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# Nutritional and anti-nutritional factors present in oil seeds: An Overview

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**Abstract**
India is one of the major oilseeds' growers and importer of edible oils. India's vegetable oil economy is the world's fourth-largest after the USA, China & Brazil. Oilseeds are rich sources of nutrition and energy. The oils and fats present in them are beneficial as industrial raw material and food fats. The proteins present in some oil seeds and their cakes are edible to humans while the remaining are useful as animal feeds. Oilseeds also contain carbohydrates, vitamins and minerals. Oil seeds and oilseed meals have an essential role in relieving the malnutrition and calorie nutrition of the human and animal population. Many compounds present in oilseed have been found to have anti-nutritional effects. These include trypsin inhibitors, goitrogens, aflatoxin, phenolic compound, gossypol, oxalic acid, chlorogenic acid, protease inhibitors, lectins, saponin allergens, phytic acid and glucosinolate, this anti-nutritional either reduce the digestibility of oilseed or cause toxic effects on their consumption.

**Keywords:** Oil seeds, carbohydrates, vitamins, minerals and antinutritional factors

## Introduction

India is one of the significant oilseed's growers and importer of edible oils. India's vegetable oil economy is the world's fourth-largest after USA, China & Brazil. The oilseed accounts for 13% of the Gross Cropped Area, 3% of the Gross National Product and 10% value of all agricultural commodities. On Global basis, India ranks first in the production of castor, safflower, sesame and niger, second in groundnut, rapeseed and mustard, third in linseed, fifth in soybean and sunflower (Rai *et al*., 2016) [37]. The major oilseed growing states in India are Madhya Pradesh (20.3%) Rajasthan (18.9%) Maharashtra (13.3%) Gujarat (12.6%) Andhra Pradesh (10.5%) Karnataka (10.3%) Uttar Pradesh (3.9%) Tamil Nadu (2.5%) Others (9.7%) of the total oilseed area of the country. The Rajasthan produces 21.3% of entire annual oilseed crops followed by Madhya Pradesh (20.5%), Gujarat (16.7%) and Andhra Pradesh (7.3%).

Indian edible oil market is the largest after China & the European Union. Each year India consumes around 10 mt of edible oils. Consumer oil preferences in India in order of North India -- Mustard, Rapeseed; East India -- Mustard, Rapeseed; West India –Groundnut; South India -- Groundnut & Coconut. The expected demand for oilseeds production is 44, 55 and 65 MT by 2010, 2015 and 2020 respectively. Oilseeds are major sources of energy and nutrition (www.nfsm.gov.in/StatusPaper/NMOOP, 2019).

The oils and fats present in oilseed are useful as food fats and industrial raw material. The proteins present in some oilseeds and their cakes are edible to humans while the others are useful as animal feeds. Oilseeds also contain carbohydrates, vitamins and minerals. Oilseeds and oilseed meals have an essential role in relieving the malnutrition and calorie nutrition of the human and animal population. Also, the vegetable oils are useful as lubricants, surface coatings, cosmetics and as raw material for various industrial products. India has a wide array of outcrops under cultivation in different areas and seasons. The most important annual oil crops are groundnuts, rapeseed-mustard, sesame, sunflower, safflower, soybean, niger, castor and linseed. The first seven are edible oil sources, while castor and linseed are non-edible. The composition and quality of the oilseeds and their products depend on various factors like genotype, season, location, maturity and cultivation practices etc. Oilseeds and their products are highly useful because of the nutritional and other energy-rich chemicals that are present in them. The presence of anti-nutritional constituents sometimes limits their utility. The biochemical composition and quality of the oilseeds and their products are essential for the food and feed purposes.

Edible oils are the concentrated sources of energy. The energy content of the oil is much higher (39.80 MJ/kg) than protein (23.88 MJ/kg) or carbohydrate (16.76MJ/kg). They contain useful carbohydrates, essential fatty acids and vitamins A, D, E and K. and provide essential fatty acids. Oil cakes/ oil meals are rich sources of protein (40-60%) to human and animals. They can also be used as organic manure. India per capita consumption of oil is 11.6 kg/head/year considerably lower than in developed countries as 17.8 kg/head/year. ICMR recommendation is 14 kg/head/year or35 - 40 g/head/day.

