Cottonseed Oil: Present Status and Future Prospects

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INTRODUCTION

Cotton is an important cash crop in India as its lint is the major raw material for Indian textile industry. India is now the largest producer of cotton in the world and during past 2-3 years, cotton lint production was 340 lakh bales (of 170 kg) or more. Fibres however constitute only one third of the weight of the harvested seed cotton while the remaining two third is constituted by the seed. Hence about 108 to 115 million tonnes surplus cottonseed is available every year in our country for processing.. Cotton seed is rich in nutrients and depending upon the species, contains about 14-24% oil and about 15-26% protein (Shaikh and Balasubrahmanya, 1999; Chakraborty and Mayee, 2010).

Whole cottonseed was traditionally fed to the cattle and it was only in the early twentieth century that cottonseed was commercially exploited for edible oil production. First cottonseed oil mill in India was established at Navsari in 1914 and it took many efforts from Government and entrepreneurs to promote its use as edible oil and to convince cattle owners to use cottonseed cake in place of whole cottonseed for feed purposes. Today annual production of cottonseed oil is about 13-14 lakh tonnes and it is the third largest contributor to the Indian edible oil basket. It has become popular in cotton producing states mainly in Gujarat.

Processing of Cottonseed for Edible Oil

Oil Extraction:

Oil can be extracted from cottonseed either by direct crushing or by scientific processing. Majority of cottonseed in our country is processed by direct crushing of ginned white cottonseeds in expellers. The process is inefficient as a large amount of oil remains in the cake, but due to its simplicity, low machinery cost and ready market for undecorticated (UD) cake for cattle feed, it is very popular.

In scientific processing of cottonseed, first linters and hulls are removed from the seeds by delinting and dehulling / decortication operations respectively and oil is then extracted from the kernels either by first using expellers and then solvent (hexane) or entirely by solvent extraction. In scientific processing, linters which are a very pure form of cellulose are recovered, oil recovery is higher and the resulting meal is low in fibre and rich in protein with just a small quantity of oil. This de-oiled cake or meal being richer in protein is a better animal feed. However due to higher machinery and operating costs, low domestic demand of linters from industry; poor demand from dairy farmers for de-oiled cake (DOC) due to traditional reasons,

and unsuitability of the cake for high end poultry or aqua feed applications due to the presence of gossypol, the process has not gained desired popularity.

Refining:

Crude oil extracted from cottonseed both by expellers and solvent extraction is dark coloured and contains a polyphenolic substance gossypol and related pigments which are toxic to non-ruminants and humans. Therefore it is further processed to make it edible. These processes consist of –

Alkali Refining- The oil and alkali are mixed allowing free fatty acids and alkali to form soap. The resulting soap stock is removed through centrifuging.. Free fatty acids, glycerol, carbohydrates, resins, metals, phosphatide and protein meal are removed and the oil now has a lighter, more desirable colour. Solvent extracted cottonseed oil is also refined using a process called miscella refining.

Bleaching -Bleaching clays are used which adsorb the impurities and eliminate trace metals and other colour bodies resulting in almost colourless oil.

Deodorization- It removes volatile compounds from the oil and the end product is a bland oil with a low level of free fatty acids and peroxide value(<1). It is basically a steam distillation process carried out under vacuum. This step also removes any residual pesticides or metabolites that might be present. As cottonseed oil as can be deodorized at lower temperatures, more tocopherols (natural antioxidants) are retained.

Properties and Composition of Cottonseed Oil

Refined, bleached and deodorized (RBD) cottonseed oil is a healthy vegetable oil for human consumption. It has a mild taste and is generally clear with a light golden colour. Cottonseed oil's light, non oily consistency and high smoke point make it most desirable for stir-fry cooking, as well as for frying making it a suitable cooking oil. Various properties of cottonseed oil in this regard are listed in Table 1. As the properties are affected by degree of refining carried out, BIS had introduced grades for raw, semi refined and refined cottonseed oil way back in 1953 which were later revised in 1968.

Properties of Cottonseed Cooking Oil (RBD)- Refined, bleached and Deodorised

Lovibond Colour (Red Max.)	2.0 – 6.0
Free Fatty Acid (as Oleic % Max)	0.05
Peroxide Value (Meq/kg. Max.)	1.0
Iodine Value	103-116
AOM Stability (hrs.)	15
Cloud Point (^{0}F)	30 – 38

Melting Point (^{0}F)	50 – 60
Smoke Point (^{0}F)	430
Flavour	Bland

Data sourced from- CSO Bulletin, 2000, Digital Edition Published on www.cottonseed.com

Fats and oils are made up of triglycerides, three molecules of fatty acids are 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 these consist of 16 and 18 carbons. A combination of both saturated (C14:0, 16:0, etc.) and unsaturated (C 18:1, 18:2, 18:3) fatty acids are present in oils and fats. Some fats, such as lard, palm and coconut oil, have higher concentrations of saturated fatty acids than others and are referred to as saturated fats, even though they also contain some percentage of unsaturated fatty acids.

