

**THE EXTRACTION OF OIL FROM AN
AGRICULTURAL
PRODUCE - PEAR AS A CASE STUDY**

BY

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DEDICATION

This project work is dedicated to my Mum, Mallama Meimunat Y. Ikunaiye and my Uncle, Mallam Muhammed Y. Ikunaiye. They believed in me and encouraged me despite my difficult moments. Above all to Almighty Allah for His Mercy and blessings.

ACKNOWLEDGMENT

I am deeply grateful to all those who with such good grace gave me their time and energy to constructively criticize this work, among such people are: Mr. Akimbode of late memory, Mr. Saka (my Supervisor), Dr Sadigu Suleman (H.O.D Fisheries Dept.), Mr. Salihu M.J Goodman, Mr. Sumaila Adinoyi.

I am highly grateful to people like Mr. Muh'd Seidu, Mall Sani Suleman (Ajans), Miss Fatty Salihu Adubazi, Mrs. Nana Muhammed, Miss Rukayat, and so many of them. I thank you all for your help variously during the course of my study.

The family of my uncle, Mallam M.Y. Ikunaiye are also being recognized with this struggle. I thank you all.

Much of any merit this project may have is due to the generosity of those mentioned above in putting their knowledge, finance and practical experiences to my disposal.

The great of all thanks go to Almighty Allah who was able to see me through my education, without whose mercy and love my education would have been a dream never to come to pass.

CERTIFICATION

This is to certify that the project: solvent extraction of pear oil from the cake of pear was presented by Bello M.A. for the partial fulfilment of the award of Bachelors degree in Chemical Engineering (B. ENG).

Approved By

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Date

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ABSTRACT

Extraction of pear oil from the pear fruit was carried out using solvent-extraction and about 87.3% of oil was extracted leaving 12.7% in the pear cake.

Three types of solvents (n-hexane, ethanol and petroleum ether) were used in the process of extraction.

The effect of solvent quantity and particle size distribution on the amount of pear oil extracted from the cake were investigated. It was observed that with the same quantity of solvent, the solvent n-hexane, extracted more oil from pear cake.

The amount of oil extracted was found to increase with decrease in particle size. For 2.80mm, 2.00mm, 1.40mm, 500um and 850um, the results of percentage oil extracted in the case of n-hexane are: 85.15%, 85.69%, 86.70% and 87.30%.

<u>TABLE OF CONTENTS</u>	<u>PAGE</u>
TITLE PAGE	i
ACKNOWLEDGMENT	ii
DEDICATION	iii
CERTIFICATION	iv
ABSTRACT	v
TABLE OF CONTENTS	vi
 <u>CHAPTER ONE</u>	
1.0 INTRODUCTION	1
1.2 LIMITATION	2
1.3 JUSTIFICATION OF PROJECT	2
 <u>CHAPTER TWO</u>	
2.0 LITERATURE REVIEW	
2.1 THE PEAR AND ITS CULTIVATION	
2.2 TYPES OF PEAR AND THEIR USES	
2.3 CHARACTERISTICS OF FATS AND OIL	
2.3.1 IODINE VALUE	
2.3.2 SAPONIFICATION VALUE	
2.3.3 ACID VALUE	
2.3.4 REFRACTIVE INDEX	
2.3.5. VISCOSITY OF OIL	
2.4 SOLVENT EXTRACTION	
2.4.1. FACTORS AFFECTING RATE OF SOLVENT EXTRACTION	

2.4.2 SOLVENT SELECTIVITY

2.4.3 PHYSICAL PROPERTIES OF SOLVENT

CHAPTER THREE

3.0 EQUIPMENT AND APPARATUS

3.1 EXPERIMENTAL PROCEDURE

3.2 DETERMINATION OF OIL CONTENT OF THE PEAR

3.3 ANALYSIS OF OIL EXTRACTED

3.3.1. DETERMINATION OF SAPONIFICATION

3.3.2 DETERMINATION OF ACID VALUE

3.3.3 DETERMINATION OF IODINE VALUE

CHAPTER FOUR

4.0 RESULTS

CHAPTER FIVE

5.0 DISCUSSION OF RESULTS AND CONCLUSION

5.1 RECOMMENDATION

i. APPENDIX I & II

ii. REFERENCES

CHAPTER ONE

1.0 INTRODUCTION

This project work intends to produce an edible oil that can compare with any other vegetable oils in terms of quantity and quality. This work came from a need to produce oil locally as fluctuation in the exchange rate coupled with economic in-balance in a developing country like Nigeria does not favor our importation of oil from developed countries like U.S.A, France, Britain etc.

