

# Extraction of Oil from Waste Date Seed Using Soxhlet Extraction Apparatus

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**Abstract:** Soxhlet extraction is the most common technique for oil seed extraction. Date seed oil is obtained from date seed through Soxhlet extraction technique. Three factors affect the performance of extraction of date seed oil particle size, type of solvent and time of extraction. The % yield and % recovery of date seed oil using methanol as a solvent. % Yield for different feed to solvent ration are 9.6, 10.4, 11.6, 12 and 12.4 for 1:2, 1:3, 1:4, 1:5 and 1:6 resp. % recovery for different feed to solvent ration are 83.8, 80, 89.2, 92.3 and 95.3 for 1:2, 1:3, 1:4, 1:5 and 1:6 resp. As per observation methanol is the best suitable for extraction of date seed oil from the date seed and 1:4 will be the optimum feed to solvent ratio in which up to 90 % recovery of oil from date seed. The optimum value for feed to solvent is 1:4 on which maximum yield for date seed oil extraction. As the feed to solvent ration increase more than 1:4 there is appreciable change in the yield but the cost of solvent increase. The 1:4 feed to solvent ration is to be optimum value for date seed oil extraction. According to various literatures Soxhlet extraction process best technique for extraction of solute having low solubility in solvent. In Soxhlet extraction based on the boiling point of solvent and again & again extraction take place in this method. Date seed oil is one of the most components of the date seed contain 5–13 % of date seed. The extraction of date seed oil carried out 2-3 hrs. The optimum time for extraction is 2.5-3 hrs. for extraction of oil from date seed. As per observation methanol is the best suitable for extraction of date seed oil from the date seed. Methanol can easily separate after extraction and has higher yield than other with low cost. Maximum % yield and % recovery for solvent Methanol shows the 12.2 % and 95 % resp. Extraction carried out at boiling temperature of solvent should be better for rate and yield of extraction. Temperature for extraction with methanol as solvent at 60-65°C.

**Keywords:** Soxhlet Extraction, Date Seed Oil, Methanol, Solvent Extraction Process.

## I. INTRODUCTION

Date seed is a byproduct of date fruit industry which is normally being discarded, used as animal feed ingredient or turned into non-caffeinated coffee by the Arabs. About 11- 18% of date fruit weight is the seed which is composed of carbohydrates, dietary fiber, fat, ash and protein. The antioxidant content in date seed oil (DSO) was found to be comparable with olive oil which can be as a good source of antioxidant in order to fulfill the consumers' demand. Date seed oil is one of the most components of the date seed contain 5–13 % of date seed. Date seed is composed of proteins, carbohydrates and lipids, which is either in wax, fat or oil form. The oil content is the most important for seed germination as the oil can supply twice the energy needed for the germination process compared to proteins and carbohydrates. About 11- 18% of the date fruit weight comes from the seed. Date seed can be as a good source of dietary fiber, phenolic component and natural antioxidant which can be further developed into new products or already existing products.

### Applications of Date Seed Oil [2]

1. Based on fatty acid composition of date seed oil suggested use for methods nutritional purpose.
2. As edible cooking oil and also for the production of margarine due to the high stability.
3. Resistance of date seed oil to thermal treatment which indicate the good shelf life and storability of this oil even for a long period of time.

4. Different degree of unsaturation of date seed oil compared to other vegetable oil make it as potential oil that can be developed for different use.
5. It is an excellent source of important lipid-soluble antioxidant compounds which reducing the risk of many diseases.
6. Date seed oil from human food (cooking, frying, seasoning, or shortening oil)
7. Date seed oil also use in pharmaceutical and cosmetic applications.
8. Date seed oil has an absorbance in the range of ultraviolet (UV)-C (100-290 nm) and UV-B (290- 320 nm) so the date seed oil use as an ingredient of UV protector products.
9. The application of date seed oil on the skin has approved the protective effects against the damage due to the exposure to UV-B irradiation when it was compared with skin that was applied with the date seed oil.
10. The presence of natural antioxidants such as phenols and tocopherols in date seed oil was capable to prevent keratinocytes oxidative damage caused by the exposure of hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) on the skin.
11. The use of this oil for nutritional purpose as edible cooking oil and also for the production of margarine due to the high stability
12. Resistance of date seed oil to thermal treatment which indicate the good shelf life and storability of this oil even for a long period of time.

