations etc. The future research work for improvement of cottonseed oil needs to be directed towards the following thrust areas:

- i. The average seed oil content in the presently cultivated varieties and hybrids is about 20-22%. The seed oil percent in germplasm has been recorded upto 27%. Thus, there is a gap of 5-6%, which could be realized through appropriate breeding techniques.
- ii. All presently cultivated cotton varieties and hybrids are glanded. The oil extracted from such varieties requires refinement to make it suitable for human consumption. There is ample scope to develop high seed oil lines with glandless trait in the seed and glanded vegetative parts to bring down the cost of cottonseed oil.
- iii. In the presently available cotton hybrids and cultivars, the amount of oleic acid needs further improvement.
- iv. The proportion of hull in the presently available cultivars and hybrids is quite high. There is ample scope to reduce the hull content and increase the kernel portion in the cotton genotypes.
- v. The modern breeding techniques such as transgenic development, molecular breeding and marker aided selection may be rewarding in developing lines with high seed oil content.
- vi. There is ample scope to incorporate through biotechnology Bt gene in glandless lines to enhance seed oil quality and productivity.

The image is a composite. In the background, two men are working in a cotton field. One man on the left is wearing a white shirt and a grey turban, looking down at the plants. Another man on the right is also in a white shirt, working. The field is filled with green cotton plants and white cotton bolls. In the foreground, there are four glass bottles of yellow oil. One is a large, rounded bottle with a yellow cap. Next to it is a taller, narrower bottle with a red cap. In front of these are two smaller bottles, one with a black cap and one with a yellow cap. The text 'Thank You' is overlaid in the center in a blue, serif font with a red outline.

Thank You