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Chemical and Antibacterial Properties of Lipids Extracted from Some Plant Seeds Commonly used in Nutraceuticals

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Abstract: Isolated nutrients, nutritional supplements, genetically modified "designer" foods, herbal products, and processed meals fall under this umbrella term, "Nutraceuticals". It has sparked great attention in recent years because of its potential nutritional, safety, and medicinal impacts. An attempt was made to identify the chemical and antibacterial properties of the lipid extracted from plant seeds like fenugreek, pumpkin seed, almond, flaxseed and sesame, commonly used in nutraceuticals. The quality evaluation of the oils such as acid value, peroxide value, specific gravity, density, P-anisidine value, total oxidation, iodine value, percentage of fatty acids, rancidity and saponification etc. were also conducted. In addition the antibacterial activity of extracted soil and the evaluation of seed efficiency were also tested.

Keywords: Nutraceuticals, Antibacterial property, Quality evaluation, Oils

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Introduction

Nutraceutical can be defined as a food or part of a food that provide medical or health benefits, including the prevention or treatment of a disease (Costa, 2017). Nutraceuticals are difficult to distinguish from nutrients, food additives, medicines, by legal definition since they blur the boundary between food and pharmaceuticals (Bhat, 2021). Several nutraceuticals found in legumes are listed among the top 200 list of the American Nutraceutical Association (Morris, 2003). Nutraceuticals increase the health value of our diet, helps to live longer, help to avoid particular medical conditions, may have a psychological benefit from doing something for oneself, may be perceived to be more "natural" than traditional medicine and less likely to produce unpleasant side-effects and may present food for populations with special needs. These

compounds may have a role in a variety of biological activities, including antioxidant defences, cell proliferation, gene expression, and mitochondrial integrity. As a result, nutraceuticals can be used to enhance health, prevent chronic illnesses, delay the aging process and therefore extend life expectancy, or simply to maintain the body's functions and integrity. These products are regarded as healthy sources for the prevention of life-threatening illnesses such as diabetes, renal and gastrointestinal problems, and other infections (Bhat, 2021).

The role of dietary active compounds in human nutrition is one of the most important areas of investigation with the findings having wide ranging implications for consumers, health-care providers, regulators and industry. Foods and nutrients play a vital role in the normal functioning of the body. They help to maintain the health of the individual and to reduce the risk of various diseases. Worldwide acceptance of this fact formed a recognition link between “nutrition" and "health", and thus the concept of "nutraceuticals" evolved (Verma and Mishra, 2016).

In human health and nutrition oil seeds have immense biological, medicinal, nutritional and economic value. They are also a rich source of nutrients, including protein, carbohydrates, essential fatty acids, fibre, vitamins, oil, minerals, and many other nutrients. They have nutraceutical value because they provide an appropriate amount of energy, nutrients and also have bioactive compounds that aid in preventing diseases. Different seeds have specific medicinal or therapeutic value in prevention or treatment of cardiovascular diseases, diabetes, hypertension, thyroid disorders, cancer, oxidative stress and other harmful conditions. Dietary supplementation of seeds in appropriate amounts can have a positive impact on overall human health in providing optimal nutrition, boosting energy levels, and protecting from multiple diseases (Pareekand Singh, 2021).

An attempt was made in the present study to identify the chemical and antibacterial properties of the lipid extracted from plant seeds like Fenugreek (*Trigonella foenum graecum*), pumpkin seed (*Cucurbita maxima*), almond (*Prunus dulcis*), flaxseed (*Linum usitatissimum*), and Sesame (*Sesamum indicum*) commonly used in nutraceuticals. The quality evaluation of the oils such as acid value, peroxide value, specific gravity, density, P-anisidine value, total oxidation, iodine value, percentage of fatty acids, rancidity and saponification etc. were also conducted. In addition the antibacterial activity of extracted soil and the evaluation of seed efficiency were also tested.

Materials and Methods

Seeds samples were weighed separately into different containers; 500 ml of petroleum ether was added to it and allowed to stand at room temperature for 24 h with regularly shaking. The mixtures were filtered and the solvent was removed by rotary evaporation (Ornella *et al*., 2022).

