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Optimization of Amla Seed Oil Extraction: A Solvent-Based Comparative Study

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Abstract: the study was conducted in order to compare the effects of the four distinct solvents—hexane, methanol, chloroform, and petroleum ether on the basis of oil yield and quality, with a particular focus on the acid value, the current study examines the extraction of amla (*Emblica officinalis*) seed oil. The extraction method has a significant impact on the utilization and efficacy of amla seed oil, which is well-known for its medicinal, nutritional, and cosmetic uses. To ensure uniformity, the extractions were conducted under identical conditions, and to assess the efficacy and quality, measurements were made from the oil yield (%) and acid value (mg KOH/g).

Methanol, a polar solvent, produced the most oil (20%) of all the solvents studied, but it also produced the highest acid value (30.85 mg KOH/g), indicating a large amount of free fatty acids and poorer oil stability. With an acid value of 22.44 mg KOH/g and a modest yield of 15%, hexane, a non-polar solvent, indicated a significant degree of hydrolysis. Petroleum ether produced the lowest yield at 9% with a comparatively lower acid value of 19.63 mg KOH/g in comparison to the other methods, whereas chloroform produced a 10% oil yield with an acid value of 28.05 mg KOH/g.

The data show a clear inverse link between solvent polarity and oil purity—more solvents that are polar in nature extract more oil but incorporate more free fatty acids, raising the acid value. Non-polar solvents, such as petroleum ether and hexane gives higher oil quality at the cost of lower yield. As a result, the solvent used in extraction process should be determined by the intention of application: use of methanol for better yield if refinement is possible, and petroleum ether for higher purity where oil quality is required. This study highlights the significance of solvent selection in increasing the efficiency and functionality of organic oil extractions.

Keywords : Amla seed oil, oil yield, polarity, acid value, extraction efficiency, free fatty acid.

1.Introduction:

Indian Gooseberry, (*Emblica officinate*) commonly known as Amla. It may be a wealthy source of Vitamin C but additionally also contain ascorbic acid the quantity of ascorbic acid may change from 0.9 to 1.3 percent. A tree "*Phyllanthus emblica"* of the subtropical South and Southeast Asia bearing acrid natural products. They are circular with six to eight vertical sections and little in size. They are believed to be of high standing within the Ayurvedic medicine and a great additive for most condiments.[1]

The extricates from various parts of *E. officinalis*, especially natural product, contain many phytoconstituents viz. higher number of polyphenols like gallic acid, ellagic acid, distinctive tannins, minerals, vitamins, amino acids, settled oils, and flavonoids like rutin and quercetin[2]

The extract or plant is known to be resistant to broadened afflictions like inflammation, cancer, osteoporosis, neurological clutters, hypertension in conjunction with way of life infections, parasitic and other infectious clutters..[3]

The AMLA is used for the treatment of a range of infections, though the most significant part is the fruit. The fruit is used either alone or in combination with other plants for the treatment of various diseases including common cold and fever; as a diuretic[2], Anti-viral[4], Ulcer protective[5], Anti-diarrheal[6],anti oxidant[7],anti cancer[2,8], Arthritis[9], gastroprotective[10]

Amla and a few of its phytochemicals like gallic acid, ellagic acid, pyrogallol, a few nor sesquiterpenoids, correlation, geraniin, elaeocarpusin, and prodelphinidins B1 and B2 too displayed anticancer action. Amla contains radio modulatory, chemo modulatory, chemo preventive impacts, free radical rummaging, antioxidant, anti-inflammatory, antimutagenic, and immunomodulatory exercises, properties that are solid within the treatment and avoidance of cancer.[2]

The seed of *Emblica officinalis*_carries great pharmacological value as they offer anti oxidant, anti microbial and anti inflammatory properties.[11] The leaf extract of amla shows heigh anti microbial activity against Staphylococcus aureus and E. coli and could be a potential cure for skin infection and urinary tract infection.[12]

Inside the seed coat of one amla fruit it holds 4-6 seeds. These seeds are sleek in touch and the colour of the fruit varies from brown to dark brown. Amla seeds serve as superior source to amla oil. Amla seeds are often employed to manage asthma and bronchitis.[13] amla seeds powder can also be used as remedy for menstrual problems[3]

