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A rapid and simple method for the determination of oil content in oil seeds- A comparative study

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Abstract

Seeds of the three varieties of oil seeds crops including Groundnut (variety Medani), Sunflower (variety Bohoth1) and Sesame (variety Gadareff) were kindly provided by Agricultural Research Center-Wad Medani,Gezira State, Sudan. According to the results of oil content, the percentage oil content using petroleum ether as a solvent, revealed a mean (%41.6) in non-toasted Groundnut, (%41.3) in toasted Groundnut, (%42) in Sunflower and (% 42.6) in Sesame seeds, using hexane a mean (%38.6) in non-toasted Groundnut, (%41.4) in toasted Groundnut, (%40.6) in Sunflower and (%39.6) in Sesame seeds, also using chloroform the mean was(%36) in non-toasted Groundnut,(%35.3) in toasted Groundnut, (%36.6) in Sunflower and (%33.6) in Sesame seed. It was clear that petroleum ether solvent was the best solvent to extract oils from Groundnut (toasted, non-toasted), Sunflower and Sesame seeds samples, followed by hexane solvent from Groundnut (toasted, non-toasted), Sunflower and Sesame seeds samples, and lastly chloroform solvent. Centrifuge machine showed efficiency of oil content in the used seeds during all the samples. In conclusion, the study revealed that using petroleum ether solvent to extract Groundnut (toasted, non-toasted), Sunflower and Sesame oils from their seeds by using centrifuge machine.

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Introduction

Vegetable oil is a substance obtained from seeds and other plant parts. Oil content, that the quantity of oil driven from different plant parts according to the source material and the extraction procedure (Barthet and Daun, 2004). The oil content is an important characteristic of the oilseed trade and also description of nutritive values with high demand of functional food (Barthet and Daun, 2004; Abdalla *et al*., 2021). For this context and others, plant breeders continually demand improved varieties of oil seed crops with high oil content (Abdalla *et al*., 2021). Besides, crude oil considered an important economic resource, many industry byproduct applications of vegetable oil including flour, oil cakes, meals and groats (Smeu *et al*., 2022). However, most edible oils contain biological components as a source of benefit health protection against many diseases (Tian *et al*., 2023). Groundnut (*Arachis hypogaea* L.) is ranked as one of the most important oil seed crops and is currently cultivated throughout the world for the production of high-quality oil. China and India are the leading producers in Asia (Nautiyal, 2002). It is also produced in several African countries. In Sudan, groundnut ranks as the second major oilseed crop and accounts for 17 percent of the world export trade (Nautiyal, 2002; Yousif *et al*., 2015). Besides essential minerals and vitamins, it contains (48-50%) oil, (26-28%) protein, and (10-20%) carbohydrates (Sreedhar *et al*., 2020). Sunflower (*Helianthus annuus*) is one of the important oil crops cultivated throughout the world, and seed oil ranked fourth in the international oilseed market after palm, soybean, and rapeseed (Abdalla *et al*., 2021). Chemically, the oil contains about 90% fatty acids, 9% phytosterols and 1% vitamin E (Rauf *et al*., 2020). Sunflower seed oil contains biological activities to cure and helps to protect against many diseases such as cardiovascular disease, bronchial, laryngeal, and pulmonary infections, coughs and colds, and whooping cough (Bashir *et al*., 2015; Staughton, 2019; Rauf *et al*., 2020; Abdalla *et al*., 2021). Sesame (*Sesamum indicum* L.) is considered a leading plant grown in China, India, Sudan, Japan, Mexico and many other countries, and sesame seed oil has ranked as one of the higher stable and healthiest oils (Oboulbiga *et al*., 2023). Chemically, it contained (50-60%) oil, (18-25%) protein, carbohydrates and ash (Gharby *et al*., 2017). Pharmacologically, sesame oil contains many biological antifungal antiviral,anti-inflammatory, anti-carcinogenic and mildly laxative (Zaid *et al*., 2019; Trad *et al*., 2023). In addition, seeds and oil possess antioxidant compounds such as sesamin, sesamolinol and sesamolin (Rosalina *et al*., 2021). On the other hand, many techniques have been possessing for oil extraction such as solvent extraction, pressing, maceration, distillation, centrifugation and others. Solvent extraction is the most widely used method, organic solvents including n-hexane have been ranked as the best available solvent for oilseed extraction (Zhang *et al*., 2018; Pe´rez-Saucedo *et al* 2021; Trad *et al*., 2023). Generally, many advantages were reported of centrifuge machines (Tamborrino *et al*., 2015; Ahire *et al*., 2018). Hence, the aim of this study was to compare of oil extraction percentages of Groundnut, Sunflower and Sesame seeds samples by using different solvents and centrifuge machines.