Oil quality for food purpose can be described in terms of Saturated Fatty Acid (SFA), Monounsaturated Fatty Acid (MUFA) and Poly Unsaturated Fatty Acid (PUFA). Saturated Fatty Acid (SFA) - Palmitic and Stearic acid they have a direct relation with blood cholesterol and coronary heart diseases as it increases harmful low-density lipoprotein. Unsaturated Fatty Acid (SFA) - Oleic, Linoleic, Linolenic and Erucic acids. Linoleic& Linolenic acids (Poly Unsaturated Fatty Acids – PUFA) are essential fatty acids (not synthesized by the human body and are too supplied from outside). If they are absent, it leads to physiological disorders (Brouwer *et al*., 2013) [8]. They increase high-density lipoprotein, which is beneficial. Groundnut, coconut, sesame and sunflower oils have moderate amounts of saturated fatty acid but lack in one essential fatty acid, i.e. linolenic acid. Soybean, safflower and mustard oils have both essential fatty acids as Linoleic and Linolenic acids. Rapeseed and mustard oil have a high amount of erucic acid, an anti-nutritional factor and leads to coronary diseases. Many compounds present in oilseed have been found to have anti-nutritional effects. These include trypsin inhibitors, goitrogens, aflatoxin, phenolic compound, gossypol, oxalic acid, chlorogenic acid, protease inhibitors, lectins, saponin allergens, phytic acid and glucosinolate this anti-nutritional either reduces the digestibility of oilseed or cause toxic effects on their consumption. It is, therefore, requisite to eliminate these substances by processing or remove them by genetic manipulation.

The oilseed is subject to various processing techniques like oil extraction, mechanical extraction, ghani extraction, mechanical pressing continuous screw press (expeller). These processing techniques not only save the time, energy, and air-fuel but several nutritional value and edible products posses an immense nutritional value, and lower toxic compound depends on the type of oilseed and processing techniques (Sharma, 2014) [40].

## Classification of oil seed

**Edible oilseed:** The most crucial source of supply of edible oils are the seeds known as edible oil seeds and the crops belong to this category are known as edible oilseed crops.

E.g. Rapeseed & Mustard, sesamum, groundnut, niger, sunflower, safflower, soybean etc.

**Non-Edible oilseed:** The most crucial source of supply of non-edible oils are the seeds known as non-edible oil seeds and the crops belong to this category are known as non-edible oil seed crops.

E.g. Castor, Linseed etc.

**Table 1:** Oil content of oil seeds (Sandeep *et al.,* 2014)

| S. No | Oil | Oil content (%) |
|---|---|---|
| 1 | Groundnut | 40-54 |
| 2 | Rapeseed | 34.9-44.9 |
| 3 | Soybean | 8.1-27.9 |
| 4 | Sesame | 48-55 |
| 5 | Sunflower | 48-53 |
| 6 | Cotton | 18-26 |
| 7 | Castor | 40-55 |
| 8 | Niger | 4-14 |
| 9 | Linseed | 22-27 |

## Nutritional parameters

Proteins, carbohydrates, fats, minerals, and vitamins are essential nutritional parameters will be discussed in brief in forthcoming paras from a human nutrition point of view.

**Protein:** The proteins are located in the cotyledons and embryonic axis of seed with an only small amount present in the seed coat. Cotyledons contribute to the significant amount of protein to the whole grain.

Groundnut seed contains 22 to 30% protein on a dry seed basis (Savage and Keenan, 1994) [38]. Groundnuts are produced to have a thick outer shell. The shell constitutes about 25-35% of the pod. The main component, namely seed accounts for the remaining portion (65-75%). The seed, in turn, consists of three parts, namely testa (4-5%), germ (3-4%) and two cotyledons (92-94%). The colour of the testa varies from red, brown, purple to white depending on the type and variety. The kernel and germ usually are white. Groundnut seed mainly contains globulin type of proteins (87% of total proteins). Two types of globulins, namely arachin and conarachin, have been identified, out of which the former constitutes 63% and the latter 33% of the total seed proteins. The groundnut proteins are more in acidic amino acids. Aspartic acid, glutamic acid and arginine account for 45% of the total amino acids. Lysine, methionine and threonine are deficient in groundnut protein. Conarachin is more abundant in sulfur-containing amino acids than arachin but inadequate in phenylalanine and tyrosine. The protein is easily digestible (97%) with a biological value of 57.9%. Because groundnut protein is deficient in lysine, methionine, threorine and tryptophan, it is nutritively poor.