## II. LITERAURE REVIEWS

Oil extraction studied for four particle size ranges (0.212-1mm, 1-2.36 mm, 2.36-3.35mm, 3.35-5mm) using different solvents. The best particle size that gives higher oil yield was the range of 0.212 - 1mm. The relatively highest oil yield was found for methanol. For particle size smaller than 1 mm ethanol gives relatively higher oil yield. Long extraction time (up to 4 hours) gives better results of oil yield. Methanol can be used successfully for the extraction of date seed oil due to the extraction results obtained and its moderate boiling point. [1] The date seed is cleaned, dried and ground to rupture the oily cells making the oil available to the solvent. The extraction yield is related to the degree of accessibility of the solvents to the oil- containing cells. Soxhlet extraction is the most common technique for oil seed extraction. Extraction yield 5% (chloroform, hexane) at 4 hrs. and Extraction yield 1% (propanol, methanol) at 4 hrs. The yield is better with non-polar solvents (n- hexane, chloroform) compared to polar solvents (methanol and propanol). Extraction yield 8.5%, hexane at 50 g, 78 OC, 3 hrs. Extraction yield 4.44 % at hexane for 8 hrs. Oil yield 9.78, 8 and 9.5%, methanol, ethanol and acetone respectively. The best conditions were found using methanol B.P.+ 15 OC, particle size range of 0.212–1 mm, 4 h. [3] The highest oil yield of 8.2% followed by Roasting (7.9%) and Soaking (7.8%) and least oil (7.2%) yield obtained in Soaking + Roasting (7.2%) sample. The decrease in particle size leads to increase of oil yield. The increased surface area of grounded seed. The contacted area between seed and solvent increased and the mass transfer of oil from the solid phase to the liquid phase increased accordingly.[6] Two solvents use petroleum ether as pure solvent for classical extraction method and essential oil + water” (60% + 40%) as azeotrope solvent for green extraction. Solvents firstly removed by a rotary evaporator and then placed at 40 OC overnight to remove excess of the solvent. Date seed powder placed in a dark flask and homogenized with essential oil. After mixing for six hours at 45 OC. The mixture was centrifuged. Liquid phase used to recover the essential oil and the DPSO yielded. Concerning Soxhlet method the extracted DPSO using petroleum ether had a maximum yield of 9.8% and achieved after four hours of extraction and green solvent maximum oil rate of 9.25% since the second hour of extraction. Soaking method using essential oil gave highest yield and maximum value 13.88% obtained after two hours of extraction. [9] The 500 mL distillation flask of the apparatus was containing 250 mL of n-hexane which solvent for the extraction. Using a temperature of 55 OC and refluxing for a period of 4 hr. desert date seed oil extracted. The thimble carefully removed and collected n-hexane in the top container of apparatus drained into another container for reuse. The oil then dried using atmospheric air so that it would be free of n-hexane. The same procedure repeated for the particle size of 1.8 mm at the same temperature but for 7 hr. [12] The dried date seed powder (4 g) was loaded into the thimbles and 40 ml of various solvents, petroleum ether (PE), chloroform, methanol mixture (2:1) MCM and hexane used for extraction over range of temperature (100-180 OC) and time (0.5-4 h) were tested. After oil extraction the solvent was evaporated at 60 OC using a Rotavapor apparatus. The pure oil was stored in a freezer (–20°C) prior to subsequent Physico-chemical analyses and PHB production. The amount of oil extracted was determine as difference in dry weight. The oil yield increases with time for all the solvents

tested and that the rate of extraction is high during the first three hours. The maximum quantities of oil recovered were 9.3%, 5.4% and 3.5% with the MCM, hexane and PE when the extraction process lasted for four hours. The high initial extraction rate was due to the mass transfer driving force being large when the oil concentration in the fresh solvent low. Extraction rate subsequently decreased with increasing oil concentration in solvent due to reduction in mass transfer driving force. [15]

#### **Chemicals and Raw Materials**

1. Waste Date Seed
2. Methanol

#### **Apparatus Requires**

1. Soxhlet Apparatus
2. Simple Distillation
3. Digital Thermometers
4. Heating Element/Mental
5. Measuring Cylinders
6. Beaker and Filter Papers

#### **Extraction of Oil by Using Soxhlet**

The color of seeds was off white and the moisture content was found to be 4%. Crushing the seeds before extraction makes the oil extraction easier and efficient. This process ruptures the cell wall which helps in easy oil release. Seeds were then heated in oven for 2 hours at 105 OC. Heat treatment also offers the easy oil release by driving moisture out of the seeds. The pre-treatment of seeds prior to solvent extraction increases the surface area and makes solvent penetration easier which results in effective oil extraction. After pre-treatment and heat treatment solvent extraction assembly was set up. Benzene, n-hexane and mixed solvent system were utilized for oil extraction. Soxhlet extractor was used for the extraction of oil from the seed with petroleum ether solvent. Extraction was done which the solvent was covered by simple distillation. The oil was allowed to cool in a desiccator before being weighed. The extracted oil was well sealed in dark brown colored glass bottle and kept for analysis. Find the various properties and % yield of oil. The oil was extracted using n-hexane as solvent in the Soxhlet extractor.