FIG 1: Amla fruit or Emblica officinalis fruit(Indian gooseberry)

2. AMLA

2.1 NUTRITIONAL VALUE OF AMLA

Amla natural products constitute a relevant source of carbohydrates that accounts for >70 g/100 g dry weight (DW). Fiber is another relevant constituent (7.2–16.5 g/100 g DW) as well as content of protein, minerals like (press, calcium and phosphorous), and fat (2.0–4.5, 2.1–3.1, and 0.2–0.6 g/100 g DW, respectively) The variability within the composition of amla fruit has been attributed to the cultivar in many studies Ascorbic acid (vitamin C) is another important constituent of amla fruit.[14] It helps maintain healthy skin and hair, enhances digestion, and boosts immunity. Regular amla eating may also improve heart health and help control blood sugar levels.[15]

Macronutrients of amla

1.Calories: 44 kcal[16]

2.Carbohydrates: 10.2g[17]

3.Sugars: 4.4g[18]

4. Dietary Fiber: 4.3g[19]

5. Proteins: 0.9g[20]

6. Fats: 0.6g [21]

7. Saturated fats: 0.03g[22]

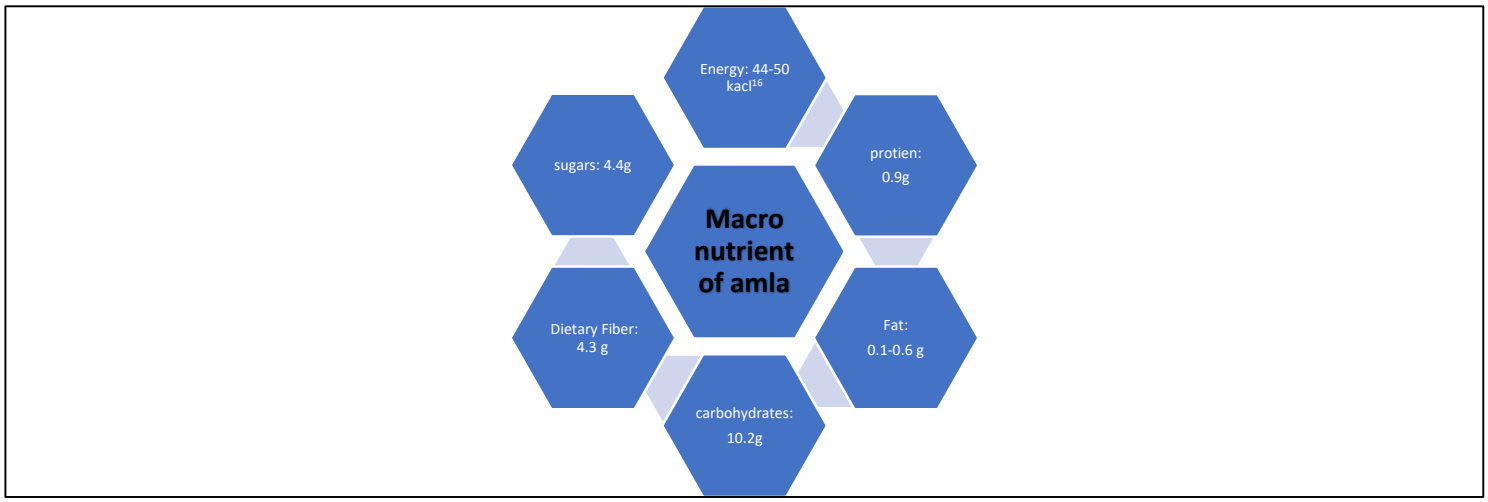

Fig 2: Macronutrients of Amla.

