JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2018, *24* (2), 75-80

Journal of Agroalimentary Processes and Technologies

Monitoring of Composition and Antimicrobial Activity of Fig (*Ficus carica* L.) Fruit and Seed Oil

Erman Duman[1], Merih Şimşek[2], Mehmet Musa Özcan[3*]

[1]*Department of Food Engineering, Faculty of Engineering, University of Afyon Kocatepe, Afyonkocatepe, Turkey*
[2]*Afyon Kocatepe University/Medical School Department Of Medical Microbiology, Afyonkocatepe, Turkey*
[3]*Department of Food Engineering, Faculty of Agriculture, University of Selçuk, 42031 Konya, Turkey*

Abstract
The inside weight, seed numbers, 1000 seed weight, dry matter and moisture of fruit and seeds were determined as 6779 g, 948 unit, 1241 g, 95.43% and 4.57%, respectively. Fig seed contained 29.17% oil. Acidity, iodine value, peroxide salue, refractive index, density, viscosity, melting point, total phenol and oxidative stability value of fig seed oil were established as 4.6 mg KoH/g,176 I_2 g/100g, 4.5 meq O_2/kg, 1.480 (nD), 0.925 mg/ml, 52.1 mPa, -15.1 ^oC,21.71 (mg GAE/g) and 2.97 110 ^oC/h, respectively. Fig seed oil contained Palmitic (6.76%), oleic (18.66%), linoleic 29.03%) and linolenic 41.85%) acids as major fatty acids. Al, Cr, Fe, Co, Ni, Cu and Zn contents of seeds were deteceted as 0.905, 784.80, 1913.67, 55.64, 1579.91, 6197.69 and 219.65 ppb, respectively. Fatty acids content in Fig has great applications as vegetable oils and could beutilized for therapeutic benefit. Also, fig seed oil had effective on *S. aureus, E. aeruginosa, E. coli, E. faecalis, and K. pneumoniae strains, C. albicans* and *A. flavus* fungal strains as in vitro..While fig seed oil showed a strong antibacterial effect on *E. coli* from gram negative bacterias, the effect determined for *P. aeruginosa* and *K. pneumoniae* was found to be weaker than the antibiotic effect used for positive control.

Keywords: Fig, *Ficus carica*, proximate, seed, oil, fatty acid, mineral, antimicrobial activity

1. Introduction

Fig (*Ficus carica* L.) is a plant which cultivated since ancient times. It is a widely known and consumed Mediterranean plant. Its fruit contains vitamins, dietary fiber, mineral and oil [1,2]. They are commonly consumed both fresh and dried. Dried figs are rich in carbohydrates, sugars, minerals, vitamins, organic acids and phenolic compounds [3,4]. Fatty acids have important role in the reduction of body cholesterol levels as indicated by omega-3 fatty acids [5,6]. In recent years, antimicrobial effect of a number of oils and their constituents have been investigated against bacteria and fungi [7]. The oils of medicinal plants have been used for treatment of various ailments since men learnt the art of extraction [8].

Many components naturally present in beneficial properties [9]. Plant oils showed antimicrobial activity against a wide range of pathogenic fungi and bacteria species [10,11]. Recently, plant derived antibiotics and antimycotics are attracting the attention of cosmetic microbiologists and dermatologists because they are cheaper, safer, eco-friendly and within the each of the medical community [12]. The objective of present study was to determine some proximate, physico-chemical properties, heavy metal contents fatty acid compositions and antimicrobial activity of Fig fruit and seed oils.

Corresponding author: *e-mail:* mozcan@selcuk.edu.tr

2. Materials and Methods

2.1.Material

Riped fig (*Ficus carica* L.) samples were collected from a fig garden in Aydın province (Bozdoğan) of Turkey. Fruits were washed with drinkable water, and kept in refrigerator by using.

2.2.Proximate analysis

The physico- chemical properties of fig seed and oils were determined [13,14]. Total phenolic content was determined with the Folin-Ciocalteu reagent according to Yoo et al. [15]. The oil was obtained from the seed powders with petroleum ether in a Soxhlet extractor for 6 h according to AOCS Official methods Am 2-93. After the solvent was removed by rotary evaporator, the oil was flushed with a stream of nitrogen and stored at -18 ºC in sealed vials.