The rapeseed cake protein content of the seed varies from 11-42%. The defatted meal possesses 36-38% protein and about 12% crude fiber. Brassica species contain two types of protein mainly, namely cruciferin andnapin. These two proteins account for about 60% and 20% each respectively of the total proteins. Rapeseed meal is widely used as an inexpensive protein supplement generally as a replacement for soybean meal in animal diet. Rapeseed protein is balanced concerning all the amino acids except methionine.

Sesame protein has, the following composition: albumins 8.6%, globulin 67.3%, prolamin 1.3% and glutelins 6.7%. The net protein utilization, true digestibility and biological value of the protein are 54, 87 and 62, respectively. Among oilseed proteins, sesame protein is more nutritious in that it is rich in methionine and tryptophan. Like other vegetable oils, it is also deficient in lysine. The other limiting amino acids are threonine, isoleucine and valine. Sesame is widely processed into several high protein products such as flakes, flours, protein concentrates and isolates. The protein isolates are richer in protein and may contain up to 80% protein (Onsaard, 2012) [36].

Sunflower protein contains 55-60% globulins, 17-23% albumins, 11-17% glutelins and 1-4% prolamines. The sunflower protein contains higher proportions of the essential amino acids. Lysine is the main limiting amino acid, followed by leucine (Nehete *et al*., 2013) [35]. Sunflower protein contains higher methionine but lowers than that of sesame. The safflower meal is high in fibre and its protein low in lysine. It is mostly used in ruminant rations.

Decorticated safflower meal has the potential to be utilized as human food if the bitter principles and phenolics are removed. The excessive hull content reduces the nutritive value. Low fibre meal can be fed to monogastric animals while the high fibre meal can be fed to ruminants. The low fibre meal contains 42% protein and 16% crude fibre. Protein isolates with 87-96% protein content have been prepared, which have the potential to be utilized as fortificant and as an ingredient in various foods like portions of pasta, baked products and beverage systems. Safflower protein, like any other vegetable protein, is deficient in lysine.

Soybean meal is a better source of protein supplement for lactating cattle and calves. The soybean protein products characterized much quantity of lysine, isoleucine, tryptophane, threonine and valine; however, sulphuric amino acids are less as compared to the protein of rape products (Ensminger *et al.* 1990; Poultry Feeding Standards, 2005) [15].

**Table 2:** Protein content (%) of common oilseeds (Kumar *et al.*, 2014)

| S.no | Oilseed | Protein (%) |
|---|---|---|
| 1 | Rapeseed | 17.8-22.0 |
| 2 | Soybean | 34.1-56.8 |
| 3 | Groundnut | 18.92-30.53 |
| 4 | Mustard | 17.8-22.0 |
| 5 | Sunflower | 10-25 |
| 6 | Sesame | 20-28 |
| 7 | Castor | 12-16 |
| 8 | Cotton | 15.7 |

**Table 3:** Essential amino acid content (g/100g) of some oil seeds (Nagaraj, 1995) [32].

| S. No. | Oilseeds | Methionine | Lysine | Threonine | Tryptophan |
|---|---|---|---|---|---|
| 1 | Groundnut | 4.37 | 18 | 12.5 | - |
| 2 | Rapeseed | 2.25 | 33.9 | 30.8 | - |
| 3 | Sesame | 3-4 | 2-3 | 3-4 | 1-3 |
| 4 | Sunflower | 1.14 | 1.9 | 2.23 | 1 |
| 5 | Safflower | 0.7 | 1.3 | 1.4 | 0.6 |
| 6 | Soybean | 6.87 | 40 | 20.3 | 23.7 |
| 7 | Niger | 1.9-2.3 | 2-2.4 | 2.6-2.7 | - |