Micronutrients of amla

1.Vitamin C: 600–700 mg[23]

2. Vitamin A: 0.02 mg[24]

3. Vitamin B1: 0.03 mg[25]

4. Vitamin B2: 0.04 mg[26]

5. Vitamin B3: 0.2 mg[27]

6. Folate:3 µg[28]

7. Calcium: 25 mg[29]

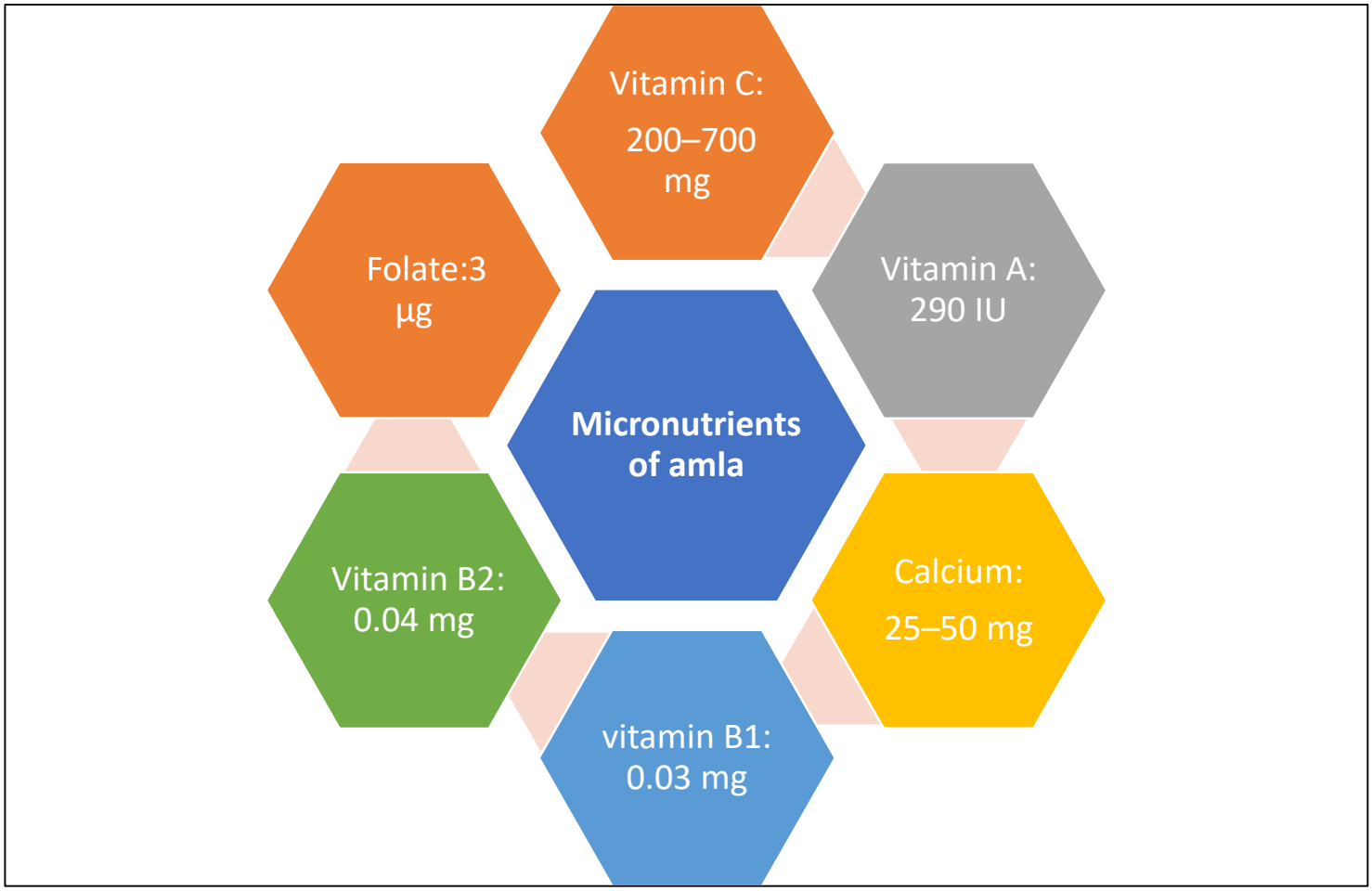

Fig 3: Micronutrient of Amla

2.2 Phytochemicals & Antioxidants present in Amla

1.Ellagic acid: Ellagic acid, which is found in amla, has anti-inflammatory, anti-cancer, and anti-oxidant properties[30]

2.Tannins: High levels of tannins, especially gallotannins, which have potent antioxidant effects as well as promote the fruit's anti-inflammatory properties, are identified in amla.[31]

3.Phenolic compounds: Amla's antioxidant capacity and ability to fight cellular damage are enhanced by its abundance of phenolic components, including gallic and ellagic acids.[32]

3 Methodology

3.1Raw material

Amla seed are protected by the seed coat present inside amla fruit harvested from Sarkaghat. The different organic solvents were used with difference in their polarity that are hexane, chloroform, methanol, diethyl ether of analytical grade.

