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Watermelon Seed Oil: Its Extraction, Analytical studies, Modification and Utilization in Cosmetic Industries

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Abstract - *Watermelon seed is one of the unexplored seed in the world which is often discarded after eating the fruit. Researches show that these seeds contain nutrients like protein, essential fatty acids, vitamins and minerals. Oil content in the seeds is between 35-40% and the unsaturated fatty acid content in oil is 78-86% predominantly linoleic acid (45-73%). This oil is effective for skin care as it is light, easily absorbable and has humectants properties. Our study is about extraction of watermelon seed oil by solvent extraction process with the use of different solvents, its analysis and application in a skin care product. Solvent extraction was carried by n-hexane, benzene and mixed solvent system. A brief process optimization of solvent extraction is also discussed. We did comparative analysis of oil on the basis of previous available literature. Since the oil contains effective skin moisturising properties it is used in a formulation of moisturisers.*

Key Words: Watermelon seed oil, essential fatty acids, linoleic acid, skin care, humectants, solvent extraction, optimization, moisturiser**.**

1. INTRODUCTION

Watermelon (Citrullus lanatus) is a fruit from the plant family of Cucurbitaceae. Watermelon is an edible fruit containing 92% water and 6% sugar. The fruits outer rind is usually green and interior part consists of red pink flesh with brown-black seeds embedded in it. It is grown in tropical and temperate regions worldwide and needs temperature more than 25□C to grow. In year 2017 world water melon production was 118 million tonnes and China been the highest watermelon producing country with 79.3 million tonnes. India is ranked 25th with Uttar Pradesh and Andhra Pradesh been the highest watermelon producing state. The watermelon seeds are rich in protein, vitamin B, mineral (Zinc, Magnesium, Sodium, Phosphorus, Potassium, Iron, Copper and Manganese) and fat content [1]. These seeds are sometimes consumed as snacks by roasting in oven and sprinkling salt over them.

Watermelon seeds are nowadays used for oil extraction. The seeds are dried and oil is extracted by pressing them. This practice is common in West Africa and the watermelon seed oil is popularly known as Ootanga oil or Kalahari oil. Oil is used as frying oil in various African nations [2]. Watermelon seed contains about 40% of oil with high amount of unsaturated fatty acids (about 80%) predominantly linoleic acid or omega 6 fatty acid (about 45-73%). Oleic, palmitic and stearic acid are also present in small quantities [3].

Various researches report the positive effect of watermelon seed oil over skin. The oil is light, consists of humectants and moisturising properties. It is easily absorbed by skin and helps in restoring the elasticity of skin. Due to these attributes this oil can be used in cosmetic industry for production of skin care products. The watermelon seed oil can also be used as an anti inflammatory agent [4].

There are many unexplored plan seeds which are rich in vital nutrients and oil in them, watermelon seed is one of them. It is often seen that the watermelon seeds are discarded after eating the fruit. These discarded seeds can be used for oil extraction purpose. The aim of our study was the extraction of watermelon seed oil with various solvents and a mixed solvent system and the extracted oil was analysed and used for skin care products.

2. Materials and Methodology

The watermelon seeds were procured from local fruit vendor, Nagpur. Seeds were dehulled, winnowed, screened, cleaned, grinded and preheated. The colour 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 [5]. Seeds were then heated in oven for 2 hours at 105 □C. Heat treatment also offers the easy oil release by driving moisture out of the seeds [6]. It can be concluded that 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 utilised for oil extraction. The solid to solvent ratio was kept at 1:5. The solvent extraction was done by Soxhlet apparatus. Miscella was allowed to cool at room temperature and then distillation of mixture was carried out in order to separate oil and solvent. The recovered solvent was measured and was used for next batch whereas; oil obtained after distillation was filtered and weighed.

Table -1: Time required for extraction with various solvents

Parameter		Solvent		
		n-hexane	Benzene	Mixed solvent
Extraction	Time	80 min	90 min	75 min
	Temperature	65□C	75□C	70□C
Distillation	Time	28 min	22 min	18 min
	Temperature	60□C	65□C	70□C

The above table shows the time required for oil extraction from different solvents and it was observed.