## Carbohydrates

The carbohydrate content in groundnut seed content of the kernel and meal is 10-20% and 38% respectively. The reducing sugars are low (1.2 to 1.8%). Sucrose is the essential sugar and ranges between 2.86 to 6.35% depending upon genotype. Glucose, fructose and galactose are the other minor sugars present. Oligosaccharides stachyose and raffinose are also present. The latter two sugars are involved in flatulence and bad taste properties of groundnut seed. Roasted peanuts possess 21.51 g of carbohydrates per 100 g. The primary carbohydrate found in peanuts is starch which is a homopolysaccharide made up of $\alpha$-D glucose residues connected by glycosidic bonds. When starch starts to undergo enzymatic degradation in the body by the action of amylase (present in human saliva), it is initially broken down to maltose and isomaltose (Zeeman and Kossmann. 2010) [44].

Rapeseed defatted dehulled meal contains up to 48% carbohydrates. The main sugars of rapeseeds are sucrose — stachyose, raffinose, glucose and fructose.

Sunflower Seeds contain around 18% carbohydrates. The defatted sunflower meals contain more sugars than the seed. Sucrose is the predominant soluble sugar. Glucose and trehalose are minor sugars. The composition of the dehulled defatted meal is 0.6% glucose, 2.3% sucrose, 3.2% raffinose and 0.8% trehalose. The hulls mainly contain cellulose, pentosan, lignin and reducing sugars.

Safflower seeds, hulls and kernels have available sugars between 3 and 4.5%. The unavailable sugars range from 11-88%.

The total carbohydrate content of soybean seeds ranges from about 18 to 30%. It contains 13.2% available and 17.6% unavailable sugars. The defatted flour mainly contains 7-8% sucrose, 5-6%.stachyose and about 1% raffinose. Flatulence arises due to the presence of the latter two sugars. The hulls contain 40% fibre (cellulose).

Sesame seed contains 21-25% carbohydrates. The soluble sugar content is 5%. The crude fibre content (3-6%) is lower than that of the other oilseeds

**Table 4:** Carbohydrate (g/100g) of oilseeds (USDA national nutrient database)

| S. No. | Oil seed | Carbohydrate (g/100g) | Percent of RDA |
|---|---|---|---|
| 1 | Groundnut | 16.6 | 12 |
| 2 | Sunflower | 20 | 15 |
| 3 | Soybean | 25 | 28 |
| 4 | Sesame | 23.45 | 18 |
| 5 | Mustard | 28.09 | 21 |
| 6 | Rapeseed | 27 | 27 |
| 7 | Cotton | 38 | 13 |

## Mineral

Oilseeds are an excellent source of minerals such as phosphorus, calcium, magnesium and potassium zinc, copper, iron and manganese. Groundnut is a rich source of minerals like phosphorus, calcium, magnesium and potassium. Other elements namely zinc, copper, iron and manganese, are also present. About 200g of groundnuts can easily furnish recommended dietary allowances of minerals as prescribed by FAO. However, some elements like Ca and Fe though present in higher quantities are not available to humans due to the presence of oxalates and phytates, which precipitate the minerals as insoluble salts. Rapeseed meal contains around 4-6% ash. The main inorganic constituents are potassium, calcium, magnesium and phosphorus. Other minor components include manganese and zinc.

Sesame is a good source of minerals. The ash content ranges from 5-7%. It has 1% Ca, and 0.7% P. Calcium is mostly present in the seed coat. The bioavailability of Ca is 65% as against 100% for $CaC0_3$. The mineral content of sunflower seeds varies from 3-4% while that of hulls ranged between 2-3%. The defatted meal contains 6-9% of minerals. The main constituents are Ca, P, Fe and K.

Minerals content of safflower seed the total ash content of the seed ranges from 2-3.5%. The hulls contain 4.5% and the cotyledons about 3% ash. The defatted meal includes 8-10% of minerals.
Safflower is rich in P (367 mg/100g), Mg (241) and Ca (214). The other elements present are Fe, Zn, Mn and Cu. The soy flour contains about 6% minerals with about 0.3% Ca, 0.7% P and 0.3% Mg.