Materials and methods

Samples of Groundnut (*Arachis hypogaea* L.), Sunflower (*Helianthus annuus* L.) and Sesame seeds (*Sesamum indicum* L.) namely; (variety Medani, variety Bohoth1 and variety Gadareff) respectively were provided by Agricultural Research Center-Wad Medani, Gezira State-Sudan. Voucher specimens have been deposited at the Faculty of Engineering and Technology, University of Gezira as reference materials.

Preparation of seeds

The healthy dry seeds were cleaned manually, then the seeds were crushed to fine granules and kept in plastic bags.

Determination of oil content

The fine granules (2g) of seeds were rolled carefully in filter paper. Solvents (Petroleum ether, Hexane and Chloroform) and centrifuge (model: 80-1, made in China) were used for determine of oil contents. The rolled samples were placed inside the centrifuge machine tubes, small cotton pieces were also put over these rolled samples. The medium speed of the device (2000 rpm) was used. On cotton pieces 2 ml, re-

injected each 2 minutes, for 5 rounds of putting in the centrifuge machine on-and-off (the total period equal 10 minutes, whereas, the total solvent equal 10 ml for each replicate).The estimation of the oil content was depended on the weight of the sample before and after the extraction. The centrifuge machine showed efficiency about 95% in determination of oil content in the used seed samples during all time intervals. According to the efficiency extracted by the centrifuge machine the determination oil content, in addition to reduction in time and different solvents needed.

Statistical analysis

The data were analyzed by one-way analysis of variance (ANOVA) and the obtained data were subjected to an appropriate statistical tool so as to clear the differences in extraction in percentages between the test periods.

Results and discussion

Table 1 showed the efficiency of using different solvents and centrifuge machine on the extraction of non-toasted groundnut oil. Petroleum ether extracts showed highest level of oil, mean (41.6%).

Table 1. Percentage oil extracted from groundnut seeds (Non- toasted) by using centrifuge machine at the interval of five rounds for 10 minutes using different solvents

Rep.	Petroleum ether	Hexane	Chloroform
1	40	40	35
2	40	40	40
3	45	35	40
4	35	35	35
5	40	35	35
6	45	35	35
7	45	40	35
8	40	40	35
9	45	35	40
10	45	45	35
11	40	45	35
12	40	40	35
13	45	35	35
14	40	40	35
15	40	40	35
Statistical analysis			
Mean	41.6	38.6	36
SE	3.08	3.51	2.07
Max	45	45	40
Min	35	35	35
f-state		13.80909	
f-crit		3.219942	
P-value		2.46E-05	

Table 2. Percentage oil extracted from groundnut seeds (toasted) by using centrifuge machine at the interval of five rounds for 10 minutes using different solvents

Rep.	Petroleum ether	Hexane	Chloroform
1	40	40	35
2	45	45	30
3	40	40	30
4	45	40	35
5	40	40	30
6	45	45	30
7	40	45	35
8	40	40	40
9	40	40	40
10	45	40	40
11	40	40	40
12	40	40	40
13	40	40	40
14	40	40	30
15	40	45	35
Statistical analysis			
Mean	41.3	41.3	35.3
SE	0.59	0.59	1.14
Max	45	45	40
Min	40	40	30
f-state		18	
f-crit		3.219924	
P-value		2.26E-06	