2.3.Fatty acid analysis

The fatty acid methyl esters were identified by comparing the retention time of the samples and appropriate fatty acids methyl esters standards [16]. About 20 mg of sodium hydrogen sulphate (monohydrate, extra pure; Merck, Darmstadt, Germany) was added, and after centrifugation at 4500 g for 10 min, the top n-heptane phase was injected in a Varian 5890 gas chromatograph with a capillary column, CP-Sil 88 (100 m long, 0.25 mm ID, film thickness 0.2 µm). A standard fatty acid methyl ester mixture (Sigma Chemical Co.) was used to identify sample peaks [13].

2.4.Determination of mineral

Fig samples were dried at 70 ºC in a drying cabinet until reached constant weight. After about 0.5 g ground sample was digested by using 5ml of 65% HNO_3 and 2 ml of 35% H_2O_2 in microwave, the volume was completed to 20 ml with ultra-deionized water, and minerals were determined by ICP AES (Varian-Vista, Australia) [17].

2.5.Antibacterial activity

It was investigated the antibacterial and antifungal effect of fig seed oil against standard bacterial and fungal strains (*Staphylococcus aureus* (ATCC 25923), *Pseudomonas aeruginosa* (ATCC 27853), *Escherichia coli* (ATCC 25922), *Enterococcus faecalis* (ATCC 51299), *Klebsiella pneumoniae* (ATCC 700603), *Candida albicans* (ATCC 90028) and *Aspergillus fulavus* (*ATCC 28539*)) that was determined with disk diffusion method in accordance with the recommendations of Clinical and Laboratory Standards Institute (CLSI).

2.6.Disc Diffusion Method

Bacterial strains were inoculated with Nutrient Broth (Difco) for activation and yeast strains with Sabouraud Dextrose Broth (Difco) and incubated at 37 ° C for 24 hours. Sterile empty discs (Oxoid) were impregnated with 20 µl of micropipette from fig seed oil and dried. Suspensions of each bacterial strain were adjusted to 0.5 McFarland and drained with Merlot-Hinton Agar (MHA, Oxoid) with the help of an extruder. The oil-impregnated discs were pressed gently and placed 2 cm apart. Then, plates with bacteria were incubated at 37 ° C for 18-24 hours. Likewise, Mueller-Hilton agar (pH: 7.2-7.4) supplemented with 2% dextrose and 0.6 µg methylene blue was used for the antifungal susceptibility test. Spectrophotometrically, the fungal suspension, which had its concentration adjusted to 0.5 Mc Farland, spread to the substratesurface. Again, oil-impregnated discs were placed on the surface of the plates. Plates were incubated at 35 ° C for 48 hours [18,19]. At the end of the period, the inhibition zones formed on the substrate were determined in mm [20].The experiments were repeated three times. In this study were used Ampicillin (10 µg) for *enterococci*, cefoxitin (30 µg) for *S. aureus*, and Fluconazole (25 µg) for *C. albicans*, amphotericin B (20 µg) for *A.flavus*, ciprofloxacin (5 µg) for gram-negative bacteria reference antibiotic discs [19,21] DMSO impregnated sterile discs were used as negative control [22].

2.7. Statistical analyses

Mean±standard deviation (MSTAT C) of results were calculated according to *Püskülcü and İkiz* [23].

3. Results and Discussions

Some physico-chemical properties of Sarı Lop fig seed and oil are given in Table 1. The inside weight, seed numbers, 1000 seed weight, dry matter and moisture of fruit and seeds were determined as 6779 g, 948 unit, 1241 g, 95.43% and 4.57%, respectively. Fig seed contained 29.17% oil. Acidity, Iodine value, peroxide value, refractive index, density, viscosity and oxidative stability values of fig seed oil were established as 4.6 mg KoH/g, 176 I_2 g/100g, 4.5 meq O_2/kg, 1.480 (nD), 0.925 mg/ml, 52.1 mPa and 2.97 110 ºC/h, respectively. Weight of 100 seeds, oil content, viscosity, refractive index, density and iodine values

