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Extraction of Mango Seed Oil From Mango Kernel

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Abstract:- Mango is a fruit which is indigenous to the Indian subcontinent, belonging to the genus Mangifera, consisting of numerous species of tropical fruiting trees in the flowering plant family Anacardiaceae. This project aims at the process development of mango seed oil production. Solvent n-Hexane was used to extract mango seed oil from the mango kernel using Soxhlet apparatus. The operating temperatures were between 40 – 70^0C. The percentage oil extraction by Solvent Extraction process, minimum solvent requirement for 20g of mango kernel, time required for extraction which was found to be 12%, 200 ml, 3 hours respectively. The mathematical modelling for the above said variables has been done in this research.

Keywords:- Mango seed oil, Mango kernel, Solvent extraction.

I. INTRODUCTION

Mango, Mangifera indica L is a member of the family Anacardiaceae. Mango has become naturalized and adapted throughout the tropics and subtropics. There are over 500 classified mango varieties, some of them have evolved and have been described throughout the world. The genus of Mangifera consists of 69 species and mostly restricted to tropical Asia.The highest variety of mango occurs in Malaysia, particularly in peninsular area and about 28 species are found in this region. There are several varieties of mango grown in Malaysia, the better known cultivars are Golek (MA 162), Masmuda (MA 204), Maha 65 (MA 165) and Chok Anan (MA 224). The domestic consumption increased from 42,634 MT (2002) to 55,901 MT (2005). The significant increases of mango consumption in domestic activity lead to the accumulation of waste. Mango seed kernel is usually wasted when processing.

After consumption or industrial processing of mangoes, approximately 40 to 60% waste is generated during processing of mangoes; 12 to 15% consists of peels and 15 to 20% of kernels. According to mango varieties, the seed represents from 10 to 25% of the whole fruit weight. The kernel inside the seed represents from 45 to 75% of the seed and about 20% of the whole fruit. However, more than one million tons of mango seeds are being treated as wastes.

In a study for Egyptian mango by-product to proximate its compositional quality of mango seed kernel, mango seed kernels contained a considerable amount of total phenolic compounds, total lipid, unsaponifiable matter and a low amount of crude protein, but the quality of protein was good because it was rich in all essential amino acids with highest values of leucine, valine and lysine. Eight phenolic compounds were identified in which tannin and vanillin were in highest amounts. Unsaponifiable matter showed the occurrence of high amounts of squaline followed by sterols and tocopherols. Stearic acid was the main saturated fatty acid, while oleic acid was the major unsaturated fatty acid in all lipid classes. The fatty acid composition of total lipid and neutral lipid was similar, while phospholipid had a high amount of palmitic, linoleic and linolenic acids .

Depending on their variety, mango seed kernels contain on a dry weight average 6.0% protein, 11% fat, 77% carbohydrate, 2.0% crude fiber and 2.0% ash. Mango seed kernels were shown to be a good source of polyphenols, phytosterols as campesterol, β-sitosterol and tocopherols. Extracted and fractionated total lipids from Alphonso mango kernel - Total lipid (11.6% of dry kernel) consists of 96.1% neutral and 3.9% polar lipids, which comprised 2.9% glycolipids and 1.0% phospholipids. Nutritional and toxicological studies of the mango seed kernel, indicated that mango seed kernel fat is promising and a safe source of edible oil and was found to be nutritious and non-toxic so that it could be substituted for any solid fat without adverse effects .

Mango kernel extracts are hidden treasures. Because the kernel, when cold pressed, renders mango kernel butter, not oil. This butter itself is highly prized and could pose as a good substitute for cocoa or shea butter. Being an excellent source of essential fatty acids, rich in minerals and vitamins, mango kernel butter exhibits beneficial moisturizing properties for skin lotions and lubricants. It is solid at room temperature, smells sweet and nutty in its pure form and has a smooth creamy color. It has a mild aroma, similiar to olive oil and a bit nutty.

Semi-solid mango kernel oil is obtained during the refining of mango kernel butter. This soft-yellow-coloured oil is said to have a stronger odor than the butter, and has a melting point of around 23-27° C, meaning that it effectively melts when it comes in contact with skin. An average mango kernel contains about 8% to 15% extract potential (butter and oil). This seed, which is usually discarded, can be used in cosmetics and beauty products. Shelf life is 3-4 years if stored cool. Most mango oils are refined and during that process the therapeutic quality is altered.