Acid value of oil and peroxide value of oil is determined by the method of AOAC (2005). Anisidine value was determined by the standard method of the American Oil Chemists’ Society Cd 18-90 (p-anisidine value) using a UV-Visible Spectrophotometer. TOTOX values of oils samples were determined based on the obtained peroxide and P-Anisidine values using the formula; TOTOX = 2PV + AV. The iodine value of an oil/fat is the number of grams of iodine absorbed by 100g of the oil/fat, when determined by using Wijs solution. Iodine value of oil is determined by the method of AOAC, (2005).

Estimation of antimicrobial activity was done by agar well diffusion method (Murray *et al*., 1995) modified by Olurinola (1996). Antimicrobial susceptibility was tested on solid (Agar-agar) media in petri plates.

The pure culture of the clinically important microbial pathogens was obtained through performing streak plate technique. A loop of full inoculums from culture was then transferred to 50

ml of the nutrient broth and incubated at room temperature (300^{0}C) for further study.

Nutrient agar medium prepared, sterilised by autoclaving, poured into sterile petri dishes aseptically to uniform depth of 4 mm and allowed to solidify at room temperature (30°C). After solidification, the test organism was inoculated by sterile swab. This Provides uniform surface growth of microorganism and is used for antibacterial sensitive studies. The wells were made using cup borer (7 mm), added 50 µl of extract samples and antibiotic and control (petroleum ether) was introduced into each well. The petri dishes were incubated at 37°C for 24 h and after 24 h of incubation, the zone of inhibition produced by the different organism in different plates was measured. The experiments were repeated under aseptic condition. Specific gravity of oil was determined by the method of AOAC (2005).

Standardisation of Pycnometer:

Carefully cleaned pycnometer by filling with Chromic acid cleaning solution and letting stand several hours. Then pycnometer was rinsed thoroughly with water, filled with recently boiled water previously cooled to about 20°C and placed in constant temperature water bath held at 30°C. After 30 min adjusted water level to proper point on pycnometer and stopper, removed from bath, wiped dry with clean cloth or towel and weighed. Filled the dry pycnometer with the prepared sample in such a manner to prevent entrapment of air bubbles after removing the cap of the side arm. Inserted the stopper, immersed in water bath at 30^{0}C and hold for 30 min. Carefully wiped off any oil that has come out of the capillary opening. Removed the bottle from the bath, cleaned and dried it thoroughly. Removed the cap of the side arm and quickly weighed ensuring that the temperature does not fall below 30°C.

$$\text{Specific Gravity at 30°C} = \frac{A - B}{C - B}$$

$$\text{Density} = \frac{A - B}{\text{Volume of oil}}$$

Where, A = weight in g of specific gravity bottle with oil at 30°C; B = weight in g of specific gravity bottle at 30°C; C = weight in g of specific gravity bottle with water at 30°C

Test for rancidity (*Kries Test*):

Mixed 5 ml of the oil vigorously with 5 ml of 0.1% phloroglucinol solution in diethyl ether and added 5 ml of conc. hydrochloric acid. A pink colour indicated incipient rancidity.

The saponification value is the number of mg of potassium hydroxide required to saponify 1 g of oil/fat. Saponification value of oil was determined by the method of AOAC (2005).

Results and Discussion

Nutraceuticals are regarded as bioactive food products that provide health as-well as medical benefits such as prevention and treatment of diseases. The need of herbal medicine is increasing day-by-day. With the modernized, competitive and stressful conditions, all types of diseases are having a field day. Allopathic cure is available for most of the diseases but they are not cost-effective and associated with a variety of side effects. Therefore, many people are inclining towards change in lifestyle and use of herbal products. These products may range from processed foods, dietary supplements, genetically engineered foods, etc. Majority of the nutra-ceuticals are claimed to possess multiple thera-peutic benefits though substantial evidence is lacking for benefits as-well-as unwanted effects. Nutraceuticals are present in most of the food ingredients with varying concentration. Concen-tration, time and duration of supply of nutra-ceuticals influence human health. Manipulating the foods, the concentration of active ingredients can be increased. Diet rich in nutraceuticals along with regular exercise, stress reduction and maintenance of healthy body weight will maximize health and reduce disease risk. Consumption of fats and oils is unavoidable in our diet now-a-days. From a nutritional perspective, plant-based oils are superior to animal-based oils and products. Particularly, plant-based oils are composed of