Table 3. Percentage oil extracted from Sunflower by using centrifuge machine at the interval of five rounds for 10 minutes using different solvents

Rep	Petroleum ether	Hexane	Chloroform
1	40	40	35
2	40	40	35
3	40	35	35
4	45	40	35
5	45	45	35
6	40	40	30
7	40	35	35
8	40	40	35
9	40	35	35
10	35	45	40
11	45	40	40
12	45	40	35
13	45	45	35
14	45	45	35
15	45	45	40
Statistical analysis			
Mean	42	41.3	35.3
SE	0.816497	0.59	1.14
Max	45	45	40
Min	35	35	30
f-state		16.46094	
f-crit		3.219942	
P-value		5.27E-06	

The lowest amount of oil content, mean (36%) was observed in chloroform. while that of groundnut

seeds was 48% within the range of that of (Arabi, 2014) of 44.8%-51.7% in groundnut seeds. The standard oil content in groundnut seeds was 45% to 55%, while that of groundnut seeds was 48%-52% (Christov, 2012). The results obtained in this study were agreed with the minimum values of these ranges (Table 2). The data obtained showed that, the percentage of oil extract from groundnut seeds (toasted). Petroleum ether extracts and hexane both were the same, mean (41.3%).

Table 4. Percentage oil extracted from Sesame seeds by using centrifuge machine at the interval of five rounds for 10 minutes using different solvents

Rep.	Petroleum ether	Hexane	Chloroform
1	45	40	35
2	40	40	35
3	45	40	35
4	40	40	35
5	40	40	30
6	45	35	30
7	40	45	35
8	40	40	35
9	50	40	35
10	40	40	35
11	45	40	35
12	50	35	30
13	40	40	35
14	40	40	30
15	40	40	35
Statistical analysis			
Mean	42.6	39.6	33.6
SE	0.959497	0.590937	0.5909337
Max	50	45	40
Min	40	35	30
f-state		38.91176	
f-crit		3.2219942	
P-value		2.75E-10	

Table 5. Descriptive analysis from all tested seeds

Summary	Count	Sum	Average	Variance
non gr	3	116.2	38.73	7.85
Toas gr	3	117.99	39.33	12
Sunfl	3	119.2	39.73	7.85
Sesam	3	116.01	38.67	21
Petroleum ether	4	167.6	41.9	0.34
Hexane	4	160.2	40.05	1.39
Chloroform	4	141.6	35.4	1.60

Table 6. ANOVA analysis from all tested seeds

Source	SS	Df	MS	F	*p*-value	F crit.
Rows	2.32	3	0.77	0.60	0.6366	4.76
Columns	89.73	2	44.86	35.01	0.0005	5.14
Error	7.69	6	1.28			
Total	99.73	11				