II. MATERIALS USED

The raw material used in this experiment is Mango seed. Hexane is the choice of solvent. Their properties are tabulated below.

A. Raw Material Specifications

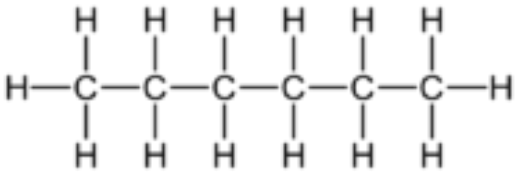


Fig.1. Chemical formula of Hexane

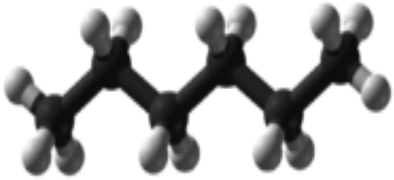


Fig.2. Structure of Hexane

Table I. Properties of Hexane

PROPERTIES	HEXANE
Boiling point	68.7°C
Vapor pressure	124 Torr at 20°C
Molecular weight	86.18
Freezing point	-95.3°C
Refractive index	1.3749 at 20°C
Density	0.6594 g/mL at 20°C
Dielectric constant	1.88 at 25°C
Dipole moment	0.08 D at 25°C
Viscosity	0.31 cP at 20°C
Surface tension	17.91 dyn/cm at 25°C
Solubility in water	0.014% at 20°C
Nature	Flammable Liquid
Flash point	-7°F (-22°C) by closed cup

Table II. Composition of Mango seed

COMPOSITION	MANGO SEED
Chemical Composition	Percent (%)
Moisture Content	45.2 ± 0.17
Oil	13.0 ± 1.28
Crude Protein	6.36 ± 1.07
Crude fiber	2.02 ± 0.80
Ash content	3.2 ± 0.30
Carbohydrate	32.24

Fig.3.Mango seed oil

B. Soxhlet extractor

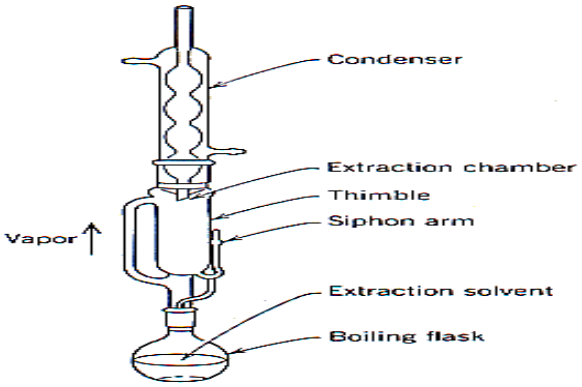


Fig.4. Soxhlet extractor

A Soxhlet extractor is a piece of laboratory apparatus invented in 1879 by Franz Von Soxhlet. Soxhlet extractor is divided in to three parts.

1) Boiling flask
2) Thimble
3) Condenser

Fig.4 presents detailed mechanism. Here Extracting Solvent in boiling flask is subsequently condensed by water flowing in and out of the extraction set-up.

III. SOLVENT EXTRACTION PROCESS

A. Extraction Process

The extraction of Mango seed oil was carried out using a Soxhlet extractor and n-hexane as solvent. Three hundred millilitres (300ml) of hexane was charged into the round bottom flask of Soxhlet apparatus. Subsequently, 20g of crushed Mango seed was charged into the thimble and fitted into the Soxhlet extractor. The apparatus was assembled. The solvent in the set-up was heated and the vapour produced was subsequently condensed by water flowing in and out of the condenser. This process of heating and cooling continued until a sufficient quantity of Mango Seed Oil was obtained. At the end of the extraction, the thimble was removed

while the remaining solvent is recharged into the round bottom flask. Finally, the set-up was then re-assembled and heated to recover the solvent from the oil.

B. Minimum Solvent Requirement

3gms of cashew nut shell was taken in a conical flask and 100ml of hexane was added and kept in a shaker for 2hrs. % oil extracted was estimated. This procedure was repeated for 200, 300, 400ml of hexane and the % oil extracted was determined.

IV. RESULTS AND DISCUSSIONS

The following parameters have been varied and the results are tabulated below.