#### **Extraction with Methanol at 1:2 Feed to Solvent Ration**

1. Take 50 gm date seed are dried in oven or sunlight to remove the moisture.
2. Crush the date seed to form powder.
3. Take 1: 2 ratios of date seed powder to methanol (100 ml).
4. Take cotton cloth or filter paper and date seed powder in cloth or filter paper.
5. Put cloth or filter paper in thimble of Soxhlet Extraction apparatus contains seed powder.
6. Take 100 ml of the methanol as solvent in round bottom flask of Soxhlet.
7. The mixture was then heated at 60 OC- 65 OC (B.P. solvent) for 2-3 hrs.
8. After extraction removal of round bottom flask from Soxhlet apparatus.
9. Date seed oil to be separated from the solvent using simple distillation.
10. Separation by simple distillation carried out at temperature 60-65 OC.
11. In distillation petroleum ether recover as top product and oil as a bottom product.
12. Calculate % recovery or yield of date seed oil.

#### **Extraction with Methanol at 1:4 Feed to Solvent Ration**

1. Take 50 gm date seed are dried in oven or sunlight to remove the moisture.
2. Crush the date seed to form powder.
3. Take 1: 4 ratios of date seed powder to methanol (200 ml).

4. Take cotton cloth or filter paper and date seed powder in cloth or filter paper.
5. Put cloth or filter paper in thimble of Soxhlet Extraction apparatus contains seed powder.
6. Take 200 ml of the methanol as solvent in round bottom flask of Soxhlet.
7. The mixture was then heated at 60 OC- 65 OC (B.P. solvent) for 2-3 hrs.
8. After extraction removal of round bottom flask from Soxhlet apparatus.
9. Date seed oil to be separated from the solvent using simple distillation.
10. Separation by simple distillation carried out at temperature 60-65 OC.
11. In distillation petroleum ether recover as top product and oil as a bottom product.

#### Economics

1. Date seed contain 5–13 % of date seed oil which economical for extraction of oil.
2. Oil extracted from waste material to be available in the market easily with very low cost.
3. Selected method for oil recovery also economical and easy to operation.
4. Cost of solvent also low and it have very high recoverability.
5. Oil will be demanding due to presence of fatty acid and antioxidants property.
6. Date seed oil healthy for human daily use as cooking, frying.
7. Seed oil contained higher amounts of saturated fatty acids.
8. The oil of date seed contains high percentage of oleic and lauric acids.
9. Natural antioxidants such as tocopherol and polyphenols are found in date seed oil.
10. The oil has high oxidative stability due to low content of polyunsaturated fatty acids.

#### Observations Table for Wt. Oil Extracted

Feed to Solvent Ratio	Weight of Seed Feed	Wt. of Seed After Extraction	ml of Oil Extracted
1:2	50	45.5	4.8
1:3	50	46.2	5.2
1:4	50	46.8	5.9
1:5	50	47.3	6.0
1:6	50	47.8	6.2

Table No. Analysis of ml of Oil Extracted for Various Feed to Solvent Ratio

Table No. shows the experimental analysis for the amount of oil extracted in ml for various solvent to feed ration. As the feed to solvent ration increase the ml of oil extracted also increase. After feed to solvent ration 1:4 there is no large change in amount of oil extracted. The experiment carried out in at temperature 60-65 OC and for extraction time 2-2.5 hrs. as optimum conditions analyzed from various literature study. According to experimental analysis optimum feed to solvent ration will be 1:4.