**Vitamins**
Oilseeds are a good source of the vitamin niacin, tocopherols, pantothenic acid, riboflavin and thiamine. Some of the oilseed vitamins given below.
Groundnut is also a good source of 'B' group vitamins, niacin and tocopherols are present at higher levels. Peanut is a poor source of vitamins A, C and D.
Rapeseed meal contains niacin, pantothenic acid, riboflavin and thiamine. The oil contains vitamin E (800-910 PPM), out of which gamma-tocopherol ranged from 60-90% while alpha-tocopherol was 10-40%).
Sesame is a good source of niacin, folic acid and tocopherols. The tocopherol level is 30-53 mg/100g oil. Its gamma-tocopherol level is around 0.2 mg.
Sunflower is a good source of B complex vitamins, namely nicotinic acid (320 mg/kg), thiamine (40), pantothenic acid (45) and riboflavin (4). Sunflower oil has higher tocopherol than other oils. Various forms of tocopherols, namely alpha, beta, gamma and delta forms together constitute vitamin E. All of them have antioxidant properties.
Safflower oil contains about 270 mg/kg of total tocopherols out of which alpha-tocopherol alone accounts for 220 mg/kg. It is deficient in gamma-tocopherol (33 mg/kg), which acts as a stabilizer even at high temperatures. The levels of total tocopherols present are not sufficient enough to offset the high levels of linoleic acid (70-80%), which is prone to oxidation. Safflower leaves are rich in carotene, riboflavin and vitamin C which are used as a green vegetable.
Soy seeds are a good source of water-soluble vitamins. Beta-carotene 0.2 - 2(mg/g) Thiamin11.0 - 17.5 (mg/g,) Riboflavin 2.3 (mg/g), Niacin (mg/g) Pantothenic acid, Pyhdoxine, Folic acid, Choline &Ascorbic acid.

**Lipids:** lipids are a group of heterogeneous components consisting of free fatty acids, mono, di and triacy glycerol, phospholipids, sterols, sterol esters, glycolipids and lipoproteins. Groundnut oil is rich in unsaturated fatty acids. Oleic and linoleic acids (the 18 carbon fatty acids with one and two double bonds respectively) are the two unsaturated fatty acids accounting for 38-56% and 16-38% each respectively. Among the saturated fatty acids, palmitic acid is the major one with about 10-16%. The other fatty acids present in minor quantity are stearic, arachidic, behenic and lignoceric, all of them together accounting for about 5-10% of the total fatty acids.
Rapeseed-mustard oil is generally rich in a long-chain fatty acid, namely erucic acid (37.9 - 57%). It is a 22-carbon fatty acid with a double bond between 12th and 13th carbon atoms. The oil also contains linolenic acid, an 18-carbon fatty acid with three double bonds (4.7 -13.0%), linoleic acid (14.0%) and oleic acid (13%). Three other fatty acids namely palmitic, stearic and eicosenoic acids (20:1) to the extent of 5-10% each are also present. The erucic acid present in rapeseed oil (of high erucic acid HEAR) appeared to be responsible for mycocardial fibrosis and hypocholesterolemia. It was felt that the nutritional quality of the oil would be substantially improved if erucic acid content is reduced. Because of this low erucic acid rapeseed (LEAR) varieties have been developed. There is a lot of variation in the fatty acid composition of HEAR and LEAR varieties.
Sesame oil contains about 80% unsaturated fatty acids, composed mainly of oleic (18:1) and linoleic (18:2) acids. The remaining 20% is composed of the saturated fatty acids namely palmitic and stearic acids. Sunflower oil is an unsaturated oil with high levels of linoleic acid. The saturated fatty acids namely palmitic and stearic acids, constitute only about 15%. The main constituent namely linoleic acid ranges from 40-70%. The oleic acid ranges from 20-50%. Safflower oil is a drying oil which is a high level of linoleic acid. The oil is extracted from the seeds by various methods. Traditional ghani extraction is a common practice followed in rural India. Improved practices like mechanical pressing, followed by solvent extraction, are also being observed. The safflower oil is pale yellow with a bland or slightly nutty flavour. It is a drying oil intermediate between soybean and linseed oils.