1)Effect of Temperature with respect to time.
2)Effect of Time with respect to No. of Cycles.
3)Effect of Quantity of solvent over percentage extraction
4)Effect of Time on percentage extraction

A. Effect of Time over percentage Extraction of oil

Table III. Extraction of Mango seed oil in 4 hours

S. NO	Temperature ^{0}C	Time difference (min)	Cumulative time (min)
1	55.0	26	26
2	56.0	19	45
3	55.5	6	51
4	56.5	11	62
5	56.5	10	72
6	57.0	10	82
7	58.0	11	93
8	58.0	9	102
9	58.0	10	112
10	59.5	11	123
11	60.0	12	135
12	61.0	7	142
13	62.0	13	155
14	61.0	11	166
15	61.5	10	176
16	62.0	9	185
17	62.5	11	196
18	62.5	13	209
19	64.0	8	217
20	64.0	12	229
21	65.0	7	236
22	66.0	14	250

Fig.5. Time in min Vs Temparature in °C, 4hrs

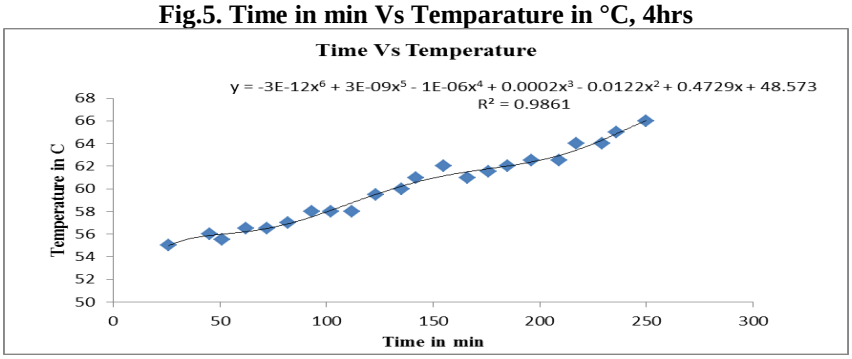


Fig.6. Time in min Vs Number of Cycles, 4hrs

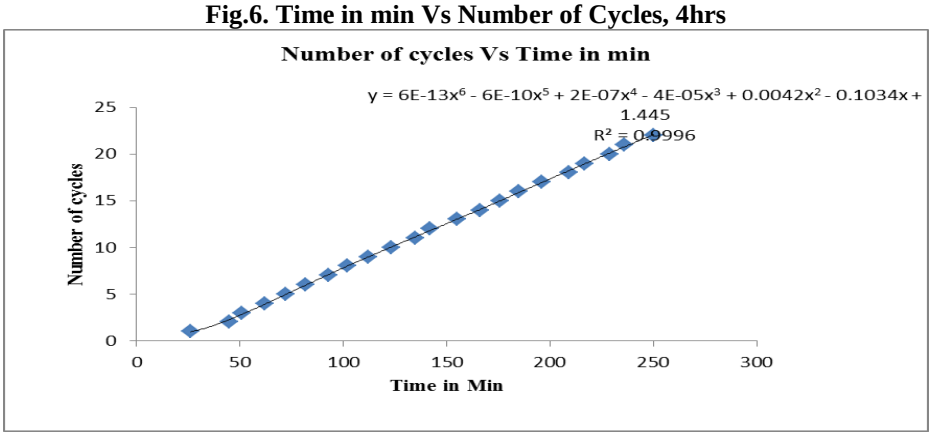