Table 1: Quality evaluation of the different seeds/oils

Plant seeds	Acid Value (mg NaOH/g oil)	Free fatty Acid (g/100g)	Iodine value (gI_2/100 g lipid)	Peroxide value ($meqO_2$/kg)	P-anisidine value (meq/kg)	Total oxidation	Specific gravity (kg/m^3)	Density (kg/m^3)
Almond	3.2	0.28	95.7	10.23	21.3	41.76	0.825	0.8115
Fenugreek	12.4	2.20	54.4	63.22	14.52	140.96	0.657	0.673
Flaxseed	1.4	0.47	186	60.3	11.6	132.2	0.694	0.708
Pumpkin	11.2	1.97	98.77	39.6	8.61	87.81	0.7103	0.7109
Sesame	4.36	0.61	74.3	32.7	13.73	79.13	0.7364	0.7138

high amounts of unsaturated fatty acids such as linoleic and linolenic acids, which deliver many physiological and nutritional benefits to human body. Literature highlighted that conjugated linoleic acids (CLA), a group of linoleic acid isomers, are effective in the prevention of obesity, atherosclerosis, and cancer. Alpha-linolenic acids, known as an omega-3 fatty acid, provide many biological roles in human body including anti-inflammatory and anti-cancer effects and act as precursors of long chain polyunsaturated fatty acids, docosahexaenoic aicd (DHA), docosapetaenoic acid (DPA), and eicosapentaenoic acid (EPA). Additionally, plant-based oils contain high amounts of tocopherols and phytosterols, which enhance food storability as well as nutritional quality (Lee *et al*., 2019).

The quality evaluation of different seeds/oils is given in Table 1.

Estimation of acid value

Acid value is taken as an important indicator of oxidation of oil. Acid base titration techniques in non-aqueous solvents are mostly used for determination of acid value in oil. In Good oil, the acid value should be very low (< 0.1). Increase in acid value should be taken as an indicator of oxidation of the oil which may lead to gum and sludge formation besides corrosion. The acid value is measure of the breakdown of the triacylglycerols into free fatty acids, which has an adverse effect. The acid value increases on oxidation of any substance and thus the quality status can be determined (Sharma and Jain, 2015).

Acid values were highest in Fenugreek seed oil (12.4 mg NaOH/g), and lowest in Flaxseed oil (1.4 mg NaOH/g) (Table 1). This gives an indication of its edibility. The oils intended for human dietary purpose should not contain high Free Fatty Acid. Edible oils such as palm oil and Landolphia Seeds have been reported to contain an average of 19.3, and 17. 31 acid values, respectively (Aliyu *et al*., 2010). Lee *et al*. (2019) reported that Japanese Mallotus (52.3) and large leaflet prickly ash (35.25) seeds have also higher acid values. Higher acid values mean higher contents of free fatty acids, indicating a degraded quality of oils (Jiang *et al*., 2019).

Estimation of percentage free fatty acid

The determination of free fatty acid (FFA) content is an important analysis for evaluating the quality of raw material and its degradation during storage, and throughout the shelf life of several vegetable oils, such as soybean, sunflower, rice, and canola. Also, the oxidation process may confer different quality and sensorial attributes to the oils. Results obtained for acid value in terms of percentage free fatty acids were compared among the extracted lipids and the values obtained indicate that the FFA of the lipids ranged from 0.61% for sesame oil to 2.20 % FFA for fenugreek oil, which was higher compared to the other oils. Low percentage free fatty acids were recorded for Almond and Flaxseed oil. In addition, all the values obtained fall within the range specified by Codex Alimentarius (≤2.5%) (1999). The acid value represents free fatty acid content due to enzymatic activity and is usually indicative of spoilage as rancidity. Its maximum acceptable level is 4 mg KOH/g oil or 2.5 % FFA, for recommended international standards for edible oil. In nearly all

the cases there are corresponding low levels of free fatty acids in the lipids, which also suggested low levels of hydrolytic and lipolytic activities in the lipids. The low percentage free fatty acids of these oils were probably a result of lower hydrolysis of triglycerides thus signified that the oil could have a long shelf life, which allows it to be used in nutraceuticals formulations.