**Anti-nutrients factors in oil seeds**
The anti-nutritional elements have a significant obstacle to the utilization of products. They have been implicated in several physiological disorders in animals. Anti-nutritional factors are those substances that generated in natural feedstuffs by the healthy metabolism of species and by different mechanisms which exert effect contrary to optimum nutrition. These substances almost found in most foods, and they are poisonous, and they are protecting themselves from being eaten. Since anti-nutrient occur in a small quantity that they cause no harm. Anti-nutritional factors are mainly organic compounds, which when present in a diet, may affect the health of the animal or interfere with average feed utilization, and they occur as natural constituents of plant and animal feeds, as artificial factors added during processing or by contaminants of the ecosystem. Anti-nutritional factors (ANFs) in feedstuffs are classified according to their chemical nature and their activity in animals as Chemical natures, in this category are acids, enzymes, nitrogenous compounds, saponins, tannins, glucosinolates and phenolic compounds. Factor interfering with the utilization, digestion and availability of minerals of dietary proteins and carbohydrates, for example, tannins, trypsin or protease inhibitors, haemagglutinins and saponins, phytates or phytic acid, oxalates or oxalic acid, glucosinolates and gossypol reported by Ingale *et al*., (2011) [21].
Many compounds present in oil seed have been found to have anti-nutritional effects. These include trypsin inhibitors, goitrogens, afflotoxin, phenolic compound, gossypol, oxalic acid, chlorogenic acid, protease inhibitors, lectins, saponin allergens, phytic acid and glucosinolate these anti-nutritional either reduce the digestibility of oil seed or cause toxic effects on their consumption. It is, therefore, necessary to eliminate these substances by processing or remove them by genetic manipulation.

**Trypsin Inhibitors:** Soyabean and French-bean have a very high content of trypsin inhibitors. The presence of trypsin inhibitors in peanut has been reported by Carvalho *et al*. (1997) [9]. The proteinous inhibitors isolated from peanut could inhibit the activity of trypsin, chymotrypsin and plasmin. Raw and heat-processed peanut flours have been reported to contain higher levels of *in vitro* trypsin inhibitory activity than similarly processed Soya flour. Mode of action: This leads to an excessive loss of endogenous protein secreted by the pancreas. It results in a net loss of sulphur-containing amino acids from the body. It has been shown that trypsin or chymotrypsin in the intestine suppresses pancreatic enzyme secretion by feedback inhibition. They block the activity of trypsin in the gut and interfere with the digestibility of dietary protein. In most cases heating or autoclaving at 120˚C and 15 Psi for 15-20 min inactivates almost all the trypsin inhibitors completely. In many legumes' germination has been found to reduce the content of trypsin inhibitor.

**Goitrogens:** It has been shown experimentally that peanut seed inhibits the iodine uptake by humans. Such inhibition leads to a deficiency of iodine in the thyroid, eventually producing goiter. The goitrogenic compound presents in peanut, mustard leaves, soybean, lentil and millet. Soybean and peanut produce goitrogenic effects. For soya bean, the causal agent is a low molecular weight oligo-peptide consisting of 2 or 3 amino acids (Dolan *et al*., 2010) [13]. The goitrogenic principal in peanut has been identified as a phenolic glucoside which resides in the skin, thereby depriving the thyroid of available iodine. The goitrogenic effect of peanut meal can be effectively counteracted by iodine supplementation (iodized common salt). Biochemical compounds such as thiocynate, isothyocynate and their derivatives such as chemline present in food plants interfere with iodine uptake by the thyroid gland. C-glycosylflavone, glycosylorientin and vitexin present in millet are gotrogens.