Fig.7. Cycles Vs cycle time ,4hrs

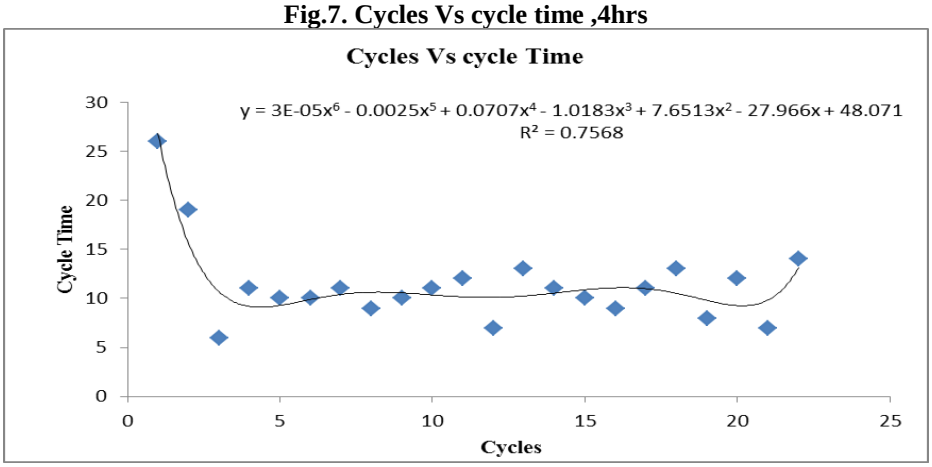


Table IV. Extraction of Mango seed oil in 3 hours

S.NO	Temperature ^{0}c	Time difference (min)	Cumulative time (min)
1	43.5	26	26
2	46.5	12	38
3	47	9	47
4	47.5	9	56
5	49	9	65
6	49	10	75
7	49	10	85
8	50	10	95
9	50.5	10	105
10	50.5	10	115
11	51	10	125
12	51	10	135
13	51	10	145
14	53	12	157
15	54	10	167
16	54.5	11	178
17	55	13	191

Fig.8. Time Vs Temperature, 3hrs

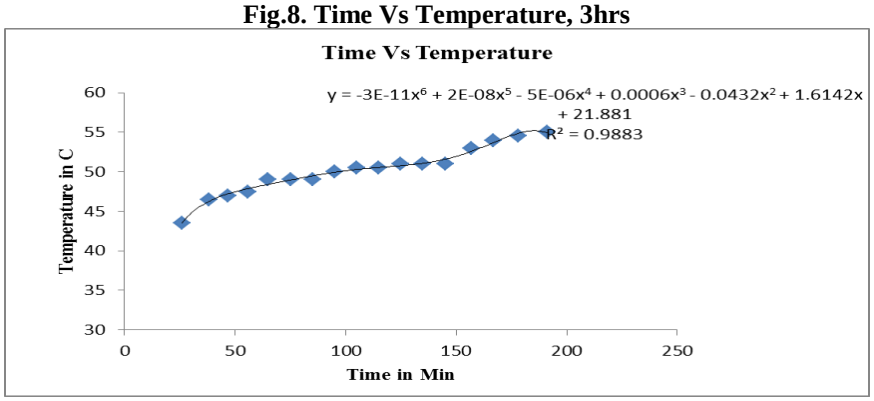


Fig.9. Time in min Vs Number of Cycles, 3hrs

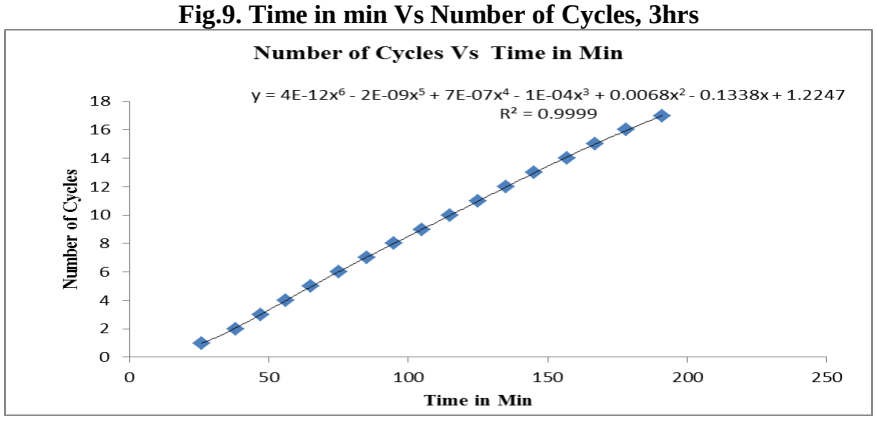


Fig.10. Number of cycles Vs temperature , 3hrs

Table V. Extraction of Mango seed oil for 2 hrs

S. NO	Temperature ^{0}C	Time difference (min)	Cumulative time (min)
1	53	26	26
2	54	16	42
3	54	17	59
4	54	17	76
5	54	16	92
6	54	17	109
7	54	18	127
8	55	18	145