This work intends to use pear (*Pyrus communis*). This material is considered because of its availability in the locality I leave. Methods available for the extraction of oil are: hydraulic or mechanical pressing and solvent extraction or leaching process. But for this work, I intend to use solvent extraction. The solvent extraction is based on the principle that non-polar components of the sample are easily extracted into organic solvents.

The oil obtained from the process is usually higher than that of mechanical method and residue contains little oil or not at all!

1.1 AIMS AND OBJECTIVE OF STUDY

The objective of this project is to extract edible oil from pericarp and mesocarp of pear (*Pyrus communis*). The project is therefore aimed at:

- (1) Characterized the oil produce and compare it with the edible oil.
- (2) Investigate the effect of quantity of solvent and particle size distribution on the amount of oil extracted.
- (3) Determine the best solvent (petroleum ether, ethanol and n-hexane) for the extraction of oil from pear.

1.2 **LIMITATION**

This work focuses on the extraction of oil from pear.

1.3 **JUSTIFICATION OF PROJECT**

What motivated in the choice of this work is the need to meet up with the growing demand for an edible oil for homes and industrial needs.

CHAPTER TWO

LITERATURE REVIEW

2.0 The market for oils and fats is a slowly expanding one; growing probably at a rate slightly faster than the increase in population [2]. The demand for oils is met largely from plant sources with animal fats and marine oils contributing less than 25% of the total production. [2]. The expansion of trade naturally puts pressure on the commodity, and so it becomes necessary to look for alternative source of plant for producing oils.

In the future the crop which might contribute most significantly to oils and fat market in the pear [*Pyrus communis*]. The two countries which are principally involved in the cultivation of pear are: the U.S.A which contributes about 65% of the world's production and France which contributes 11% of the total world's figure [2]. The eastern part of Nigeria happens to be leading producer of pear in the country.

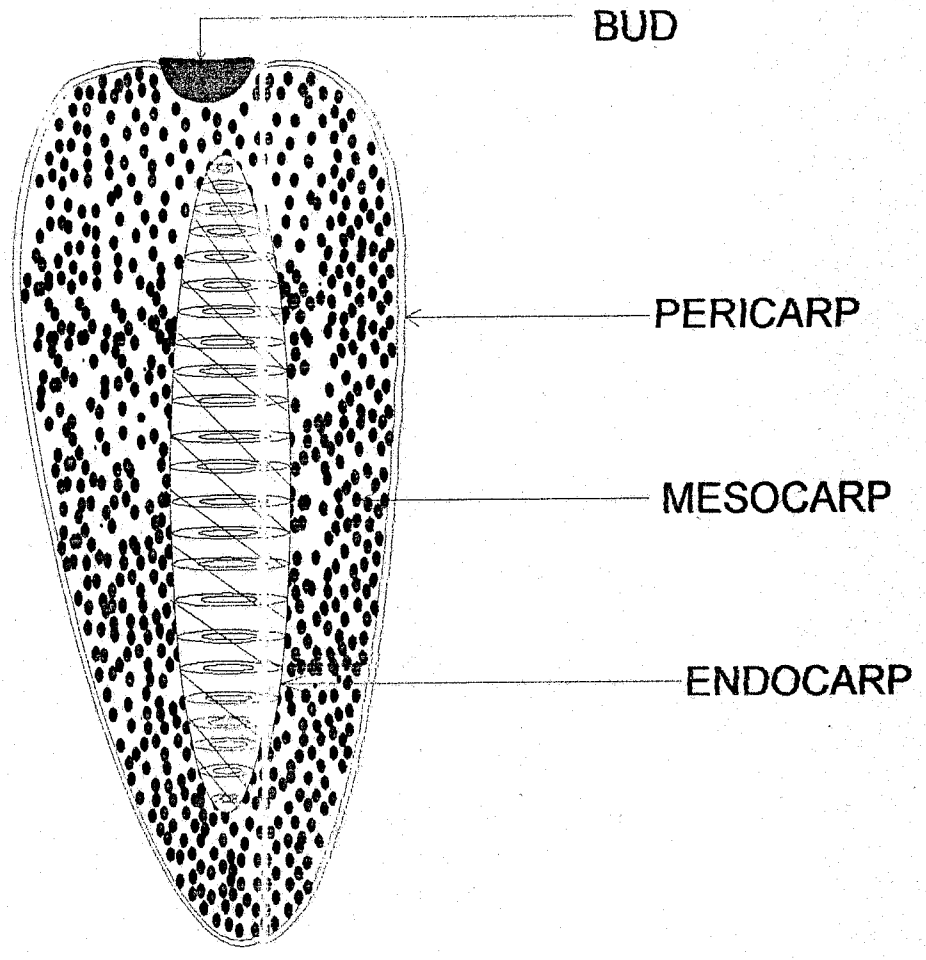
2.1 THE PEAR PLANT CULTIVATION

The pear (*Pyrus communis*) is generally propagated by budding the desired varieties. The pear will grow upon almost any soil, but does best on well drained loam soils except the Chinese hybrids which do best upon lighter soils (1,4).