- ✓ Hexane- SDFCL, s d fine-chem limited, Mumbai-30
- ✓ Petroleum Ether- KPI, K. Patel International, Mumbai-92
- ✓ Chloroform- Qualikems Fine Chem Pvt. Ltd., Industrial Estate Nandesari, Vadodara
- ✓ Methanol.

3.2 Amla seed oil production process:

3.2.1 Preparation of sample for the extraction process

The amla fruits were harvested from the Sarkaghat,dist. Mandi (H.p) in the month of January and February which is consider a peak harvesting time for amla fruits then these amla fruits were sun dried for one day and then the fruit part of amla is removed from the the seed coat with the help of knife and the seed coat of amla was obtained the seed coat was break and then around 3-4 seeds were obtain from each seed coat. the seeds were collected and cleaned

3.2.2 Extraction process of the seed oil

The seed of amla were collected by removing the fruit part of the amla and seed coat or seed shell of amla and then the seeds were placed in hot air oven at 80^0C until the moisture content is removed. The dried amla seeds were then crushed in motar pestle and the powered is passed through sieve number 60. The amla seed powder was obtained.

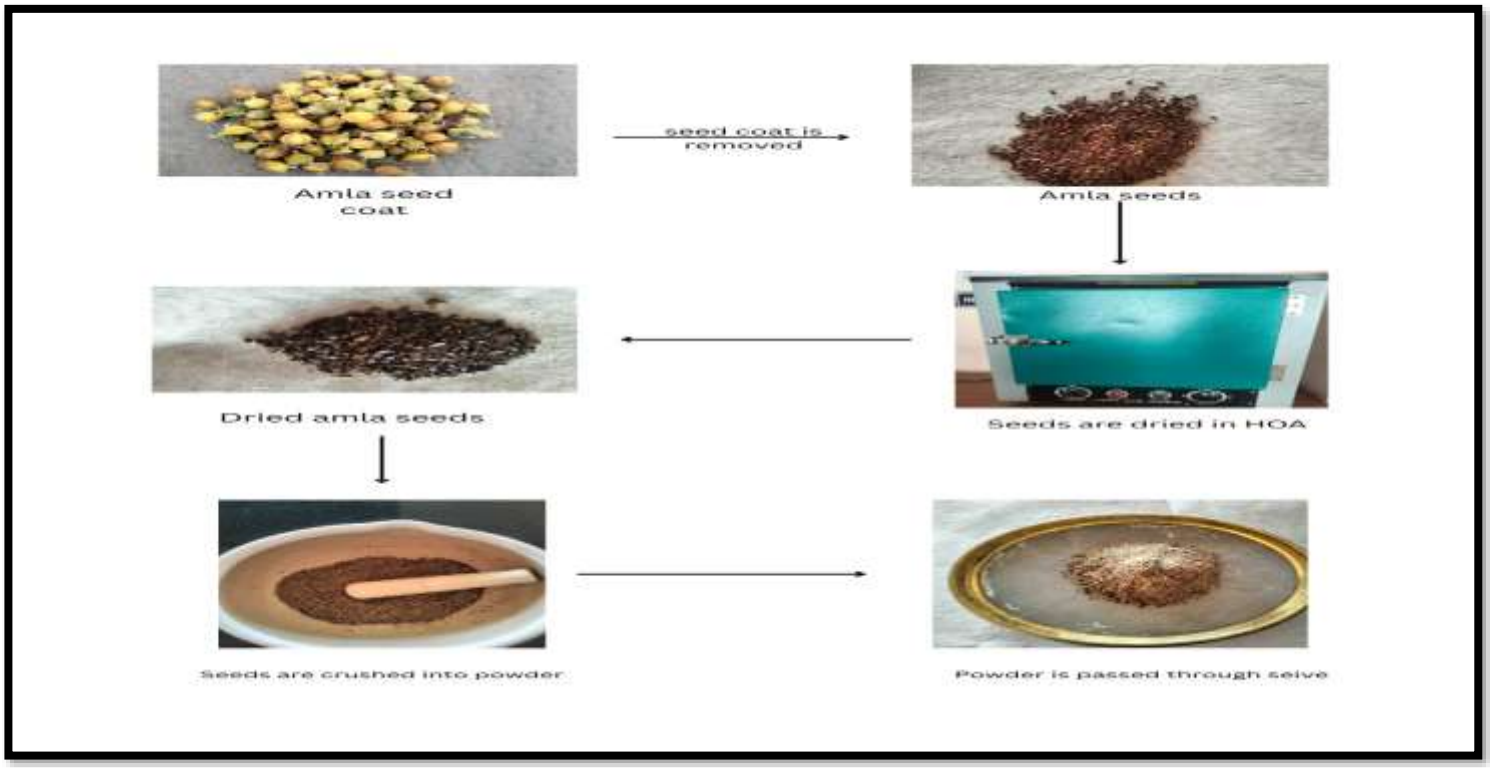

Fig 4: Extraction Process Of Seed Oil

4. Extraction of seed oil using different reagent

In this research, we have employed different solvents, such as hexane, petroleum ether, chloroform, and methanol, to study their impact on the process of extraction. The selection of solvents was influenced by their differences in polarity, which significantly affects the efficiency and selectivity of extraction. Through the comparison of these solvents, we sought to evaluate their influence on the yield. This research gives insight into how solvent polarity

affects the extraction process and aids in optimizing the choice of solvent for enhanced efficiency and specific extraction results.

Different solvents were used in the extraction process according to their increasing polarity

i.e petroleum ether< hexane <chloroform<methanol.