Estimation of iodine value

Iodine value (also called iodine number, in analytical chemistry) is measure of the degree of unsaturation of an oil, fat, or wax; the amount of iodine, in grams, that is taken up by 100 g of the oil, fat, or wax. Saturated oils, fats, and waxes take up no iodine, and therefore their iodine value is zero, but unsaturated oils, fats, and waxes take up iodine (unsaturated compounds contain molecules with double or triple bonds, which are very reactive toward Iodine.) The more iodine is attached, the higher is the iodine value, and the more reactive, less stable, softer, and more susceptible to oxidation and Rancidification is the oil, fat, or wax. Table 3 shows the result of iodine value of different seeds used in Nutraceuticals. From the result iodine value of Almond is 95.7gI^2/100g lipid, pumpkin is 98.77 gI^2/100 g lipid, sesame is 74.3 gI_2/100 g lipid, flaxseed is 186 gI_2/100g lipid, and fenugreek is 54.4 gI2/100 g lipid. Fenugreek have the lowest iodine value than other seeds. The low Iodine value represents the fewer amounts of unsaturated bonds and thus the oil has fewer tendencies to go through oxidative rancidity (Nour *et al*., 2009).

Estimation of peroxide value

Peroxide values (PV) measure the concentration of hydrogen peroxide, the primary oxidation product, which is an important estimate of early phase oxidation (Kaleem *et al*., 2015). Peroxide value is an appropriate measure to assess the time-dependent quality of oil-containing foods, meaning that a drastic increase of peroxide value indicates deteriorated oils after the early oxidation (Asakawa and Matsushita, 1980). The oil had also undergone some chemical decomposition process whereby the obtained PV is 10.23, 63.22, 60.3, 39.6, and 32.7 meq O_2/kg for almond, fenugreek, flaxseed, pumpkin, and sesame, respectively; and was determined immediately after the extraction of the oil. PV indicates the rancidity process whereby the higher the PV, the higher is the oxidation level and the deterioration of lipids (Mohammed and Hamza, 2008). Theoretically, oil that shows a high amount of PV is more prone to undergo rancidity that affects the total quality of the oil (Ibeto *et al*., 2012). A low peroxide value increases the appropriateness of the oil for long storage because of low level of oxidative and lipolytic activities.

Estimation of P-anisidine value

The anisidine value (AV) in oils and fats is a measure of the aldehydes present and therefore the level of secondary oxidation that has occurred and, secondary oxidation occurs when the peroxides (as measured via PV) decompose to form aldehydes and it is these compounds that generate the characteristic odour associated with rancidity.

Table 5 shows the result of p-anisidine value of different seeds used in Nutraceuticals. From the result p-anisidine value of fenugreek is 14.52 meq/kg, Sesame is 13.73 meq/kg, almond is 21.3 meq/kg and pumpkin is 8. 61 meq/kg and flaxseed 11.6 meq/kg. In the present study, almond has more p-anisidine value than other seeds. P-anisidine value (p-AV) of the extracted seed oils ranged from 8.61 to 21.3. The highest Anisidine values are obtained with almond and the lowest with pumpkin. The p-AV values suggest the presence of significant amounts of secondary oxidation products in the test oil samples. The high value of almond oil indicates that considerable oxidative activity might be due to either pipoxygenase or autoxidation. These values are comparable between all the samples.

Total oxidation

The Total Oxidation Value (TOTOX) is a measure of the overall Oxidation profile of a sample and is calculated from the PV and AV data and taken into

account how the PV and AV results will potentially change over time.

Table 1 shows the result of total oxidation of different seeds used in Nutraceuticals. Total oxidation for fenugreek is 140.96, sesame is 79.13, flaxseed is 132.2, almond is 41.76 and pumpkin is 87.81. It showed that fenugreek has more total oxidation than other seeds.

The primary and secondary oxidation (TOTOX) products of seed oil extracted were higher with Fenugreek followed by flaxseed. Almond oil show lower oxidation. The high TOTOX value obtained with sesame oil is a result of its high p-anisidine value and high peroxide value which can be due to the method of extraction or the low content in natural antioxidants. The low level of unsaturated fatty acid provides the oil with high oxidative stability.

Estimation of Specific gravity

Specific gravity, more formally known as relative density, is a measure of the density of a substance in comparison to the density of water. Specific gravity shows whether something will float or sink. Table 1 shows the result of specific gravity of different seeds used in Nutraceuticals. In this study, specific gravity of fenugreek is 0.657 kg/m^3, Sesame is 0.7364 kg/m^3, almond is 0.825 kg/m^3, flaxseed is 0.694 kg/m^3 and pumpkin is 0. 7103 kg/m^3. It indicates that almond has more specific gravity than other Seeds.