of *O. ficus indica* were found as 1.38 g, 10.90%, 0.0531 (Pas), 1.475 nD, 0.903 mg/ml and 101.5, respectively [24]. Peroxide value, iodine value, free fatty acid, viscosity values of *Annona muricata* oil were found as 0.89 meq/kg, 102.4, 14.2% and 27.0 mPa.s, respectively [25]. Viscosity is commonly perceived as thickness, or resistance to pouring [25]. The density of the seed oil at 20 °C compared flavourably with native rapeseed oil (0.910) and soybean oil (0.921) [26]. The results on fig oil was in accordance with the published density data for coconut, corn and rapeseed oils [26, 27]. Acid value, iodine value, peroxide value, specific gravity and refractive index values of *Citrullus vulgaric* seed oil were determined as 6.48 mgKOH/g, 123 g I_2/ 100 g, 21 meq/kg, 0.915 mg/ml and 1.46, respectively [6]. The specific gravity and refractive index measures the purity of the oil. Results showed differences when compared with literature values. These differences can be probably due to plant species, variety, genetic factor and analytic conditions. In addition, saturated and unsaturated fatty acid contents of seed oils can change phycio-chemical properties of oil samples.

Fatty acid compositions of fig seed oil are shown in Table 2. Palmitic, oleic linoleic and linolenic acids were found as key fatty acids of fig seed oil. As a saturated fatty acid, myristic (0.014%), palmitic (6.76%) stearic (2.81%), arachidic (0.27%), behenic (0.08%) and bignoseric (0.04%) were determined. Especially, polyunsaturated fatty acid contents of Fig seed oil were found higher than those of both saturated and unsaturated fatty acid contents. Mean values of saturated, nansaturated and polyunsaturated fatty acid contents were found as 9.97%, 18.99% and 89.87%, respectively. The fatty acid composition of the oil showed differences with values obtained in previous studies on several seed oils. *Jeong and Lachance* [28] reported that dried fig seed oil contained 53.1% linolenic, 21.1% linoleic, 13.8% palmitic, and 9.8% oleic acids. In an other study, *A. muricata* oil contained 20.33% palmitic, 4.22% stearic, 41.41% oleic, 30.60% linoleic and 2.13% linolenic acids [25]. The content of linolenic acid was found partly low (41.85) than that of reported (53.1%) by *Jeong and Lachance* [28]. The fatty acid composition and ratio of unsaturated to saturated fatty acids were similar to those reported in the literature. The oil exhibited good physicochemical properties and could be useful as edible oils and for industrial applications.

Heavy metal contents of both seed and oil are given in Table 3. Al, Cr, Fe, Co, Ni, Cu and Zn contents of seeds were determined as 0.905, 784.80, 1913.67, 55.64, 1579.91, 6197.69 and 219.65 ppb, respectively. In addition, fig seed oil contained 0.384 Al, 621.35 ppb Cr, 246.79 ppb Fe, 32.93 ppb Co, 1267.63 ppb Ni, 3312.98 ppb Cu and 13347 Zn. Excessive accumulation of heavy metals in agricultural soils through wastewater irrigation may affect food quality and safety [29]. Metals like iron, copper, zinc and manganese are required for metabolic activities in organisms [30]. Generally, heavy metal contents of seeds were found higher than those of results of oil.

The results revealed that fig seed oil has a good lipid content with an average oil yield 29%. Palmitic, stearic, oleic, linoleic and linolenic acids had been key fatty acids of fig seed oil. Fatty acid content of Fig oil has great applications as vegetable oils and could be utilized for therapeutic benefit.

Table 1. Physico-chemical properties of Sarı Lop fig seed and oil

Parameters	Mean	Parameters	Mean
Peel weight (g)	9.20±2.36*	**Acidity (%)**	4.6±0.1
Inside weight (g)	6.78±2.34	**Peroxide value (meq/kg)**	4.5±0.14
Seed acount (unit)	948±3.32	**Iodine value (I_2g/100 g)**	176±0.36
Lengh (mm)	1.13±0.32	**Refractive Index (nD)**	1.480±0.001
Width (mm)	1.00±0.10	**Density (20 °C)**	0.925±0.003
1000 seed weight (g)	1.241±0.02	**Viscosity(22 °C-mPa)**	52.1±0.152
Dry matter (%)	95.43±1.17	**Oxidative stability (110°C/h)**	2.97±0.22
Crude oil (%)	29.17±1.6	**Melting point (°C)**	15.1±0.70
		Total phenol (mg GAE/g)	21.71±2.08
		pH	6.4±0.15

*mean±standard deviation

Table 2. Fatty acid composition of fig seed oil (%)