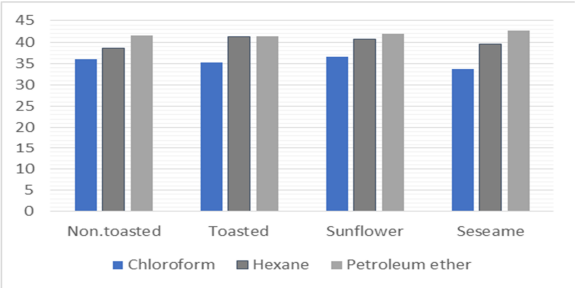

Fig. 1. Mean oil extract (%) from all tested seeds by using different solvents

The lowest amount of oil content (35.3%) was observed in chloroform. while that of groundnut seeds was 48% within the range of that of (Arabi, 2014), of (44.8% - 51.7%) in groundnut seeds. The standard oil content in groundnut seeds was 45% to 55% while that of groundnut seeds was (48%-52%) (Christov, 2012). The results obtained in this study were agreed with the minimum values of these ranges. Table 3 showed the efficiency of using different solvents and centrifuge machine on the extraction of sunflower seeds. The percentage of oil extract showed petroleum ether extracts are the highest level, mean (42%). The lowest amount of oil content, mean (36.6%) was observed in chloroform. While that of the results obtained from using hexane and Soxhlet extractor revealed that, the extraction percentages of sunflower seeds were 43% within the range of that of (Ahmed, 2013), who found 39%-45% (mean 41.6 %) of oil contents in sunflowers. The seeds of Sunflowers contain bioactive compounds (Abdalla *et al.*, 2021). Table 4 showed the efficiency of using different solvents and centrifuge machine on the extraction of sesame seeds. The obtained oil content petroleum ether, hexane and chloroform extracts were mean (42.6%), (39.6%) and (33.6%) respectively. Sesame seeds contain 40-50% oil (Salunkhe *et al.*, 1992). El Harfi and co-workers in a previous study showed the oil content in 13 (*Sesamum indicum* L.) cultivars and reported that oil content varied from 53.24 to 66.87%, with an average value of 60.89%). Descriptive analysis (Table 5) revealed that, the mean % extraction ratio from the all used samples of seeds was 41.9 for petroleum ether, 40.05 for hexane and 35.4 for chloroform solvents (Fig. 1). ANOVA analysis (Table 6) revealed a

significant difference between solvents (f=35.1; f-crit=5.14), petroleum ether is the best solvent to be used for extraction of oil from these seeds, followed by hexane and lastly, chloroform. In conclusion, the estimation of the oil content depended on the weight of the samples before and after the extraction, petroleum ether solvent was the best solvent to extract oils, followed by hexane and chloroform. Centrifuge machine showed efficiency of oil content in the used seeds during all the samples.

References

Abdalla AAA, Yagi S, Abdallah AH, Abdalla M, Abdalla M, Zengin G, Sinan KI. 2021. Phenolic profile, antioxidant and enzyme inhibition properties of seed methanolic extract of seven new sunflower lines: From fields to industrial applications. Process Biochemistry **111** (2), 53-61.

Ahmed T. 2013. The Effect of x-rays on physical and chemical characteristic of first generation (F1) Sesame Sesame (*Sesamum indicum* L.) and Sunflower (*Helianthus annuus*) seeds. M.Sc. thesis, University of Gezira, Sudan.

Ahire R, Mandale P, Thakare S, Wagh K. 2018. Centrifugal Oil-Burr Separator Machine. International Research Journal of Engineering and Technology **5**(3), 2538-2540.

Arabi HN. 2014. Effect of x-ray gamma rays and ultra violet light on morphological characteristic and nutritional content of the first-generation groundnut (*Arachis hypogaea* L.) seeds. M.Sc. thesis, University of Gezira, Sudan.

Barthet VJ, Daun JK. 2004. Oil content analysis: myths and reality. In: Luthria DL (Ed) Oil extraction and analysis: Critical issues and comparative studies. AOCS Press, Arlington, 100-117p.

Bashir T, Zahara K, Haider S, Tabassum S. 2015. Chemistry, pharmacology and ethnomedicinal uses of *Helianthus annuus* (Sunflower): A review. Pure and Applied Biology **4**(2), 226.

Christov M. 2012. Contribution of interspecific hybridization to sunflower breeding. Helia **35**(57), 37-46.

El Harfi M, Nabloussi A, Rizki H, Ennahli S, Hanine H. 2019. Proximate Composition and Fatty Acid Composition, Phytochemical Content of Sesame (*Sesamum indicum* L.) Seeds Landrace from Morocco. Advances in Crop Science and Technology **7**(3), 426.

Gharby S, Harhar H, Bouzoubaa Z, Asdadi A, Yadini EL A, Charrouf Z. 2017. Chemical characterization and oxidative stability of seeds and oil of sesame grown in Morocco. Journal of the Saudi Society of Agricultural Sciences **16**(2), 105-111.