Estimation of density

The formula for Density is d = M/V, where d is density, M is mass, and V is volume. Density is commonly expressed in units of grams per cubic centimetre. The results showed that density of fenugreek is 0.673 kg/m^3, sesame is 0.7138 kg/m^3, almond is 0.8115 kg/m^3, flaxseed is 0.708 kg/m^3 and pumpkin is 0.7109 kg/m^3. Here almond has more density than other seeds.

The density recorded for the different plant seed oils in this study ranged between 0.673-0.8115 kg/m^3. It has been reported that density value ranged from 0.195 to 1.024 kg/m^3, which is in conformity with the observations of the present study (Radha and Manikandan, 2011).

Rancidity

Rancidity, condition produced by aerial oxidation of unsaturated fat present in foods and other products, marked by unpleasant odour or flavour. When a fatty substance is exposed to air, its unsaturated components are converted into hydroperoxides, which break down into volatile aldehydes, esters, alcohols, ketones, and hydrocarbons which have disagreeable odours. Butter becomes rancid by the foregoing process and by hydrolysis, which liberates volatile and malodorous acids, particularly butyric acid. Saturated fats such as beef tallow are resistant to oxidation and seldom become rancid at ordinary temperatures. In the present study, the seed oils have not shown pink colour (Fig. 1) for rancidity and hence concluded that the seeds are not rancid at all and have high oxidative stability and effectively good quality.

Rancidity which is determined by acid values, peroxide values, and p-Anisidine values, is a critical estimate of off-flavours and undesirable sensory characteristics in lipid-containing foods, probably influencing overall sensory preferences and acceptability (Kaleem *et al*., 2015). It is therefore important to control the extent of lipid oxidation in order to utilize the plant seed oils as potential food sources.

Antibacterial activity

Antimicrobial activity (Table 2; Figs. 2 to 11) can be defined as a collective term for all active principles (agents) that inhibit the growth of bacteria, prevent the formation of microbial colonies, and may destroy microorganisms. A variety of laboratory methods can be used to evaluate or screen the *in vitro* antimicrobial activity of an extract or a pure compound. The most known and basic methods are the disk-diffusion and broth or agar dilution methods. Other methods are used especially for antifungal testing, such as poisoned food technique. Bacterial activity depends on the uptake of dissolved

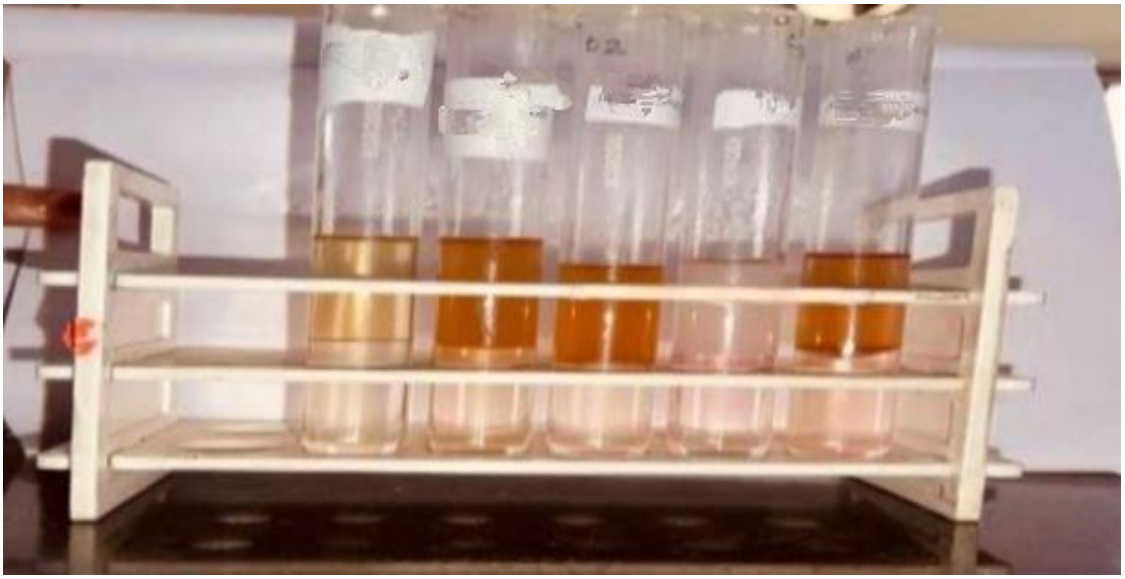

Fig. 1: Rancidity of fenugreek, almond, sesame, pumpkin seed oils.