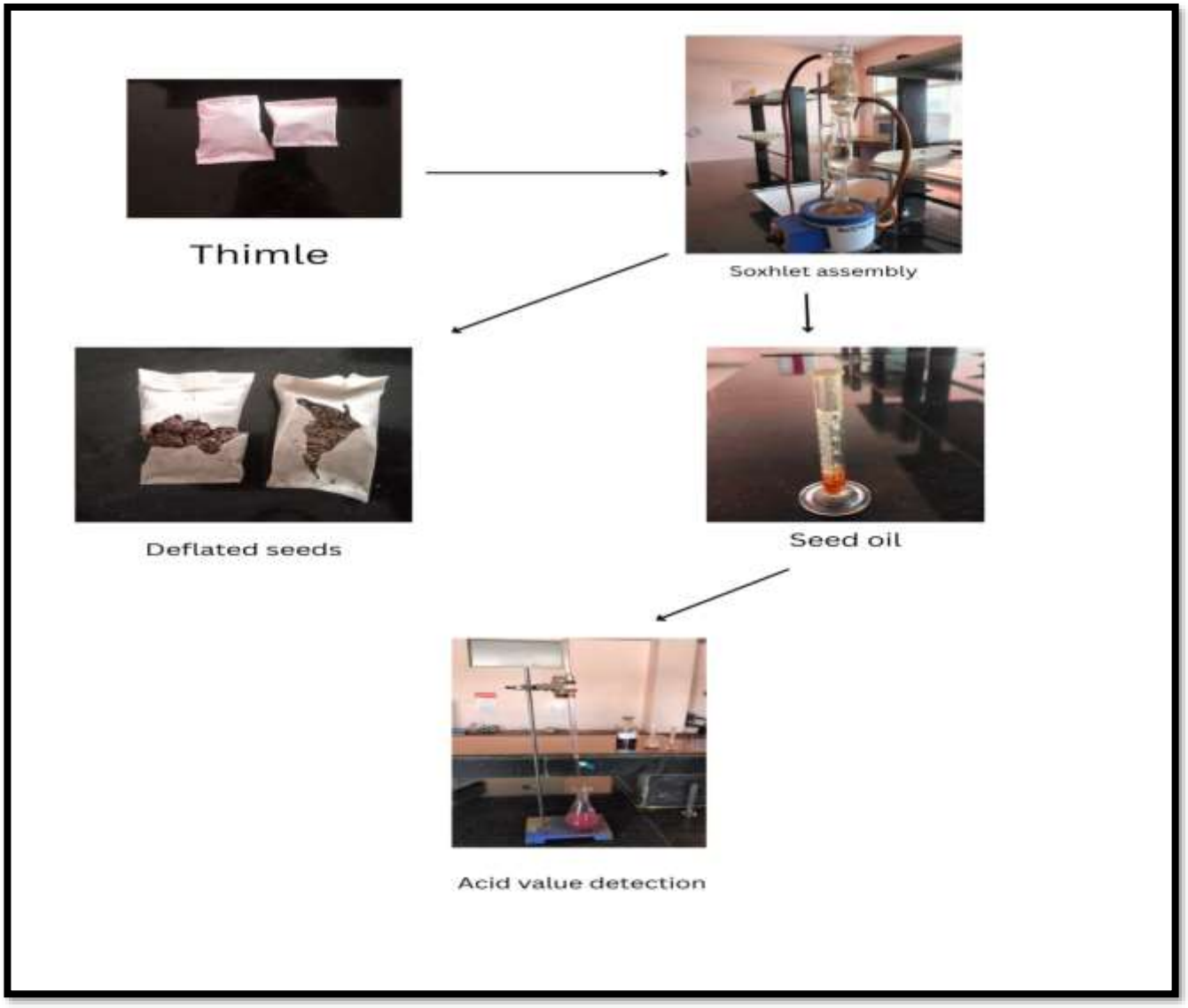

Fig4: Soxhlet extraction and acid value determination

4.1 Hexane

Hexane is an natural solvent, is classified as a straight-chain neutral aliphatic hydrocarbon. A unstable, colorless distillate of petroleum that's moderately insoluble in water could be a minor component in gasoline. As a result of its low water dissolvability and instability, it would be more likely emigrate into the environment taking after an natural discharge and would not posture risk to the food web.[33]

Procedure:

1 The amla seed powder was weighted 10gram accurately.

2 The amla seed powder was transferred on whatman filter paper and it was packed inside the filter paper by forming a thimble.

3 The extraction process was carried out with sample and solvent in the ratio of 1:20.

4 200ml of hexane was taken in round bottom flask and soxhlet assembly was assembled and attached to the round bottom flasks.

5 The process of extraction was begun. the temperature of the heating mantle was set on 70^0C which is the boiling point of hexane.

6 The process of extraction was continued upto 3 hours or 180 minutes and the extraction process is stopped and the extract solution is collected

7 the extracted solution is now heated until the hexane is completely evaporated and fat/oil content is remained in the flask

8 the collected/ extracted oil content is measured.[1]

Table 4.1.1: properties of hexane