% Yield and Recovery of Date Seed Oil

% Yield of Date Seed Oil

% Yield of Oil = [ Mass of Oil Extracted / Mass of date Seed Feed] \*100

#### 1. Yield Using 1:2 Feed to Solvent Ratio

$$\% \text{ Yield of Oil} = [4.8/50] *100 = 9.6 \%$$

#### 2. Yield Using 1:3 Feed to Solvent Ratio

$$\% \text{ Yield of Oil} = [5.2/50] *100 = 10.4 \%$$

#### 3. Yield Using 1:4 Feed to Solvent Ratio

$$\% \text{ Yield of Oil} = [5.9/50] *100 = 11.8 \%$$

**4. Yield Using 1:5 Feed to Solvent Ratio**

$$\% \text{ Yield of Oil} = [6/50] * 100 = 12 \%$$

**5. Yield Using 1:6 Feed to Solvent Ratio**

$$\% \text{ Yield of Oil} = [6.2/50] * 100 = 12.4 \%$$

**% Recovery of Date Seed Oil**

$$\% \text{ Recovery of Oil} = [\text{Mass of Oil Extracted} / \text{Max. Oil in Seed}] * 100$$

Date seed contains 9-13 % oil on weight basis on dry basis. So we consider max. value of oil 13 %. For Seed amount 50 gm max. amount of oil will be 6.5 ml.

**1. Recovery For 1:2 Feed to Solvent Ration**

$$\% \text{ Recovery of Oil} = [4.8/6.5] * 100 = 73.8 \%$$

**2. Recovery For 1:3 Feed to Solvent Ration**

$$\% \text{ Recovery of Oil} = [5.2/6.5] * 100 = 80 \%$$

**3. Recovery For 1:4 Feed to Solvent Ration**

$$\% \text{ Recovery of Oil} = [5.9/6.5] * 100 = 90.7 \%$$

**4. Recovery For 1:5 Feed to Solvent Ration**

$$\% \text{ Recovery of Oil} = [6.0/6.5] * 100 = 92.30 \%$$

**5. Recovery For 1:6 Feed to Solvent Ration**

$$\% \text{ Recovery of Oil} = [6.2/6.5] * 100 = 95.3 \%$$

**Observations Table for % Recovery and Yield**

Sr. No.	Feed to Solvent Ration	% Yield of Oil	% Recovery of Oil
01	1:2	9.6	83.8
02	1:3	10.4	80
03	1:4	11.6	90.7

Table No. % Yield of Date Seed Oil for Different Solvents

Observation table shows the % yield and %

The ration of feed to solvent also important factor to be consider for extraction process which effect on the yield of oil. The optimum value for feed to solvent is 1:4 on which maximum yield for date seed oil extraction. As the feed to solvent ration increase more than 1:4 there is appreciable change in the yield but the cost of solvent increase. The 1:4 recovery of date seed oil using methanol as a solvent. % Yield for different feed to solvent ration are 9.6, 10.4, 11.6, 12 and 12.4 for 1:2, 1:3, 1:4, 1:5 and 1:6 resp. % recovery for different feed to solvent ration are 83.8, 80, 89.2, 92.3 and 95.3 for 1:2, 1:3, 1:4, 1:5 and 1:6 resp. As per observation methanol is the best suitable for extraction of date seed oil from the date seed and 1:4 will be the optimum feed to solvent ratio in which up to 90 % recovery of oil from date seed.

**Factors Affected on the Yield of Date Seed Oil**

**1. Size of Date Seed**

Size of date seed oil has influence on the recovery of oil and recovery of oil small size date seed is more than large size. Crushed seed in powdered form gives large surface area for solid-liquid contact. Due to small size particles increase rate as well as yield of extraction of oil from date seed.

## **2. Moisture Content of Date Seed**

By the Experimental analysis the moisture content of the date seed at the time of oil extraction has a great influence on the extraction recovery of the oil. Moisture should be lower for increase rate and yield of extraction.

## **3. Feed to Solvent Ratio**

Feed to solvent ration is to be optimum value for date seed oil extraction.

## **4. Solvent for Extraction**

Selected solvent should be easily separated from the oil and giving high yield operation with low cost. Solvent like methanol are best suitable for extraction of oil. As per experimental analysis methanol shows the higher yield than the other. As per observation methanol is the best suitable for extraction of date seed oil from the date seed. Methanol can easily separate after extraction and has higher yield than other with low cost. Maximum % yield and % recovery for solvent Methanol shows the 12.2 % and 95 % resp.

## **5. Time of Extraction**

As the time range of extraction increased the date seed oil yield increases but up to a limit. The time of extraction increased yield of oil also increase and up to maximum level. The extraction of date seed oil carried out 2-3 hrs. The optimum time for extraction is 2.5-3 hrs. for extraction of oil from date seed.

## **6. Temperature**

At the lower temperature the yield of oil is low while at high temperature it Combustible. As compared to low and high temperature range the oil yield is high at moderate temperature. Extraction carried out at boiling temperature of solvent should be better for rate and yield of extraction. Temperature for extraction with methanol as solvent at 60-65 OC.