Table 2: Antibacterial activity of different seeds against *E.coli* and *S.aureus*

Organism used	**Plant seed**	**Zone of inhibition**	
		Lipid extract	**Antibiotic**
E. coli	Almond	Nil	2.8
	Fenugreek	2.5	3.2
	Flaxseed	1.7	3.2
	Pumpkin	2.2	3.3
	Sesame	2.4	3.5
Staphylococcus aureus	Almond	Nil	2.6
	Fenugreek	2	3.2
	Flaxseed	Nil	3.7
	Pumpkin	2.2	3.5
	Sesame	3	3.5

substrates; the substances are transported to the cell by a diffusive flux driven by a concentration gradient caused by uptake at the cell surface. Table 2 shows the result of antibacterial activity of almond, fenugreek, flaxseed, pumpkin and sesame against two different bacterial strains. The present study revealed that lipid extract of seeds such as fenugreek, pumpkin and sesame has antibacterial activity against *E. coli* and *S. aureus.*

Saponfication value

The saponification value of an oil or fat is defined as the number of milligram of potassium hydroxide (KOH) required neutralizing the fatty

Fig. 2: Fenugreek oil against *E. coli.*

Fig. 3: Fenugreek oil against *S. aureus.*

Fig. 4: Sesame oil against *E. coli.*

Fig. 5: Sesame oil against *S. aureus.*

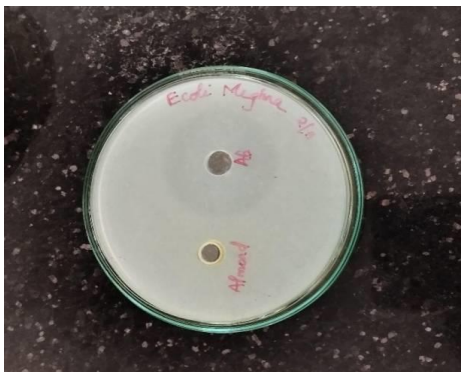

Fig. 6: Almond oil against *E. coli.*

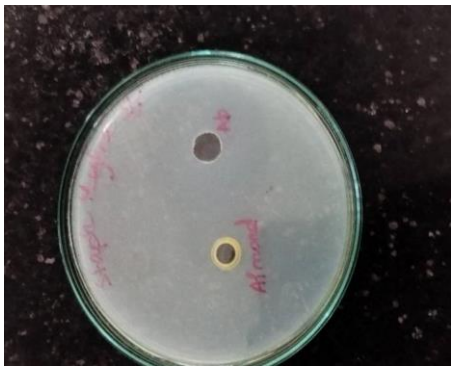

Fig. 7: Almond oil against *S. aureus.*

Fig. 8: Pumpkin oil against *E. coli.*

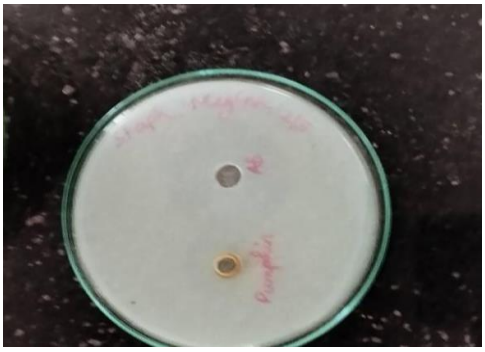

Fig. 9: Pumpkin oil against *S. aureus.*

Fig. 10: Flaxseed oil against *E. coli.*

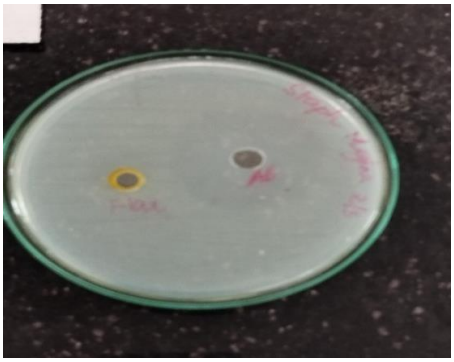

Fig. 11: Flaxseed oil against *S. aureus.*

acids resulting from the complete hydrolysis of 1 g of the sample. Saponification value is a measure of the content of ester linkages. It is determined by back titration of potassium oxide in the presence of Phenolphthalein indicator with 0.5 N sulphuric or hydrochloric acid. Thus, it is a value that can be found experimentally. In the case of a pure triglycerides (containing only a single type of fatty acid), the saponification value (SV) can be obtained by the following formula:

$$SV = \frac{(B-S) \times M \times 56.106}{W_{oil/fat}}$$

Where, B is the volume of HCl (ml) used for the blank run; S is the volume of HCl (ml) used for the tested sample; M is the molarity of HCl (mol/L); 56.106 is the molecular weight (g/mol) of KOH; $W_{oil/fat}$ is the weight of sample (g).

Table 3: Saponification value of different plant seeds

Plant seeds	Saponification value (mg KOH/g lipid)
Almond	153.96
Fenugreek	125.61
Flaxseed	186.22
Pumpkin	191.53
Sesame	185.35

Table 3 shows the saponification value of almond, fenugreek, flaxseed, pumpkin and sesame lipids. Almond oil has the saponification value of 153.96 mg KOH/g lipid. Fenugreek has the saponification value of 125.61 mg KOH/g lipid. Flaxseed has the saponification value of 186.22 mg KOH/g lipid, Pumpkin has the saponification value of 191.53 mg KOH/g lipid, and Sesame oil has the saponification value of 185.35 mg KOH/g lipid.

Conclusion

Nutraceutical is the hybrid of nutrition and pharmaceutical. Nutraceuticals; in broad, are food or part of food playing a significant role in modifying and maintaining normal physiological function that maintains healthy human beings. The food products used as nutraceuticals can be categorized as dietary fibre, prebiotics, probiotics, polyunsaturated fatty acids, antioxidants and other different types of herbal natural foods. These nutraceuticals are used in various diseases such as obesity, cardiovascular diseases, cancer, osteoporosis, arthritis, diabetes, cholesterol etc. Nutraceuticals have led to the new era of medicine and health, in which the food industry has become a research oriented sector. Nutraceuticals have proven their health benefits and disease prevention capability, which should be taken according to their acceptable recommended intake. In the present scenario of self-medication nutraceuticals play major role in therapeutic development. But their success depends on maintaining on their quality, purity, safety and efficacy.

The present study was carried out to determine the chemical and antibacterial properties of lipids extracted from plant seeds commonly used in nutraceuticals. To achieve this, the physico-chemical and antibacterial activity of five oil seeds especially: Sesame (*Sesamum indicum*), Fenugreek (*Trigonella foenum graecum*),

Pumpkin (*Cucurbita pepo*), Almond (*Prunus dulcis*) and flaxseed (*Linumus itatissimum*) were analysed. The lipids were extracted and lipid quality (acid value, percentage free fatty acid, iodine value, peroxide value, ρ-anisidine value, total oxidation, specific gravity and density) was analysed. Almond showed higher specific gravity and density than other seeds. Fenugreek has higher acid value than other seeds which is not a favourable trait for a neutracueticals. Antibacterial activity was evaluated by well diffusion methods. Results revealed from the physico-chemical analysis of the fenugreek, pumpkin, and sesame, were probably a result of lower hydrolysis of triglycerides thus signified that the oil could have a long shelf life, which allows it to be used in nutraceuticals formulations. Fenugreek, pumpkin, and sesame exhibited high antibacterial activity against selected microorganisms like *Staphylococcus aureus* and *Escherichia coli*. These results suggest that studied oils may have nutraceuticals and technological applications in food industry. Moreover, increased consumer awareness toward natural remedy and the emergence of natural-based cosmetics along with plethora of other merits make these seed oils promising industrial and health-promoting oil of the future. The result evaluation of the following seeds gives us an idea about the different traits of oil which is used in nutracueticals. **F**enugreek and pumpkin seeds have values which satisfy most of the qualitative assays. Almond, sesame, and flaxseeds have some of the properties which can be utilized for nutracueticals. Further studies in this feild can give us more qualitative and quantitative knowledge in the field of nutracueticals which give more benefit to mankind.

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Conflict of Interest

The authors declare no conflicts of interest.

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