Properties	**Standard**
Molecular formula	C_6H_{14}[34]
Molecular weight	86.18g/mol.[34]
Boiling point	68.7°C (155.7°F)[34]
Vapour pressure	150 mmHg at 20°C[35]
Solubility	Insoluble in water and soluble in organic solvents[36]
Flash point	−22°C (−7.6°F)[37]
Combustion	Hexane burns in oxygen and gives to give CO_2 and H_2O[38]

4.2 Methanol:

Methanol shows up as a colorless reasonably unstable fluid a faintly sweet pungent odor like that of ethyl alcohol. It is completely soluble in water. It is used to make chemicals, to remove water from automotive and aviation fuels, as a solvent for paints and plastics, and as an ingredient in a wide variety of products[13]

Table 4.2.1: Properties of methanol

Properties	**Standard**
Molecular formula	CH_3OH[39]
Molecular weight	32.04g/mol[40]
Boiling point	64.7°C (148.5°F)[41]
Vapour pressure	12.8 kPa at 20°C[41]
Solubility	Soluble in ethanol, water, ether[41]
Flash point	11–12°C (52–54°F).[42]
Combustion	Methanol burns in the presence of oxygen to give CO_2 and H_2O.[43]

Procedure:

1 The amla seed powder was weighted 10gram accurately.

2 The amla seed powder was transferred on Whatman filter paper and it was packed inside the filter paper by forming a thimble.

3 The extraction process was carried out with sample and solvent in the ratio of 1:20.

4 200ml of methanol was taken in round bottom flask and Soxhlet assembly was assembled and attached to the round bottom flasks.