3. Characterization

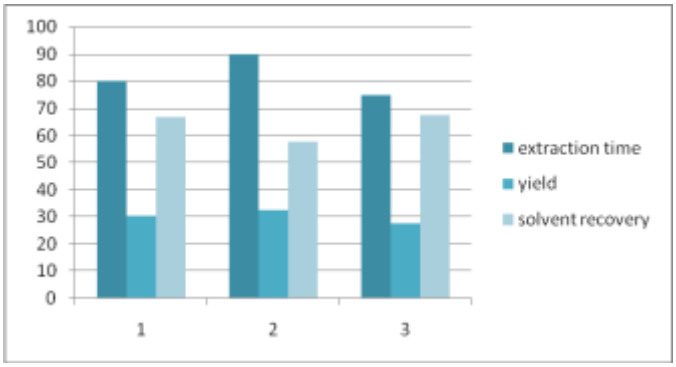
3.1 Analytical method

The watermelon seed oil obtained from solvent extraction was analysed using official method mentioned in Manual of Methods of Analysis of Foods by Food Safety and Standards Authority of India (FSSAI) for the determination of moisture content, acid value, saponification value (Sap.value) and iodine value [7]. Abbeys refractometer was used for determining the refractive index of oil.

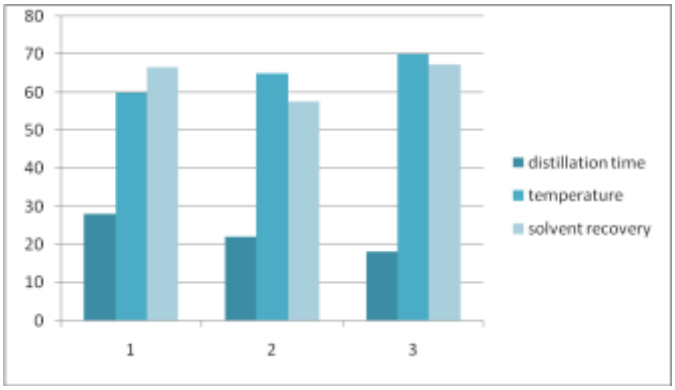
Table-2: Analysis of the oil extracted with various solvents

Analysis	Solvents		
	n-hexane	Benzene	Mixed solvent
Moisture content	0.05 %	0.0.4 %	0.07 %
Refractive index	1.4735	1.4752	1.4514
Colour	Pale yellow	Dark brown	Dark brown
Acid value	2.88	5.44	3.45
Sap.value	208.3	218.2	195.5
Iodine value	111	121	106
Solvent recovery	66.67 %	57.64 %	67.33 %
Yield (%)	30.55	32.61	29.78

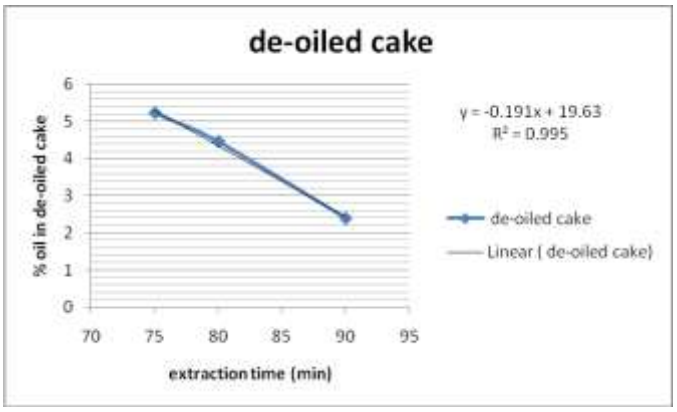
Graph 1: Extraction of watermelon seed oil.



Graph 2: Effect of time and temperature on solvent recovery



Graph 3: Oil left in the seed after extraction



3.2 Analysis of fatty acids composition by Gas Chromatography (GC)

The analysis of oil for fatty acid compositions was carried out at CDRI (CSIR) Laboratory Lucknow. The sample were converted into methyl esters and were charged in the GC instrument of Flame Ionization Detector and Integrator. Nitrogen was used as carrier gas, retention time was 12 minutes. Vitamin E as gama tocopherol was also present to the amount of 0.25 %. It also contains minor amount of unusual fatty acid i.e, Margaric acid (0.68 %).