The field should be deeply plowed and thoroughly harrowed before the

LONGITUDINAL SECTION THROUGH

PEAR FRUIT (PYRUS communis). [4].



trees are set and throughout the season the land should be kept loose, open and free weeds by frequent cultivation. After the trees are set the top should be pruned (cut), only 2 or 3 buds be left from 3 to 5 well spaced twigs. Pear should be harvested when they will readily separate from the twigs without breaking the fruit stalk [4].

2.2 TYPES OF PEAR AND THEIR USES

The various types of pear are:

1. Chinese sand pear (*Pyrus sinensis*)
2. Avocado pear (*Persea americana*)
3. Seckel
4. Winter Nelis

Pear can be eaten fresh or cooked form with yam, maize etc. Pear oil is highly unsaturated which can be used as edible oil for cooking, and can be used in industries as starting material in the production of soap, as food emulsifier and as flocculation agents [1,2].

2.3 CHARACTERISTICS OF FATS AND OILS

some of the most important properties of fats and oils include: Iodine value, Saponification value, Acid value, Refractive index and viscosity.

2.3.1 IODINE VALUE

This is the measure of the proportion of unsaturated acid present in the oil. This test measures the amount of iodine which can be absorbed by the unsaturated acids. One of the properties of unsaturated organic compounds

is the reactivity of the double bonds especial their ability to form addition compound with halogen [3].

2.3.2. SAPONIFICATION VALUE

This is the measure of the mean molecular weight of the fatty acids present in the oil. The process of saponification is the hydrolysis of triglycerides into glycerol and potassium salts of the fatty acid using a solution of KOH (Potassium hydroxide) in alcohol.

The determination of the saponification values is a reasonable reliable means of characterizing the oil. The value is expressed as the number of milligrams of KOH required to saponify one gram of oil. Saponification value also gives the actual amount of alkali required by an oil or fat [3].

2.3.3. THE ACID VALUE

This is the measure of the amount of the fatty acid present in a fat or oil. These free fatty acids must be removed in the preparation of edible fats, commercial yield will be reduced by an amount of fatty acid present. The acid value is the number of milligram of KOH required to neutralize the free fatty acids in one gam of fat. It's of importance that it indicates the correct amount of alkali to be added f the fat is to be subjected to alkali refining [3].

2.3.4. REFRACTIVE INDEX

This is a physical attributes of oils measured by the angle through which a beam of light is bent when passing through a thin film of melted fat. The

index of each fat falls within a narrow range and can be used as a characteristics of the fat in checking purity. It's temperature dependent and is usually measured of 104°F (40°C); a temperature at which most fats are liquid [3].

2.3.5 VISCOSITY OF OIL

This is a measure of internal molecular friction which hinders flow. a low viscosity is desirable since extraction is in part governed by capillary flow. Solvent with high viscosities may have low rates of extraction. Viscosity decreases with evaporation and vapor pressure. The greater the vapor pressure the lower viscosity. Liquid chosen as solvent should have sufficient low viscosity [5,6].

2.4 SOLVENT EXTRACTION

Solvent extraction, sometimes called liquid extraction, is the separation of the constituents of a liquid solution by contact with another insoluble liquid if the substances constituting the original solution distribute themselves differently between the two liquid phases [5]

ADVANTAGES OF SOLVENT EXTRACTION

- (1) It constitutes the most efficient method for the recovery of oil from any oil - bearing material.
- (2) It extracts 99% of oil from any types of oil bearing materials.
- (3) The oil extracted is of high quality.

DISADVANTAGES OF SOLVENT EXTRACTION

- (1) Except when flammable solvents are mistakenly used, solvents extraction presents no danger of fire or explosion.
- (2) Solvent- extraction equipments are relatively expensive.
- (3) Difficulty in the selection of solvent to be used can make separation of the solvent from oil-solvent mixture difficult or impossible.

2.4.1 FACTORS AFFECTING RATE OF SOLVENT -EXTRACTION

The selection of equipment for an extraction process will be influenced by the factors which limit the extraction rate. These factors are discussed below.

2.4.1.1 SOLVENT

Solvents affect the rate of extraction. Some of its properties that affect the rate of extraction are:

- (1) Viscosity
- (2) Boiling point
- (3) Density
- (4) Surface tension
- (5) Vapor pressure
- (6) Purity

Generally a relatively pure solvent will be used initially, but as extraction

proceeds, the conduction of solute will decrease and the rate of extraction will progressively decrease; first because the conduction gradient will be reduced, and secondly because the solution will generally become more viscous [5,6]

2.4.1.2 PARTICLE SIZE

The size of particle does affect the rate of extraction since the smaller the size the greater the interfacial area between the solid and solvent hence the higher the rate of transfer of material. Smaller size also means that the solvent has to travel smaller distance within the solid thereby increasing rate of extraction [5,6].