5 The process of extraction was begun. The temperature of the heating mantle was set on 70^0C.

6 The process of extraction was continued up to 3 hours or 180 minutes and the extraction process is stopped and the extract solution is collected

7 the extracted solution is now heated until the methanol is completely evaporated and fat/oil content is remained in the flask. The equipment used in evaporation process of methanol was rotatory evaporator.

8 The collected/ extracted oil content is measured.

4.3 Chloroform

Table 4.3.1: Properties of chloroform.

Properties	**Standard**
Molecular formula	$CHCL_{3.}$[44]
Molecular weight	119.38 g/mol.[45]
Physical state and appearance	Colourless liquid with sweet ether like odour.[46]
Flammability	Non inflammable.[46]
Reactivity	Reacts with O_2 and light to give phosgene s($COCl_2$) which is a toxic gas.[46]
Boiling point	61.2°C.[47]
Melting point	-63.5°C.[47]
Density	1.489 g/cm³ at 20°C.[47]

PROCEDURE:

1 The amla seed powder was weighted 10gram accurately.

2 The amla seed powder was transferred on whatman filter paper and it was packed inside the filter paper by forming a thimble.

3 The extraction process was carried out with sample and solvent in the ratio of 1:20.

4 200ml of chloroform was taken in round bottom flask and soxhlet assembly was assembled and attached to the round bottom flasks.

5 The process of extraction was begun. The temperature of the heating mantle was set on 70^0C.

6 The process of extraction was continued up to 3 hours or 180 minutes and the extraction process is stopped and the extract solution is collected

7 the extracted solution is now heated until the chloroform is completely evaporated and fat/oil content is remained in the flask. The equipment used in evaporation process of chloroform was rotatory evaporator.

8 The collected/ extracted oil content is measured[1].

4.4 Petroleum ether:

Petroleum ether is the petroleum division comprising of aliphatic hydrocarbons and boiling within the range 35–60 °C, and commonly utilized as a research facility solvent.

Table 4.4.1: Properties of petroleum ether

Properties	Standard
Molar mass	82.2 g/mol
Appearance	Unstable, clear, colorless and non-fluorescent fluid
Melting point	< −73 °C (−99 °F; 200 K)
boiling point	42–62 °C (108–144 °F; 315–335 K)
Solvency	water insoluble

Procedure

1 The amla seed powder was weighted 10gram accurately.

2 The amla seed powder was transferred on whatman filter paper and it was packed inside the filter paper by forming a thimble.

3 The extraction process was carried out with sample and solvent in the ratio of 1:20.

4 200ml of petroleum ether was taken in round bottom flask and soxhlet assembly was assembled and attached to the round bottom flasks.

5 The process of extraction was begun. The temperature of the heating mantle was set on 70^0C.

6 The process of extraction was continued up to 3 hours or 180 minutes and the extraction process is stopped and the extract solution is collected

7 The extracted solution is now heated until the petroleum ether is completely evaporated and fat/oil content is remained in the flask. The equipment used in evaporation process of petroleum ether was rotatory evaporator.

8 The collected/ extracted oil content is measured[1].

3.5 Analysis of quality of amla seeds oil.

4.5.1 Percentage yield of amla seed oil

Percentage yield = (Oil weight / Weight of sample) *100.

4.5.2 Chemical analysis of amla seed oil.

4.5.2.1 Acid value (mg KOH/g)

The acid value (AV) is characterized as the number of milligrams of potassium hydroxide (KOH) required to neutralize the free fatty acids present in 1 gram of fat or oil. It is a critical parameter for deciding the freshness and quality of oils and fats[48]

Materials and Reagents:

1**. Sample**: Oil or fat.

2. **Solvent:** 50 mL of ethanol and diethyl ether (1:1 ratio).

3**. Indicator**: Phenolphthalein solution (1% in ethanol).

4. **Titrant:** 0.1 N potassium hydroxide (KOH) solution.[13]

Procedure:

1**Preparation of the sample solution:**

- Weigh 1–10 g of the oil or fat sample and transfer it into a conical flask.
- Add 50 mL of the ethanol-diethyl ether mixture.
- Shake well until the fat dissolves completely.