Saturated fatty acid	**Mean**	**Mono unsaturated fatty acid**	**Mean**	**Poly unsaturated fatty acid**	**Mean**
Myristic	0.014±0.003*	Palmitoleic	0.065±0.001	Linoleic	29.028±0.13
Palmitic	6.764±0.017	Heptadecenoic	0.055±0.003	Linolenic	41.848±0.21
Stearic	2.813±0.021	Oleic	18.664±0.27	Eicosadienoic	-
Arachidic	0.265±0.007	Eiconsenoic	0.213±0.009	∑PUFA	**70.876**
Behenic	0.079±0.003	Erusic	-**		
Lignoseric	0.038±0.003	Nervonic	-		
∑Saturated fatty acid	**9.973**	∑ MUFA	**18.997**		

*mean±standard deviation;**nonidentified

Table 3. Heavy metal contents of fig seed and oil (ppb)

Samples	**Cr**	**Al**	**Fe**	**Co**	**Ni**	**Cu**	**Zn**	**As**
Seed	784.79 ±1.26*	0.905 ±0.017	1913.67 ±11.46	55.64 ±0.89	1579.91 ±17.89	6197.69 ±9.81	219.65 ±0.67	<0.000
Oil	621.35 ±3.18	0.384 ±0.044	246.79 ±4.78	32.93 ±1.73	1267.63 ±21.56	3312.97 ±32.19	133.47 ±1.28	<0.000

*mean±standard deviation

Table 4. Measured inhibition diameters (mm) for standard bacterial and fungal strains of fig seed oil tested

Standard strains Suşlar	**Inhibition zone diameters (mm)**
Staphylococcus aureus (ATCC 25923)	30
Pseudomonas aeruginosa (ATCC 27853)	25
Escherichia coli (ATCC 25922)	35
Enterococcus faecalis (ATCC 51299)	20
Klebsiella pneumoniae (ATCC 700603)	20
Candida albicans (ATCC 90028)	25
Aspergillus flavus (ATCC 28539)	30

Table 5. The effects of tested standard antibiotics against 7 different microorganisms tested (inhibition zone diameters = mm)

Standart antibiyotikler	***S. aureus ATCC 25923***	***P. aeruginosa ATCC 27853***	***E. coli ATCC 25922***	***E. faecalis ATCC 51299***	***K. pneumoniae ATCC 700603***	***C. albicans ATCC 90028***	***A. flavus ATCC 28539***
Ampicillin	*	*	*	18	*	*	*
Cefoxitin	27	*	*	*	*	*	*
Ciprofloxacin	*	30	35	*	35	*	*
Fluconazol	*	*	*	*	*	22	*
Amphotericin B	*	*	*	*	*	*	28

(*) *nongrowth*

The effect of fig seed oil on the standard microorganism strains is shown in Table 1. The inhibition zone diameters measured for the same microorganisms for the antibiotics used for control are given in Table 2. In this study, fig seed oil had effective on *S. aureus, E. aeruginosa, E. coli, E. faecalis, and K. pneumoniae strains, C. albicans* and *A. flavus* fungal strains as in vitro. When were compared the inhibition diameters obtained with antimicrobial and antifungal drugs used for positive control and the inhibition diameters obtained with fig seed oil, it was found that fig kernel oil had a strong effect for gram positive bacteria. While fig seed oil showed a strong antibacterial effect on *E. coli* from gram negative bacterias, the effect determined for *P. aeruginosa* and *K. pneumoniae* was found to be weaker than the antibiotic effect used for positive control. For fungi tested in yeast and mold, antifungal activity was found to be similar to antifungal drugs used for positive control. It has been shown that fig oil seed is effective at varying degrees of yeast and mold fungi to gram-positive and gram-negative bacterial strains tested in vitro. Tabassum and Vidyasagar [31] investigated antimicrobial activity of *Cocos nucifera, Helianthus annus, Brassica juncea, Ricinus communis, Arachis hypogea, Glycine max, Gossypium hirsutum and Sesamum indicum* oils against bacterisa and fungi (*Escherichia coli, Trichophyton rubrum* and *Candida albicans*) by agar well diffusion method. *Helianthus annus* seed oil showed maximum antimicrobial activity against tested bacteria and fungi with MIC values ranging from 0.62 to 40 mg/mL using inhibitory zone estimation, followed by Ricunus Communis, *Cocos nucifera, Brassica juncea, Sesamum indicum, Gossypium hirsutum, Glycine max* and *Arachis hypogea.* Sunflower seed oil was affective on microorganisms such as *Staphylococcus aureus, Bacillus subtilis, E.coli* and *C.albicans* which commonly involved in urinary tract infection [32]. *Kushwah and Singh* [33] reported the antimicrobial activity of *Ricinus communis* seed against *E.coli, B. subtilis, B. cereus, S. aureus, C. glabrata* and *C. albicans* and revealed methanolic seed extract with strongest antibacterial activity against *E.coli* (15mm). Antimicrobial activity of Cassava (*Manihot esculenta* Crantz) seed oil was investigated using agar-well diffusion method against *Staphylococcus aureus, Propionibacterium acnes, Escherichia coli, Pityrosporium ovale* and *Candida albicans* which were isolated from skin infections, and cassava seed oil had inhibitory effect on the growth of all the test isolates [12]. The results revealed that all the seed oils are potent antimicrobials against all the microorganisms tested. There is the need to further conduct in vivo studies with the oils.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