2.4.1.3 TEMPERATURE

Increase in temperature lowers the viscosity of oil and the solvent which in turn increase their diffusion coefficients. However, care must always be taken in choosing the extraction temperature so as to prevent explosion of equipment when dealing with flammable solvents [5,6].

2.4.1.4 MOISTURE CONTENT

This is usually expressed as the amount of water contained in the oil-bearing material. As the moisture content of the material increases the extraction rate increases. Decrease in moisture content leads to decrease in the water in the tissue which encircles the oil [5,6].

2.4.1.5 AGITATION OF FLUID

Agitation of the solvent is important because it increase the eddy diffusion

and therefore increase the transfer of material from the surface of the particles to the bulk of the solution. Again agitation of suspension of fine particles prevents sedimentation and more effective use is made of the interfacial surface [5,6].

2.4.2 SOLVENT SELECTIVITY

For solvent extraction operation, it's important that the right solvent is selected. In making this choice, it's important to remark on some of general characteristic of solvents. These are discussed below.

2.4.2.1 PURITY

By this we mean that the solvent should not contain impurities of such quantity that can interfere with the use for which the solvent is intended.

2.4.2.2 RELATIVE VOLATILITY

This is defined as the ability of a liquid to change into a vapor or gas. It's therefore require that the relative volatility of the solvent be favourable.

2.4.2.3 RECOVERABILITY

It's always necessary to recover the solvent for reuse and this must ordinarily be done by another mass transfer operation; the most commonly used being distillation. The solvent should therefore form no azeotrope with the extracts and mixture should show high relative volatility for low temperature recovery [5,6].

2.4.2.4 SOLVENT POWER

This is the ability of a solvent to dissolve a wide variety of substance. In solvent extraction, a solvent with high solvent power should be chosen [5,6].

2.4.2.5 INFLAMMABILITY

This is a measure of the ease with which solvent goes up in flame. Generally all liquids with flash point below 32.2°C are flammable. In order to avoid disaster, solvents with flash point higher than 32.2°C should be used [5,6]

2.4.2.6 CHEMICAL REACTIVITY

The solvent should be stable chemical and inert to the components of the system and material of construction.

2.4.2.7 TOXICITY

This is the amount of toxin contained in a solvent. The solvent to be selected should be non-toxic as this can conterminates the oil.

2.4.3 PHYSICAL PROPERTIES OF SOLVENT

The physical properties of solvent largely determine the relative suitability for oil extraction some of the physical properties determining in selecting a solvent are discussed below.

2.4.3.1 SPECIFIC HEAT

This is a measure of the quantity of energy (in cal) required to raise the temperature of one gram of solvent by one degree centigrade [6].

2.4.3.2 SPECIFIC GRAVITY

This is the mean of the mass (in g) of solvent relative to its volume (in cm^3). [6]. Since solvent expand in volume with increase in temperature. Specific gravity is usually determined at a standard temperature of 20°c [5,6].

CHAPTER THREE

3.0 EQUIPMENT AND APPARATUS

3.0.1 ELECTRIC BALANCE

This was used to weigh the samples during the experiment.

3.0.2 ELECTRIC OVEN

This was used today the sample before the extraction takes place. It was also used to evaporate any solvent that may still remain in the oil after extraction.

3.0.3 SOXHLET APPARATUS

This was used to carry out the extraction process. It was also used to recover solvent from the oil - solvent mixture obtained after extraction.

3.0.4 THIMBLE

This was the container used in which a sample of known weight was kept before extraction.

3.0.5 PESTLE AND MORTAR

These were used to grind or mill the cake sample obtained from electric oven after drying.

3.0.6 SIEVER

This was used to sieve the sample and separate them into different sizes.

3.0.7 ROUND BOTTOM FLASK

This was used to collect the oil - solvent mixture after extraction.

3.0.8 PETRI-DISH

This was used to dry the sample in the oven.

3.1 EXPERIMENTAL PROCEDURE

3.1.1. PEELING

The samples of pear were collected and the endocarp [seed] of the pear was removed and thrown away.

3.1.2. DRYING

The sample obtained from peeling was kept in oven for 24hrs at temperature of 100°C. This was done to reduce the moisture content of the sample before extraction.

3.1.3. MILLING

The dry cake obtained from drying stage was milled using pestle and mortar. This stage can also be called size reduction stage. The following were obtained: sample 1, sample 2, sample 3, sample 4 and sample 5.