## **Economics**

1. Date seed contain 5–13 % of date seed oil which economical for extraction of oil.
2. Oil extracted from waste material to be available in the market easily with very low cost.
3. Selected method for oil recovery also economical and easy to operation.
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9. Natural antioxidants such as tocopherol and polyphenols are found in date seed oil.
10. The oil has high oxidative stability due to low content of polyunsaturated fatty acids.

## **III. FUTURE SCOPE AND DEVELOPMENT**

Date seed is composed of proteins, carbohydrates and lipids which is either in wax, fat or oil form. The oil content is the most important for seed germination as the oil can supply twice the energy needed for the germination process compared to proteins and carbohydrates. The antioxidant content in date seed oil (DSO) was found to be comparable with olive oil which can be as a good source of antioxidant in order to fulfill the consumers' demand. Dates are the fruit of the palm tree. It has a very important nutritional value. It has been considered an important food in the past. We can optimize the parameters for increase rate of extraction and yield of oil with low cost solvent. Dates contain a large proportion of important minerals for the human body in its construction and protect it from many of the disease. Date seed oil from human food (cooking, frying, seasoning, or shortening oil). Date seed oil also use in pharmaceutical and cosmetic applications. The application of date seed oil on the skin has approved the protective effects against the damage due to the exposure to UV-B irradiation when it was compared with skin that was applied with the date seed oil. The use of this oil for nutritional purpose as edible cooking oil and also for the production of margarine due to the high stability.



Resistance of date seed oil to thermal treatment which indicate the good shelf life and storability of this oil even for a long period of time. According to all above applications there we understand the scope of date seed oil for human and animals use. Date seed oil is beneficial product which extracted from the waste product. Solvent have low cost and can be recycle which has high recoverability.

#### **IV. CONCLUSION**

Solvent extraction is one of the traditional techniques of extracting vegetable oil. Oil seeds is one of the cheapest sources, applied to produce oil from seeds. Rate of extraction of oil from date seed depends on type of solvent, partial size of date seed, time of extraction and temperature. Three factors affect the performance of extraction of date seed oil particle size, type of solvent and time of extraction. Conventional extraction for date seed oil with different solvents (petroleum ether, hexane, chloroform, methanol etc.) using the maceration and Soxhlet methods. Soxhlet extraction is the most common technique for oil seed extraction. Date seed oil is obtained from date seed through Soxhlet extraction technique. The date seed oil is mainly composed of the four fatty acid namely oleic, linoleic, lauric and palmitic acid.

The % yield and % recovery of date seed oil using methanol as a solvent. % Yield for different feed to solvent ration are 9.6, 10.4, 11.6, 12 and 12.4 for 1:2, 1:3, 1:4, 1:5 and 1:6 resp. % recovery for different feed to solvent ration are 83.8, 80,89.2, 92.3 and 95.3 for 1:2, 1:3, 1:4, 1:5 and 1:6 resp. As per observation methanol is the best suitable for extraction of date seed oil from the date seed and 1:4 will be the optimum feed to solvent ratio in which up to 90 % recovery of oil from date seed.

The optimum value for feed to solvent is 1:4 on which maximum yield for date seed oil extraction. As the feed to solvent ration increase more than 1:4 there is appreciable change in the yield but the cost of solvent increase. The 1:4 feed to solvent ration is to be optimum value for date seed oil extraction.

According to various literatures Soxhlet extraction process best technique for extraction of solute having low solubility in solvent. In Soxhlet extraction based on the boiling point of solvent and again & again extraction take place in this method. Date seed oil is one of the most components of the date seed contain 5–13 % of date seed.

As the time range of extraction increased the date seed oil yield increases but up to a limit. The time of extraction increased yield of oil also increase and up to maximum level. The extraction of date seed oil carried out 2-3 hrs. The optimum time for extraction is 2.5-3 hrs. for extraction of oil from date seed.

Selected solvent should be easily separated from the oil and giving high yield operation with low cost. Solvent like methanol are best suitable for extraction of oil. As per experimental analysis methanol shows the higher yield than the other. As per observation methanol is the best suitable for extraction of date seed oil from the date seed. Methanol can easily separate after extraction and has higher yield than other with low cost. Maximum % yield and % recovery for solvent Methanol shows the 12.2 % and 95 % resp.

At the lower temperature the yield of oil is low while at high temperature it Combustible. As compared to low and high temperature range the oil yield is high at moderate temperature. Extraction carried out at boiling temperature of solvent should be better for rate and yield of extraction. Temperature for extraction with methanol as solvent at 60-65 OC.

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