References

1. Joseph B, Justin Raj S., Pharmacognostic and phytochemical properties of *Ficus carica* IJPRIF 3,8-12.
2. Ficsor E, Szentmihályi K, Lemberkovics E, Blázovics A, Balázs A. Analysıs of *Ficus carıca* l. -volatıle components and mıneral content. *Eur Chem Bull*., **2013**, *2*, 126-129
3. Slatnar A, Klancar U, Stampar F, Veberic R. Effect of drying of figs (*Ficus carica* L.) on the contents of sugars, organic acids, and phenolic compounds. *J Agric Food Chem.*, **2011**, *59*(21), 11696-11702
4. Soni N, Mehta S, Satpathy G, Gupta RK. Estimation of nutritional, phytochemical, antioxidant and antibacterial activity of dried fig (*Ficus carica*). *J. Pharm. Phytochem*., **2014**, *3*(2), 158-165.
5. Okorie O, Okonkwo TJN, Nwachukwu N, Okeke I. Potentials of Detarium microcarpum (Guill and Sperr) seed oil as a matrix for the formulation of Haloperidol injection. *Int J Pharm Sci Rev Res.* **2010**, *5*(1), 1-4.
6. Adnaik RS, Mohite SK. Analysis of physiochemical properties and fatty acid profile of *Citrullus vulgaris* seed oil. *J Chem Pharm Res.*, **2015**, *7*(4), 230-233
7. Mohamed Saleem TS. Anti-microbial activity of sesame oil. *Int J Res Phytochem Pharm*. **2011**, *1*(1), 21-23.
8. Dan B, Steven C, Erich's Andrew G. *Chinese herbal medicine: Materia Medica*, Edition 3. Vol.3, **2004**, pp.9-90.
9. Mohammad A, Syed MN.Taxonomic perspective of plant species yielding vegetable oils used in cosmetics and skin care products. *African J. Biotechnol.*, **2005**, *4*(1), 36-46.
10. Okeke NJ, Iroegbu CU, Jideofor CO, Okoli AS, Osinime CO. Antimicrobial activity of ethanol extracts of two indigenous *Nigeria spices*. *J Herbs Spices Med Plant.*, **2001**, *8*, 39-46.
11. Pawar VC, Thaker VS. In vitro efficacy of 75 essential oils against *Aspergillus niger*. *Mycoses*., **2006**, *49*, 316-323.
12. Popoola TOS, Yangomodou OD, Akintokun AK. Antimicrobial activity of Cassava seed oil on skin pathogenic microorganisms. *Res J Med Plant.*, **2007**, *1*(2), 60-64.