3.1.4. METHOD

18.31g (sample 1) was placed inside the thimble which was kept inside the soxhlet apparatus. The pre-weighed solvent flask beneath the apparatus was connected to the soxhlet machine. 300ml of petroleum ether was added to the thimble inside the barrel arm of the soxhlet machine and this arm was connected to the condenser. The heating rate was adjusted to give a condensation rate of 2 to 3 drops/second and extract for six hours.

On complete extraction, the thimble was removed from the barrel arm of the soxhelt machine and dried in oven for 30 minutes at temperature of 100°C. After cooling, the final weight of thimble was noted. The difference between final weight and initial weight gives the weight of oil extracted.

The experiment was repeated for sample 2, sample 3, sample 4, and sample 5 for petroleum ether as solvent. The next sieving was done to obtain different weights labeled as: sample 1, to sample 5. The solvent in used for this experimental stage was 300ml ethanol.

Finally, another sieving was done to obtain different weights labeled as: sample 1 to sample 5. The solvent used for this experimental stage was 300ml n-hexane.

3.2 DETERMINATION OF % OIL CONTENT OF THE PEAR.

The percentage oil content was calculated using the expression below.

$$\% \text{ oil content} = \frac{\text{Weight of fresh sample (W}_1) - \text{weight of dried sample (W}_2)}{\text{Weight of fresh sample (W}_1)} \times 100$$

This was repeated using different samples for the same quantity of different solvent.

3.3 ANALYSIS OF OIL EXTRACTED

3.3.1 Determination of saponification value

0.1g of oil was weighed in a beaker and 3ml of n-hexane was dissolved. The contents of the beaker was transferred to a 250ml conical flask. 25ml of 0.5mol/ml alcoholic KOH (Potassium hydroxide) was added and attached to a reflux condenser.

Another reflux condenser as control test without the oil but other reagents present was set up. Both flasks were heated on a boiling bath for 30mins. It was left to cool to room temperature and titrated with 0.5mol/ml Hcl and phenolphthalein indicator.

The difference between the control test and real test reading gave the number of milliliters of 0.5 mol/ml KOH required to saponify 0.1g of oil [3].

The molecular weight of KOH is 56 [3]. And since three molecules of fatty acid are released from a triglyceride, then.

$$\text{Saponification value (s)} = 3 \times 56 \times \frac{1000}{\text{Average molecular Weight of oil. [3]}}$$

3.3.2 DETERMINATION OF ACID VALUE

2g of oil was weighted and was suspended in 50ml of n-hexane. 1ml of phenolphthalein solution was added and mixed thoroughly. This was titrated with 0.1 mol/ml KOH until the faint pink colour persisted for 20-30 seconds. Note, the number of milliliter of standard alkali required and calculate the acid value of the oil 0.1 mol/ml KOH contains 5.6mg/ml. [3]

The acid value was calculate using the formula

$$\text{Acid value (A.V)} = \frac{56.1 \times T \times V}{M}$$

Where

V= number of moles of standardized KOH

T= exact normality of KOH solution

M= mass (in g) of the oil

3.3.3 DETERMINATION OF IODINE VALUE

10ml of the oil solution was pipetted into a stoppered bottle. 25ml of the Iodine chloride ICL solution was added. It was left to stand in the dark for 1hr after shaking thoroughly. At the same time, a controlled test was set up in which the oil solution was replaced by 10ml of chloroform.

The difference between the blank (controlled test) and test readings (BL-T) gives the number of milliliters of 0.1 mol/ml thiosulphate needed to react with the equivalent volume of Iodine.

The amount of oil taken was 2g and 1000ml of 0.1 mol/ml Iodine contains 12.7g of Iodine, so the number can be calculated as shown below:

$$\begin{aligned} \text{Iodine number} &= \frac{(\text{BL} - \text{T})}{1} \times \frac{12.7}{1000} \times \frac{1000 \times 0.1}{2} \\ &= (\text{BL} - \text{T}) \times 6.35 \end{aligned}$$

CHAPTER FOUR

4.0 RESULTS

TABLE 4.1

SOLVENT USED FOR EXTRACTION: n-hexane			
TIME TAKEN	“	”	: 6HRS
TEMPERATURE	“	”	: 105°C

S/No.	WEIGHTS (IN g) BEFORE EXTRACTION	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5
1.	Weight of thimble + glass wool (X)	5.92	5.26	5.62	5.72	5.86
2.	Weight of thimble + sample + glass wool (Y)	16.68	16.02	16.38	16.48	16.62
	Weight (in g) After Extraction					
3	Weight of thimble + Sample + glass wool (Z)	7.29	7.51	8.75	9.73	10.75
	CALCULATIONS					
4	Weight of sample before extraction (W ₁)	10.76	10.76	10.76	10.76	10.76
5	Weight of sample after extraction (W ₂)	1.37	2.25	3.13	4.01	4.89
6	Weight of oil extracted (W ₃)	0.8730	0.7910	0.7090	0.6270	0.5455
7	Percentage of oil extracted (W ₄)	87.30	79.10	70.90	62.70	54.55