Fig.11. Time Vs Temperature, 2hrs

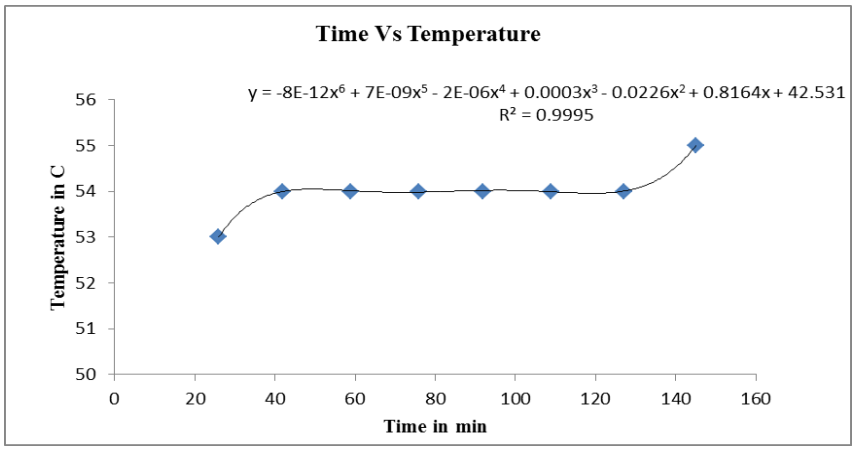


Fig.12. Time in min Vs Number of Cycles , 2hrs

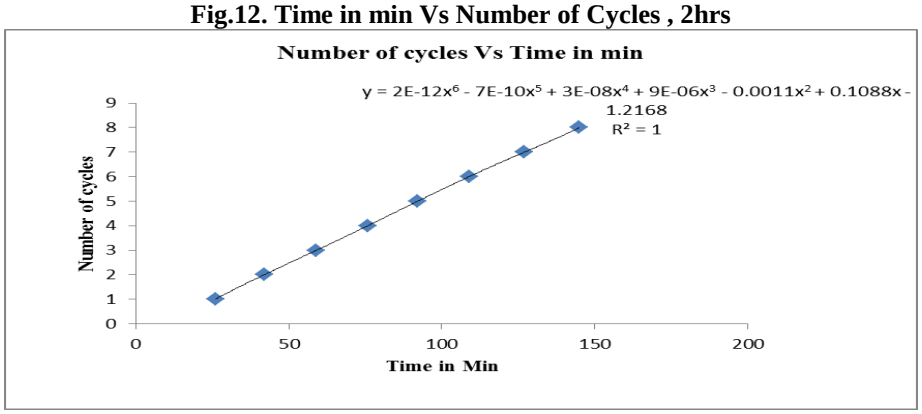


Fig.13 Number of cycles Vs temperature , 2hrs

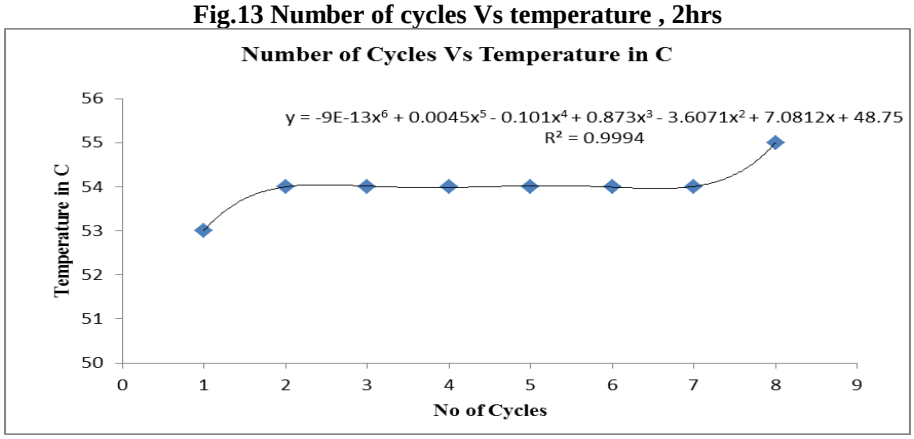


Table VI. Extraction of Mango seed oil for 1 hr

S. NO	Temperature 0C	Time difference (min)	Cumulative time (min)
1	60.5	29	29
2	62	5	34
3	64.5	2	36
4	65.5	4	40
5	66.5	2	42
6	67.5	7	49
7	68	3	52
8	68	3	55
9	69.5	7	62