**Protease inhibitors:** The Protease inhibitors (The Kunitz inhibitor and Bowman-Birk inhibitor) are active against trypsin and chymotrypsin (Liener, 1994) [23]. These inhibitors interfere with the digestion of proteins resulting in decreased animal growth. The activity of trypsin inhibitor range from 100 to 184 TUI/ mg of protein (Kakade *et al.* 1972) [23]. The limit of activity for soy products is to 0.4 urease units. Thacker & Kirkwood (1990) report a range for trypsin inhibitors of 21.1 to 31.1 mg/g. Toasted or heated processes may decrease the activity of these inhibitors in soybean products. The right warming up of soybean and its products eliminate above 90% of antitrypsin activity.

**Saponin:** It is glycosides of steroids or triterpenoids present in many plants including the soybean. The saponin content of SBM typically ranges from 0.43 to 0.83% (Ireland *et al*. 1986; Goda *et al.* 2002) [23, 20]. Saponins are surface-active compounds that mediate membrane transport (Francis *et al.* 2001). When mixed with water, they can become toxic to fish by causing damage to the gill epithelium through detergent action (Francis *et al*. 2001) [18].

**Lectins:** Lectins (Hemaglutinins) are proteins that bind to carbohydrates. In raw soybean can decrease growth and cause increase mortality rate in animals. The level of the lectins in soybean can vary from 37 to 323 HU /mg of protein (Kakade *et al*. 1972) [23]. In soybean meal content of lectins joining carbohydrates carried out since 0.2 to 3.1 g/kg, and there are mainly agglutinating lectins (Fasina *et al*. 2003) [16]. This strong influence of lectins practically disappearance after autoclaving.

**Aflatoxin:** Like other legumes seeds, peanut contain trypsin inhibitors and other protease inhibitors, and proper processing is required to destroy these. The other undesirable constituent associated with peanut meal is aflatoxin produced by the fungus *Aspergillus flavus* which infests peanuts before, during and after harvest. Aflatoxin is responsible for causing cancer (Kumar *et al*., 2017) [25]. Aflatoxin is mainly four types recorded in India mainly $B_1$, $B_2$, $G_1$ and $G_2$, among all $B_1$ is responsible for causing cancer in human being. Aflatoxin was identified against standard aflatoxin $B_1$ and $B_2$ based on Rf values and fluorescence under ultra-violate light. The ELISA methods estimate aflatoxin. The thin layer chromatography plates coating separates aflatoxin with MN- Kieselgel G-HR silica gel developed with methanol solvent system (Murphy, 1993) [28].

**Allergens:** The allergenic effect is attributed to the globulin fraction of soybean proteins. In the soybean seeds, the globulins comprise about 85% (80-90%) of total protein. The most important allergens of soybean are GLY 1 and GLY1B - glicynine and betaconglicynine. Soybeans contain several antigenic proteins which can stimulate the immune system sensitive of calves, pigs and human. These proteins are not sensitive on temperature. The denaturation of betakonglicinine needs of temperature about $75^0$C. Allergens were also ascertained in lecitine of soybean, which is described as occupational allergens at the bakers. The allergic activity can also show tryptase inhibitor present in soybeans (El-Shemy, 2011) [14].

**Gossypol**: It is the yellowish phenolic pigment distributed throughout the cotton plant but mainly in cottonseed kernels, flowers and barks of roots. Its content is varied depending on the species, variety, climatic and agro-climatic factors. The occurrence of gossypol lower the quality of cottonseed oil, cake, etc. However, it confers resistance to the cotton plants against several pest and diseases (Gadelha *et al*., 2014) [17].

**Oxalic acid:** Sesame seeds contain high levels of oxalic acid (35mg/100g) and phytic acid (5%). The darker colored varieties are higher in these anti-nutritional factors than red-colored varieties. Oxalic acid and phytate are known to interfere with mineral metabolism and decrease the availability of calcium, phosphorus, magnesium, zinc and iron. The oxalic acid may also cause kidney lesions and reduces palatability due to bitter taste.