NOTE:

- CALCULATIONS**
- (1) $W_1 = Y - X$
 - (2) $W_2 = Z - X$
 - (3) $W_3 = \frac{W_1 - W_2}{W_1}$
 - (4) $W_4 (\%) = [W_3 \times 100]$

- KEY (CLASSIFICATION OF SIZE)**
- (1) SAMPLE 1 = 500um
 - (2) SAMPLE 2 = 850um
 - (3) SAMPLE 3 = 1.40mm
 - (4) SAMPLE 4 = 2.00mm
 - (5) SAMPLE 5 = 2.80mm

CONVERSION
(10³um = 1mm)

20...

ABLE 4.2

SOLVENT USED FOR EXTRACTION: Petroleum ether		
TIME TAKEN	“ ”	: 6HRS
TEMPERATURE	“ ”	: 105°C

S/No.	WEIGHTS (IN g) BEFORE EXTRACTION	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5
1.	Weight of thimble + glass wool (X)	4.14	4.09	4.18	4.20	4.14
2.	Weight of thimble + sample + glass wool (Y)	22.45	22.40	22.49	22.51	22.45
	Weight (in g) After Extraction					
3	Weight of thimble + Sample + glass wool (Z)	10.95	11.10	11.39	11.61	11.75
	CALCULATIONS					
4	Weight of sample before extraction (W_1)	18.31	18.31	18.31	18.31	18.31
5	Weight of sample after extraction (W_2)	6.81	7.01	7.21	7.41	7.61
6	Weight of oil extracted (W_3)	0.6280	0.6171	0.6062	0.5953	0.5843
7	Percentage of oil extracted (W_4)	62.80	61.71	60.62	59.53	58.43

21....

NOTE:

CALCULATIONS

- (1) $W_1 = Y - X$
- (2) $W_2 = Z - X$
- (3) $W_3 = \frac{W_1 - W_2}{W_1}$
- (4) $W_4 (\%) = [W_3 \times 100]$

KEY (CLASSIFICATION OF SIZE)

- (1) SAMPLE 1 = 500um
- (2) SAMPLE 2 = 850um
- (3) SAMPLE 3 = 1.40mm
- (4) SAMPLE 4 = 2.00mm
- (5) SAMPLE 5 = 2.80mm

CONVERSION

(10³um = 1mm)

TABLE 4.3

SOLVENT USED FOR EXTRACTION: Ethanol			
TIME TAKEN	“	”	: 6HRS
TEMPERATURE	“	”	: 105°C

S/No.	WEIGHTS (IN g) BEFORE EXTRACTION	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5
1.	Weight of thimble + glass wool (X)	3.98	3.76	3.82	4.01	3.92
2.	Weight of thimble + sample + glass wool (Y)	22.70	22.48	22.54	22.73	22.64
	Weight (in g) After Extraction					
3	Weight of thimble + Sample + glass wool (Z)	8.98	9.64	10.54	11.65	12.44
	CALCULATIONS					
4	Weight of sample before extraction (W ₁)	18.72	18.72	18.72	18.72	18.72
5	Weight of sample after extraction (W ₂)	5.00	5.88	6.76	7.64	8.52
6	Weight of oil extracted (W ₃)	0.7329	0.6858	0.6389	0.5919	0.5448
7	Percentage of oil extracted (W ₄)	73.29	68.58	63.89	59.19	54.48

NOTE:

	<u>CALCULATIONS</u>	<u>KEY (CLASSIFICATION OF SIZE)</u>	<u>CONVERSION</u>
(1)	$W_1 = Y - X$	(1) SAMPLE 1 = 500um	(10 ³ um = 1mm)
(2)	$W_2 = Z - X$	(2) SAMPLE 2 = 850um	
(3)	$W_3 = \frac{W_1 - W_2}{W_1}$	(3) SAMPLE 3 = 1.40mm	
(4)	$W_4 (\%) = [W_3 \times 100]$	(4) SAMPLE 4 = 2.00mm	
		(5) SAMPLE 5 = 2.80mm	

22...

TABLE 4.4 DRYING OF SAMPLE FOR 5HRS.
AT TEMPERATURE OF 100°C IN OVEN.