Fig.14. Time Vs Temperature, 1hr

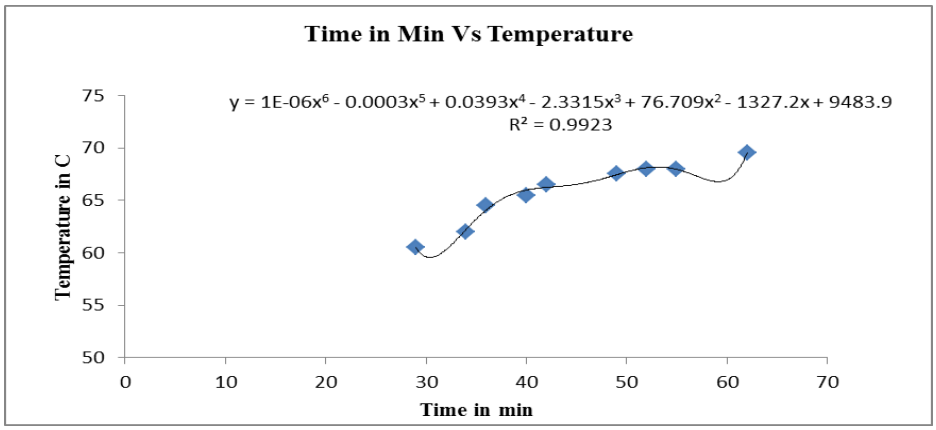


Fig.15. Time in min Vs Number of Cycles,1 hr

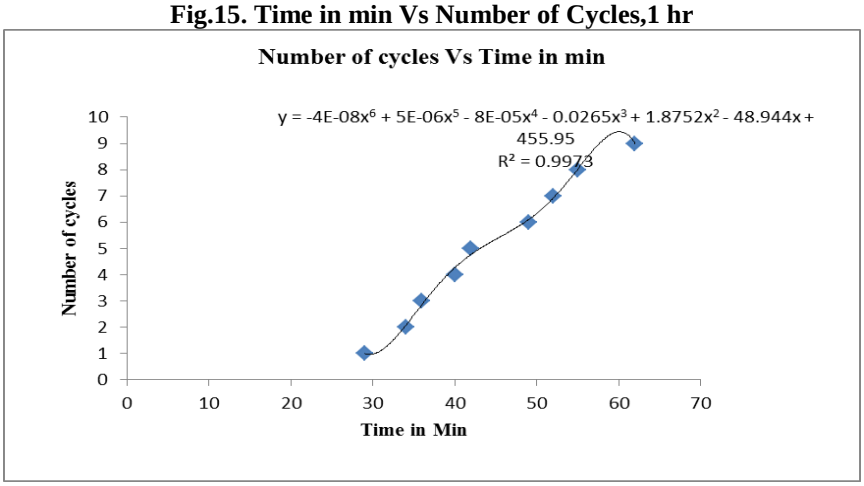
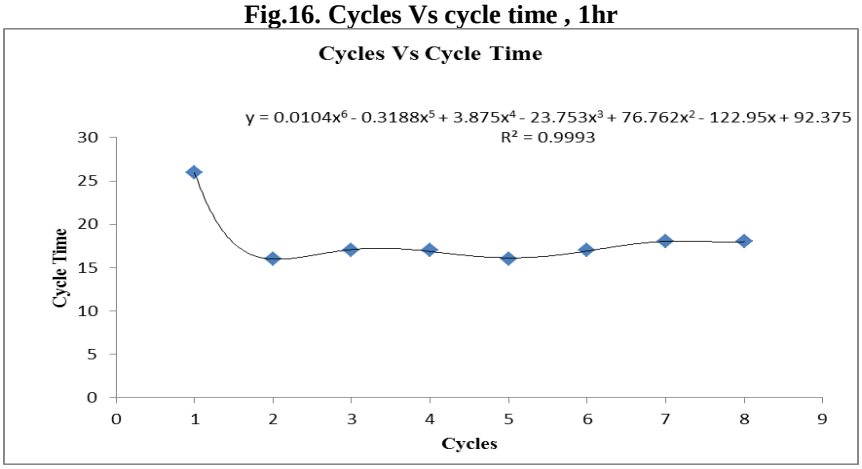


Fig.16. Cycles Vs cycle time , 1hr



B. Minimum Solvent Requirement

Table VII. Solvent (Hexane) used in ml Vs Percentage Mango seed oil extracted

Time taken for experiment (hrs)	Weight of mango seed (gms)	Hexane taken(ml)	Weight of mango oil extracted(gms)	% of mango oil	% loss of hexane
2:00	3	400	0.36	12	31.25
2:00	3	300	0.36	12	33.33
2:00	3	200	0.36	12	40.00
2:00	3	100	0.28	9.3	50.00