13. AOCS. Official Methods and recommended practices (Vol.1, 4th ed.). American Oil Chemists Society, **1990**, Champaign, IL.
14. AOCS. Official Methods and recommended practices of the American Oil Chemists`Society, **1993**, Champaign, IL:American Oil Chemists`Society
15. Yoo KM, Lee KW, Park J B, Lee HJ, Hwang IK. Variation in major antioxidants and total antioxidant activity of Yuzu (*Citrus junos* Sieb ex Tanaka) during maturation and between cultivars, *J Agric Food Chem*., **2004**, *52*, 5907-5913.
16. Hişil Y. *Instrumental Analysis Techniques* (Eng Fac Publ 55). Ege Üniversity, 1998; Bornova -İzmir. (in Turkish)
17. Skujins S. Handbook for ICP-AES (Varıan-Vista). A hort Guide To Vista Series ICP- ES Operation.Varian Int.AG Zug.Version 1.0. pp 29., 1998, Switzerland.
18. Dağcı EK, Dığrak M. Bazı Meyve Ekstraktlarının Antibakteriyal ve Antifungal Aktiviteleri., *KSU J Sci Eng*. **2005**, *8*(2), 1-8
19. Koç AN. Antifungal duyarlılık testleri ve klinik önemi. *Ankem. Derg*. **2012**, *26*(Ek 2), 270- 276
20. Yiğit N, Yiğit D, Özgen U, Kandemir A, Ayyıldız A. Bazı Bitki Ekstraktlarının (*Laurocerasus officinalis, Rhododendron luteum, Rhododendron ponticum, Sambucus bulus, Muscari fennifolium, Muscari masmeganus, Ornithogalum sphaerocarpum, Ornithogalum umbellatum, Mentha longifolia, Prangos ferulacea, Galium verum, Salvia limbata, Artemisia austriaca*) Antibakteriyel Aktiviteleri Üzerine Bir Araştırma. *Türk Mikrobiyol Cem Derg.*, **2003**, *33*, 269-272.
21. Molla,Y., Nedi,E., Tadesse,G., Alemayehu, H., Shibeshi,W. Evaluation of the in vitro antibacterialactivity of the solvent fractions of theleaves of Rhamnus prinoides L'Herit (Rhamnaceae) against pathogenic bacteria. *BMC Complemen. Alter Med*., **2016**, *16*, 287
22. Benli, M., Güney, K., Bingöl, Ü., Geven, F., Yiğit, N. Antimicrobial Activity of Some Endemic Plant Species from Turkey. *Afr J Biotechnol*. **2007**, *6*, 1774-1778.
23. Püskülcü H, Ikiz F. *Introdiction to Statistic*. Bilgehan Presss, p 333, **1989**, Bornova, Izmir, Turkey.(in Turkish)
24. Ennouri M, Evelyne B, Laurence M, Hamadi A. Fatty acid composition and rheological behaviour of prickly pear seed oils. *Food Chem*., **2005**, *93*, 431-437
25. Kimbonguila A, Nzikou JM, Matos L, Loumouamou B, Ndangui CB, Pambou- Tobi NPG, Abena AA, Silou Th, Scher J, Desobry S. Proximate Composition and Physicochemical Properties on the Seeds and Oil of Annona muricata grown In Congo-Brazzaville. *Res. J. Environm Earth Sci.*, **2010**, *2*(1), 13-18.
26. Noureddini H, Teoh BC, Clements DL. Densities of vegetable oils and fatty acids. *J Am Oil Chem Soc*. **1992**, *69*(12), 1184-1188.
27. Valeri D, Meirelles AJA. Viscosities of fatty acids, triglycerides, and their binary mixtures. *J Am Oil Chem Soc.*, **1997**, *74*(10), 1221–1226.
28. Jeong WS, Lachance PA. Phytosterols and fatty acids in fig (*Ficus carica* var. *mission*) fruit and tree components. *Food Chem Toxicol.*, **2001**, *66*, 278–281.
29. Muchuweti M, Birkett JW, Chinyanga E, Zvauya R, Scrimshaw M D, Lester JN. Heavy metal content of vegetables irrigated with mixture of wastewater and sewage sludge in Zimbabwe: implications for human health. *Agric Ecosystem Environ*., **2006**, *112*, 41–48.
30. Ellen G, Loon JW, Tolsma K. Heavy metals in vegetables grown in the Netherlands and in domestic and imported fruits. *Z Lebensmittel-Unt Forsch*. **1990**, *190*, 34-39.
31. Tabassum N, Vidyasagar GM. In vitro antimicrobial activity of ediblke oils against human pathogens causing skin infections. *Int. J. Pharm Sci Res*. **2014**, *5*(1), 4493-4498.
32. Eromosele IC, Eromosele CO, Akintoye AO, Komolafe TO. Characterization of oils and chemical analysis of the Seeds of wild plants. *Plant Food Hum Nutr*. **1994**, *46*, 361-65.
33. Kushwah P, Singh KP. Antimicrobial activities of *Ricinus communis* against some human pathogens. *Int Res J Pharm.*, **2012**, *3*(7), 209-210.