**Phytic acid and glucosinolate:** Phytic acid, which is mainly present as calcium, magnesium or potassium phytate, amounts to 1 to 6% in rapeseeds. Phytates can form complexes with proteins and hence, decrease protein functionality. Besides, the presence of high amounts of phytate also hinders the absorption of minerals from food. Furthermore, the presence of glucosinolates in rapeseed flours has been extensively reduced by breeding of so-called double-zero varieties. The de-oiled flours of these varieties have glucosinolate concentrations below the critical value of 30 μmol/g (Von Der *et al*., 2014) [42]. However, in aqueous solutions applied during protein recovery, enzymatic hydrolysis of the glucosinolates to isothiocyanate, nitrile, and thiocyanate, among others by myrosinase is possible after the disintegration of the rapeseed cells. The resulting compounds interact with rapeseed proteins and reduce their nutritive value (Mieth *et al.*, 1983) [26].

**Chlorogenic acid:** Sunflower meal contains high levels of chlorogenic acid, a tannin like a compound that inhibits the activity of digestive enzymes including trypsin, chymotrypsin, amylase and lipase (Akande *et al*., 2010) [2]. Because chlorogenic acid is uncondensed and non-hydrolysable, its content of 1% or more of a total of 3-3.5% phenolic compounds in sunflower meal is not reported in tannin assays.

**Phenolic compounds:** Various phenols, tannins and related pigments are present in peanut hulls, skin and cotyledons. Sinapic acid and its derivatives like sinapine comprise app. 73% of the phenolic compounds present in rapeseed flour and therefore, are the most abundant phenolic compounds (Von Der *et al*., 2014) [42] The brown coloration of peanut hulls is due to the presence of tannins. In nature peanut on fresh weight basis contains the hulls 0.43%, seed coats 6.04% and fruit 0.04% tannins. Thus, most of the flavonoids, including condensed tannins, are concentrated in seed coats and hulls, while the fruit is practically devoid of any tannin. The tannins of skin have been characterized. The skins are often removed during processing of peanuts; hence, most of the polyphenols are estimated from such deskinned peanuts before consumption. However, when peanuts are processed along with the skin, such as during oil extraction in expeller or hydraulic pads, peanut-based products, defatted peanut flour, the phenolic contaminate such products. Beside their anti-nutritional nature, phenolic may impart off-flavours and undesirable dark colour to the peanut products. Peanut protein products contain phenolic compounds, which have been implicated in off-flavours and colour defects. An ion-exchange chromatography and activated carbon treatments could remove more than 80% of the total phenolics from peanuts protein isolates.

**Table 5:** Anti-nutritional factors of Asian Protein Meals (Nagaraj, 1995) [32].

| S. No. | Ingredients | Anti-nutritional factor |
|---|---|---|
| 1 | Soybean meal | Protease inhibitors*, allergens*, oligosaccharides, phytin, lipoxygenase*, lectins*, saponin |
| 2 | Rapeseed meal | Erucic acid, glucosinolates, sinapine, tannins, pectins, oligosaccharides |
| 3 | Canola meal | Glucosinolates, sinapine, pectins, oligosaccharides |
| 4 | Cottonseed meal | Gossypol, cyclopropanoid fatty acids, tannins |
| 5 | Sunflower meal | Chlorogenic acid, fiber |
| 6 | Peanut meal | Mycotoxins, tannins, protease inhibitors*, lectins, oligosaccharides, |
| **7** | Sesame meal | Phytate, oxalate |

## Conclusion

- Oilseeds are a good source of the vitamin niacin, tocopherols, pantothenic acid, riboflavin and thiamine.
- Groundnut seed contains 22 to 30% protein on a dry seed basis.
- The anti-nutritional elements have a significant obstacle to the utilization of products.
- The goitrogenic principal in peanut has been identified as a phenolic glucoside which resides in the skin, thereby depriving the thyroid of available iodine.
- Rapeseed-mustard oil is generally rich in a long-chain fatty acid, namely erucic acid (37.9 - 57%).
- Safflower oil contains about 270 mg/kg of total tocopherols out of which alpha-tocopherol alone accounts for 220 mg/kg. It is deficient in gamma-tocopherol (33 mg/kg).
- Sesame seeds contain high levels of oxalic acid (35mg/100g) and phytic acid (5%).
- Gossypol lower the quality of cottonseed oil and cake.
- Phytic acid, which is mainly present as calcium, magnesium or potassium phytate, amounts to 1 to 6% in rapeseeds

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