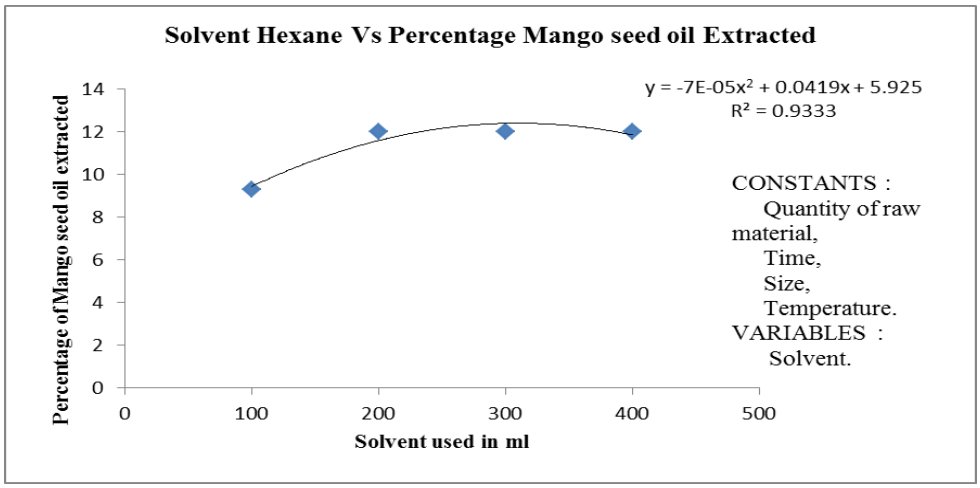


Fig.17. Solvent (Hexane) used in ml Vs Percentage Mango Seed Oil extracted

From the above experimentation the minimum solvent required to extract maximum oil from the mango seed kernel is found to be 200 ml.

C. Effect of time on extraction of Mango seed oil:

An experiment is conducted by varying the time of extraction for a fixed quantity of Mango seed Kernel, minimum solvent required (200 ml). A graph is plotted between percentage of Mango seed Oil extracted and the time taken for extraction. The percentage of Oil extracted increases with increase in time and remains constant after 2 hrs.

Table VIII. Time Vs Percentage of extraction

Time taken for experiment (hrs)	Weight of kernel (gms)	Weight of oil extracted (gms)	% Mango seed oil extracted	% loss of Hexane	Number of cycles
4	20.00	2.52	12.50	20.00	18
3	20.05	2.50	12.48	23.30	12
2	20.09	2.42	12.39	26.66	6
1	20.03	2.17	10.85	33.33	4

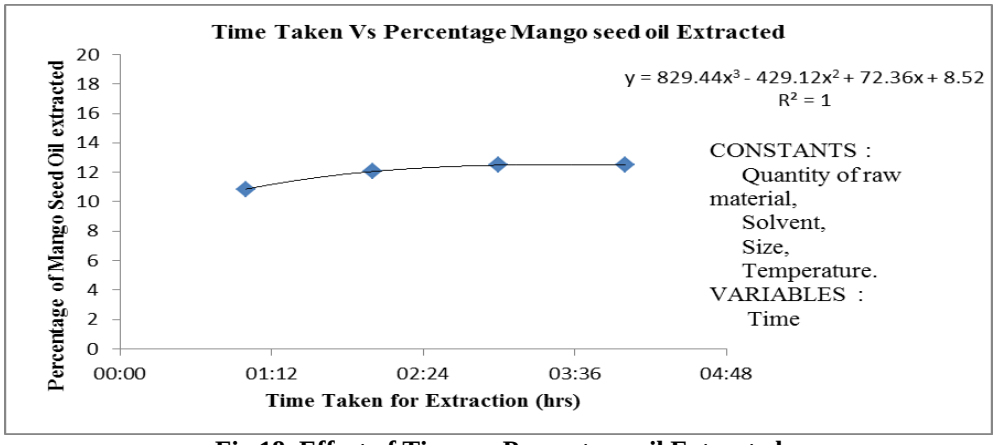


Fig.18. Effect of Time on Percentage oil Extracted

V. CONCLUSIONS

Mango seed oil was extracted using Hexane as a solvent and different process variables are studied and the following conclusions were derived.

The percentage of extraction of Mango seed oil by Solvent Extraction process is 12%

The minimum solvent requirement is estimated as 200ml for 20 g of Mango seed oil.

The minimum time required for the extraction is 3 hours.

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