2. Titration:

- Add 2–3 drops of phenolphthalein indicator to the solution.
- Titrate the mixture with 0.1 N KOH solution, shaking continuously, until a persistent light pink color appears.

Calculation:

Record the volume (mL) of KOH used.

Use the formula to calculate the acid value:

Acid Value = (56.1*V*N)/W[48]

Where:

V = Volume of KOH used (mL)

N = Normality of KOH solution (0.1 N)

W = Weight of oil or fat sample (g)

56.1 = Molecular weight of KOH.[48]

4.6 Calculation and results

4.6.1 Table of acid value

Sample No.	**Sample Description**	**Volume of KOH (mol/L)**	**Normality of KOH solution**	**Acid value (mg KOH/g)**
1.	Extract obtain from using Hexane as solvent.	4 ml	0.1 N KOH	22.44
2.	Extract obtain from using petroleum ether as solvent.	3.5 ml	0.1 N KOH	19.63
3.	Extract obtain from using chloroform as solvent.	5 ml	0.1 N KOH	28.05
4.	Extract obtain using methanol as solvent.	5.5 ml	0.1 N KOH	30.85

The observed acid value of different extract ranges from19 to 30.85 mg KOH/g

According to Prakash D., et al. (2012) – Antioxidant and oil content analysis of Emblica officinalis seed oil.

Their observed acid value ranges from 12–26 mg KOH/g depending on different solvents.[49]their previous study is not in agreement with our observations value.

4.6.2. Table of result for percentage yield of oil.

S.no	Extraction reagent	temperature	Time of extraction (min.)	Percentage yield
1.	Hexane	70^0c	180 min	15%
2.	Petroleum ether	70^0c	180 min	9%
3.	Chloroform	70^0c	180 min	10%
4.	Methanol	70^0c	180 min	20%

5. Result and discussion:

The research was successfully done to study the effect of different solvent in the extraction process. in the following study we observe that the amla seeds when extracted in methanol as a solvent using the Soxhlet apparatus has provided the highest oil content that is 20% but despite of providing the highest yield it also gives the acid value of 30.85 mg KOH/g which indicates the presence of higher free fatty acids results in the poor quality of oil where as in case of petroleum ether we observed the lowest acid value of all four solvent used in the extraction i.e. 19.63 but it also contributes lowest in the yield of oil percentage that is 9% that shows petroleum ether gives low quantity of oil but have slightly good quality of oil than other solvents . In case of hexane the percentage yield of seed oil was found to be 15% with the acid value of 22.44 mg KOH/g, it provides a good balance of yield of oil and low acid value than other solvents which are providing the balance only on one side ether the oil yield or the acid value. Chloroform as a solvent in extraction process provides a middle ground as it gives oil yield slightly more than the petroleum ether and is not as effective as hexane and methanol in term of oil yield but have the acid value range close to methanol that is 28.05 mg KOH/g.

6. Conclusion:

Different type of solvent varying in their polarity for extraction process strongly influence the quality as well as quantity of the extract/oil of amla seeds. The more polar solvent such as methanol maximize the result of quantity of the oil as well as increase the amount of free fatty acids and moisture content in the extract results in the increase value of acid value of oil which makes the extract unsuitable for the pharmaceutical use. Conversely, the non-polar solvents like hexane and petroleum ether limits the hydrolyzing of the oil/extract results in the superior quality of the oil. Hexane is considered to be the best choice for the extraction of the amla seed oil due to its yield and low acid value than chloroform and methanol which is considered to be acceptable acid value. petroleum ether as a solvent can be consider as a good choice in cosmetic industry or pharmaceutical industry where the purity and quality are required as an essential factor and consider as a standard. petroleum ether's extract has the lowest acid value among all four solvents so it is considered as the purest extract of all other extracts. At last the polarity of the solvent is directly co related with the quality and quantity of the extract so the solvent's polarity should be considered on priority biases based on the intention of use , if the intention is to have the heigh quantity extract than the polar solvents like methanol or chloroform can be used however if the extract need to be of heigh quality or to be use in pharmaceutical industry non polar solvents like hexane and petroleum ether should be considered due to their low acid value or low content of free fatty acid.

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