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 and there are varietal differences in contents of individual fatty acids. It 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). It is oleic-linoleic type oil and a typical fatty acid composition of cottonseed oil is given in Table 2. Due to high content of unsaturated fatty acids, it is one of the few oils advised for reducing saturated fat intake. When it is partially hydrogenated, monounsaturated fatty acids content increases. Partial hydrogenation to a typical Iodine Value of about 80, changes its fatty acid profile to 50% monounsaturated, 21 % polyunsaturated, and 29% saturated which is ideal according to health guidelines.

Table 2: Typical Fatty Acid Composition of Cottonseed oil

FATTY ACID	REFINED 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

****Partially hydrogenated cottonseed oil (Iodine Value, approximately 80)***

*****Essential Fatty Acids; Linolenic is an Omega-3 Fatty Acid.***

Small amounts (0.4- 1%) of cyclopropenoid fatty acids such as malvalic acid and sterculic acid are also present in cottonseed oil but these are unstable and they get destroyed to a large extent during the deodourisation process.

Cottonseed oil also has a high content of antioxidants- tocopherols which can be seen from the data presented in Table 3. Tocopherols are good for health as they neutralize the damage caused by the free radicals to the body. High tocopherol content along with presence of oleic, palmitic, and stearic acids contributes to the long shelf life of cottonseed oil. Studies show that products fried in cottonseed oil retain the natural antioxidants thereby preserving their freshness and resulting in a longer shelf life. Like all oils, cottonseed oil also consists of 100% fatty matter and has a high calorific value and its intake through food needs to be restricted to avoid weight gain.

Table 3: Tocopherol contents of various edible Oils

Vegetable Oil	Total Tocoferols (mg/100g)	α -Tocopherol equivalent
Canola	66	23
Corn	104	33
Cottonseed	65	38
Olive	13	12
Palm	26	8
Peanut	13	9
Rapeseed	67	24
Soybean	104	17
Sunflower	65	62

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

Wide variations in fatty acid composition of cottonseed oil from various germplasm accessions was observed at ICAR- CICR, Nagpur and many high oleic and high linoleic lines were identified. Not much information is available on the fatty acid composition of the Bt varieties currently being cultivated in the country though a study by Dowd et al (2010) on current US cotton lines does not show much variation. According to NCPA, USA, there is no risk from the consumption of oil from Bt cottonseed, as no Bt protein content has been detected in the refined cottonseed oil (ICAC recorder, March, 2001)

Future prospects and Conclusion

Cottonseed in spite of being the major component of harvested seed cotton in terms of weight is considered a by-product on account of the larger commercial importance of lint and not much attention is given to its handling and processing which has not advanced to the desired level. It is therefore underutilized with current recovery of oil alone being only about two third of its potential. Still, with increase in cotton production in the country, cottonseed oil has become an important source of edible oil and is now the third largest contributor to the domestic edible oil supply. As only about one third of the edible oil consumed in the country is produced indigenously, it is necessary that attention be paid to this neglected sector so that the full potential of this important commodity can be realized.

Not much research and development work is presently being carried out in the country on cottonseed. It is the need of the hour that this neglected cotton by product gets due importance and research is carried out on various aspects of its handling and processing. Development of cotton varieties and agronomic practices for higher oil content and better fatty acid composition may be undertaken and similarly development and adoption of proper seed cotton and cottonseed handling practices at farmers field and ginneries and improvements in cottonseed processing technologies and machineries and their promotion through government policies and incentives would not only improve the self sufficiency of the country in edible oil but would also contribute to reducing the national loss of various cottonseed byproducts due to unscientific processing.

Meal /cake produced obtained after extraction of the oil is an important protein source for animal feed. Microbial/ chemical degossypolisation technology can open the application of DOC for poultry and aquafeed markets and perhaps for human food also and can thus make the scientific processing more attractive. Incentives for industries utilizing linters as raw material would reduce the dependency of cottonseed processors on exports. That would increase the value realized from this important cash crop which would in turn benefit the country and all stakeholders in the cotton value chain including the farmers.

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