Fatty Acids in %	Sample No. 1 (pale yellow)	Sample No. 2 (dark brown)
Palmitic acid	34.43	34.01
Stearic Acid	13.12	13.01
Oleic Acid	5.11	5.34
Linoleic Acid	45.22	45.01
Arachidic Acid	1.12	1.63

4. Application

The above studies shows that watermelon seed oil has excellent humactant and moisturizing properties and it is to be observed that it has positive effect over the both oily and dry skin. It is easily absorbed by the skin and helps in

restoring the elasticity of the skin, due to this attributes this oil can be utilized by cosmetic industries. The preparation of the moisturizer was done according to the given formulation, which shows the properties similar to the market grade moisturizer.

Sr. No	Component	Amount
1.	Watermelon seed oil	6-10%
2.	Stearic acid	2-5%
3.	GMS	2-10%
4.	PEG	2-6%
5.	Water	70-85%
6.	Glycerine	5-10%
7.	Miscellaneous	1-3%

5. Results and Discussion

From table 2, the acid value of the oil sample was found to be 2.88 mg KOH/gm with n-hexane, with benzene 218.2 mg KOH/gm and 3.45 mg KOH/gm for mixed solvent system. These acid values are lower than 5.05 mg KOH/gm reported by Nueza[8]. Since the acid value <10 mg KOH/gm proves the stability towards rancidity. The saponification value with n-hexane, benzene and mixed solvent was found 208.2 mg KOH/gm, 218.2 mg KOH/gm and 195.5 mg KOH/gm respectively. These values are lower than the values 220 mg KOH/gm reported by Edidong [9]. Since the values are <220 mg KOH/gm it can be said that the oil is not suitable for soap manufacture. The iodine value is found to be 111 gm/100 gm, 121 gm/100 gm and 106 gm/100 gm for oil by n-hexane, benzene and mixed solvent respectively. These values are much higher than 74.5 ±0.5 reported by Oyeleke and Olagunju [10]. The higher iodine value makes the oil suitable for paint manufacture, and can also be used for production of hydrogenated and interesterified fats.

From graph 1, the graph shows the relation between extraction time, yield and solvent recovery. For better yield it takes more extraction time and increase in extraction time results in lesser solvent recovery.

From graph 2, the graph shows the relationship between the parameters of distillation which are responsible for better solvent recovery. From graph it can be concluded that for high temperature distillation time required is less and vice versa.

Muzendu observed that the solvent extraction process was enhanced by increasing the extraction time [11]. This can be seen in graph 1 in which the oil yield is more at higher extraction time. It is also observed that the colour of oil extracted from benzene and mixed solvent was dark brown of dark colour. This could have happened because benzene may have extracted the pigments present in seeds, due to this reason benzene could not be the suitable solvent for extraction of watermelon seed oil by solvent extraction even though the yield was highest. The best oil quality which we got was from n-hexane with an optimum yield (30.55%) and of best quality.

From graph 3, the relationship between residual oil and extraction time is shown here. The deoiled seed contains 2.39 %, 4.45 % and 5.22 % for solvents benzene, n-hexane and mixed solvent system at temperatures 75 min, 80 min and 90 min respectively. The oil remaining in de-oiled cake can be calculated by the given equation i.e;

$$Y= -0.191X+19.63 \qquad R^2=0.995$$

Where; X= extraction time
Y= % oil in de-oiled cake

Vilas M. reports deoiled cake contains 26.8 % protein which was used for formulation of detergent [12]. The de-oiled seed can be used as cattle feed or used in protein extraction which could be used in nutraceutical industries.

6. Conclusions

The watermelon seed, despite its high nutritional content and medicinal value still remain unexplored and unutilized in India. Over the years, due to high rate of production and lack of awareness of benefits of its seeds, the seed is suffered negligence which results in wastage of oil seed.

We also observed that extraction is dependent on some factors such as contact time between solvent and solute, amount of solvent that is to be used, amount of heat supplied, oil content in the seed and the pre-treatment which are done on the seeds before extraction to remove moisture, hulls, impurities carried out by harvesting and to increase surface area for extraction.

As watermelon seed oil is rich in vitamin E and has good humectant and moisturizing properties so it can be used as anti-inflammatory agent for skin care products. The oil can be used for modifying the properties of skin care products and used as modification oil.

The DOC (De Oiled Cake) remained after extraction can be further utilised for protein extraction as it contains a significant amount of protein which can be utilised by surfactant industries as well as nutraceutical and pharmaceutical industries. The DOC is also used to feed the cattle.

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