Meu I, Dobre AA, Cucu EM, Mustăţea G, Belc N, Ungureanu EL. 2022. Byproducts from the Vegetable Oil Industry: The Challenges of Safety and Sustainability. Sustainability **14**(4), 2039.

Nautiyal PC. 2002. Groundnut Post-Harvest Operations; Food and Agriculture Organization of the United Nations: Rome, Italy, 1-115p.

Oboulbiga EB, Douamba Z, Compaoré-Sérémé D, Semporé JN, Dabo R, Semde Z, Tapsoba FW, Hama-Ba F, Songré-Ouattara LT, Parkouda C, Dicko MH. 2023. Physicochemical, potential nutritional, antioxidant and health properties of sesame seed oil: a review. Frontiers in Nutrition 1(10), 1127926.

Pérez-Saucedo MR, Jiménez-Ruiz EI, Rodríguez-Carpena JG, Ragazzo-Sánchez JA, Ulloa JA, Ramírez-Ramírez JC, Gastón-Peña CR, Bautista-Rosales PU. 2021. Properties of the avocado oil extracted using centrifugation and ultrasound-assisted methods. Food Science Biotechnology **30**(8), 1051-1061.

Rauf S, Warburton M, Naeem A, Kainat W. 2020. Validated markers for sunflower (*Helianthus annuus* L.) breeding. OCL **27**, 47.

Rosalina R, Weerapreeyakul N. 2021. An Insight into Sesamolin: Physicochemical Properties, Pharmacological Activities, and Future Research Prospects. Molecules **26**(19), 5849.

Salunkhe DK, Chavan JK, Adsule RN, Kadam SS. 1992. World oilseeds: Chemistry, technology, and utilization. New York: Van Nostrand. Reinhold.

Smeu I, Dobre AA, Cucu EM, Mustăţea G, Belc N, Ungureanu EL. 2022. Byproducts from the Vegetable Oil Industry: The Challenges of Safety and Sustainability. Sustainability **14**(4), 2039.

Sreedhar M, Singh DV, Reddy DC, Vasudha A. 2020. Biochemical changes in groundnut pods due to infestation of bruchid *Caryedon serratus* (Olivier) under stored conditions. Journal of Stored Products Research **88**, 101678.

Staughton J. 2019. The amazing benefits of sunflower oil. Oilseeds Focus **5**(2), 40-41.

Tamborrino A, Leone A, Romaniello R, Catalano P, Bianchi B. 2015. A Comparative experiment to assess the performance of an innovative horizontal centrifuge working in a continuous olive oil plant. Biosystems Engineering **129**, 160-168.

Tian M, Bai Y, Tian H, Zhao X. 2023. The Chemical Composition and Health-Promoting Benefits of Vegetable Oils-A Review. Molecules **28**(17), 6393.

Trad S, Chaabani E, Aidi Wannes W, Dakhlaoui S, Nait Mohamed S, Khammessi S, Hammami M, Bourgou S, Saidani Tounsi M, Fabiano-Tixier AS, Bettaieb Rebey I. 2023. Quality of Edible Sesame Oil as Obtained by Green Solvents: In Silico versus Experimental Screening Approaches. Foods **12 (17),** 3263.

Yousif AI, Mohamed IS, El Naim M, Elobeid HA, Ahmed AE. 2015. Estimating Technical Efficiency of Groundnut (*Araches hypogaea* L.) Production in New Halfa Agricultural Production Corporation, Sudan. International Journal of World Policy and Development Studies **1**(1), 16-20.

Zaid AN, Jaradat N, Malkieh N, Al-Rimawi S, Hussein F, Isa L. 2019. Impact of sesame oil source: a quality assessment for Cosmeceutical and pharmaceutical use. FABAD Journal of Pharmaceutical Science **44**(3), 189-96.

Zhang QW, Lin LG, Ye WC. 2018. Techniques for extraction and isolation of natural products: A comprehensive review. Chinese Medicine **13**, 20.