S/NO	QUANTITY OF FRESH SAMPLE (IN g)	TIME (IN hr) FOR EVAPORATION
1	50	0
2	46.5	1
3	37.1	2
4	26.8	3
5	26.0	4
6	26.0	5

APPENDIX I

(TABLE OF RESULTS)

TABLE 3.5.1 SAPONIFICATION VALUE TEST

Quantity of oil used (g)	Volume of acid (Hcl) (v ₁)	Volume of Hcl used in blank (v ₀)	Saponification value (S.V.)	Average S.V
0.1	23.12	23.78	185.13	189.34
0.1	25.20	25.89	193.54	

TABLE 3.5.2 ACID VALUE TEST

Quantity of oil used (g)	Oil of 0.5 KOH used	Acid value	Average Acid Value.
2	0.6	8	7.5
2	0.5	7	

APPENDIX II

TABLE 3.3.3. IODINE VALUE

Quantity of oil used (in g)	Blank Reading BL (in mol/ml Icl)	Test Reading (T) (in mol/ml Icl)	(BL-T) mol/ml Icl	Average (BL-T)
2	25.04	22.41	2.63	3.05
2	24.81	21.34	3.47	

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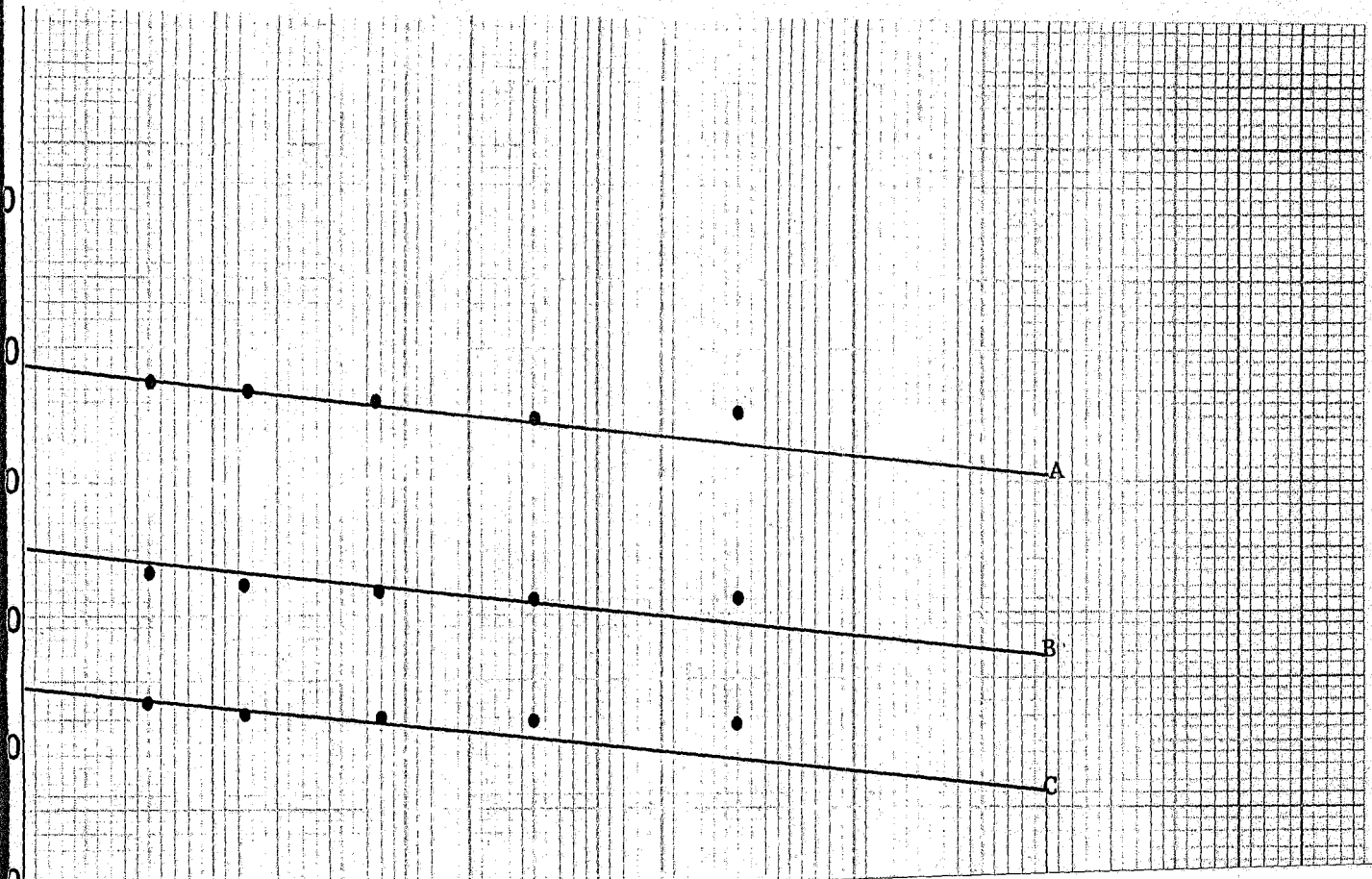
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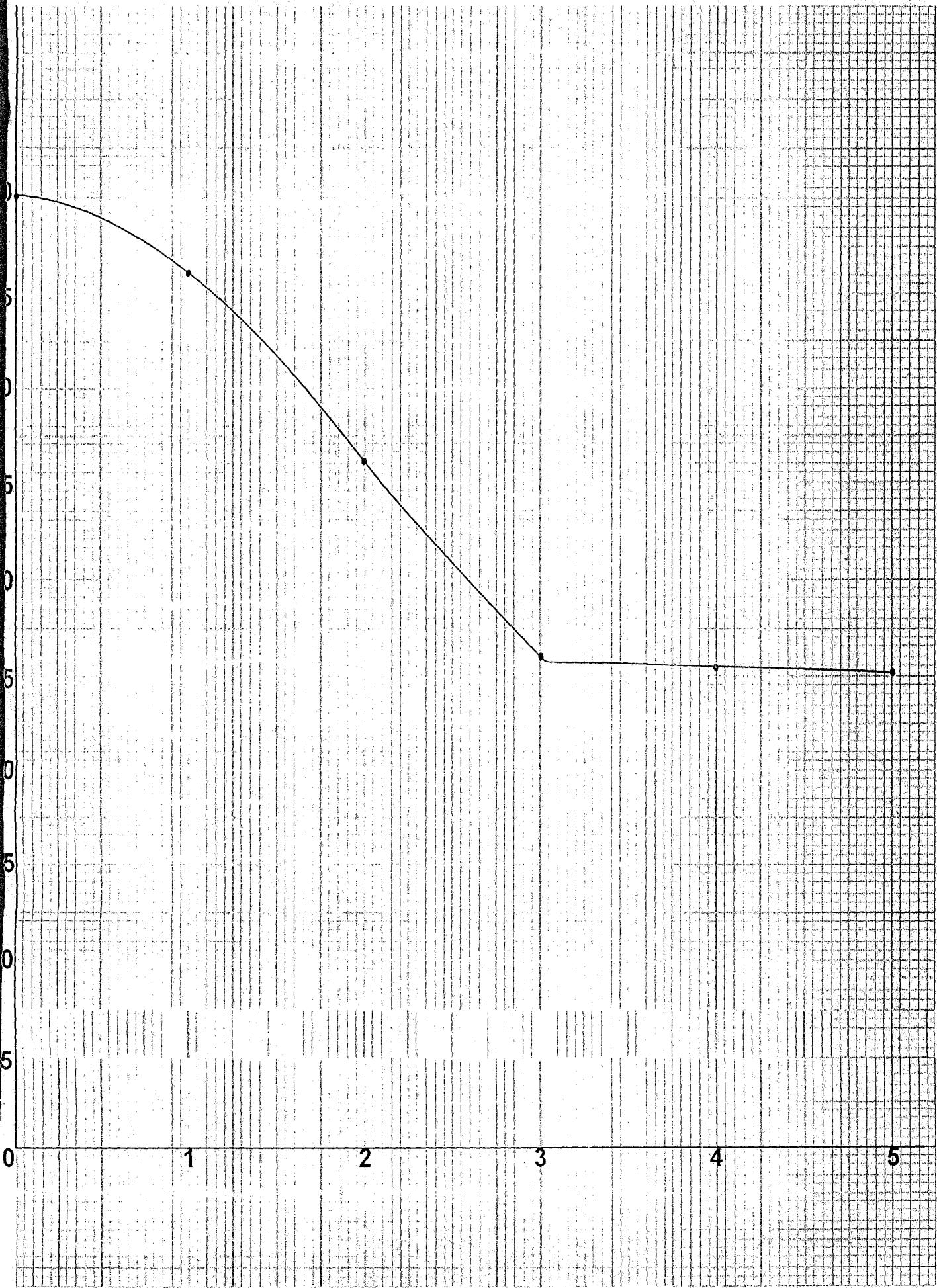
**DEPARTMENT OF CHEMICAL ENGINEERING,
SCHOOL OF ENGINEERING AND ENGINEERING
TECHNOLOGY.**

**FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA,**

No.2 GRAPH OF WEIGHT OF FRESH SAMPLE(IN g)

Vs
DRYING TIME (IN hr)

SCALE: 2cm = 5 Units on Y - Axis
4cm = 1 Unit on X - Axis



No 1 GRAPH OF % OIL YIELD USING DIFFERENT SOLVENTS
VS
PARTICLE SIZE

SCALE: 2cm = 10 Unit on Y-axis
4cm = 1 Unit on X-axis



KEY
A. = n-hexane
B. = methanol
C. = petroleum ether