EXTRACTION OF OIL FROM FLUTED PUMPKIN SEED (*Telfairia Occidentalis*) BY SOLVENT EXTRACTION METHOD

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Abstract
Fluted pumpkin seeds (Telfairia Occidentalis) contain valuable edible oil. A study of oil extraction from the seed was conducted using a 3 x 4 factorial experiment in a Randomized Complete Block Design (RCBD). Fluted pumpkin seed pods were procured from National Horticultural Research Institute (NIHORT), Ibadan, Nigeria. Some of the major equipment used were: laboratory test sieve (RO-TAP: ASTME11, AASHTOM92, HUMBOLDT, standard sieve) and digital weighing balance (OHAUS 3001, accuracy: 0.001).Three different solvents with four levels (100%, 80%, 60% and 40%) and three replicates were used. The solvent used were petroleum ether, n-hexane and methanol. AOAC (2002) standard was used for quality analysis of oil. Data obtained for oil yield, extraction efficiency, extraction loss, acid value, iodine value, saponification value, peroxide value, refractive index and viscosity were analyzed using (ANOVA) at ($P \leq 0.05$). The values obtained for oil yield, extraction efficiency, extraction loss, acidic value, peroxide value, iodine value, saponification value, refractive index and viscosity at 100% levels were 16.446%, 79.9%, 2.857%, 3.16Mg/KOH/g, 0.84Meq/g, 103.2Mg/I/g, 154.2Mg/KOH/g, 1.4323, 1.88cm/s respectively for petroleum ether, 20.185%, 96.7%, 4.153%, 4.20Mg/KOH/g, 0.79Meq/g, 104.4Mg/I/g, 147.3Mg/KOH/g, 1.4235, 1.92cm/s for n-hexane and 8.994%, 43.8%, 2.571%, 14.10Mg/KOH/g, 0.90Meq/g, 92.6Mg/I/g, 87.4Mg/KOH/g, 1.3987, 1.60cm/s for methanol. The results obtained showed that all the solvents used performed better at 100% level; and the lower the level of solvents the lower the output parameters in terms of oil yield, extraction efficiency, extraction loss and oil qualities(acid value, iodine value, saponification value, peroxide value, refractive index and viscosity).

Keywords: Quality, Extraction, Fluted Pumpkin Seed, Solvent, levels.

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1.INTRODUCTION

Fluted pumpkin (*Telfairia occidentalis*) plant was said to have originated from the South Eastern Nigeria, and it is widely distributed among the Igbo speaking people, especially, around Imo state, Nigeria (Esiaba, 1982 and Akoroda, 1990). It has the widest diversity in terms of variation in pod and seed colour, seed and plant vigour, anthocyanin content of leaves and petioles or shoots, leaf size and their succulence, dioecious or monoecious plants (IPGRI, 1999). Fluted Pumpkin seeds and leaves contain a lot of nutrients. The seeds are rich in many nutrients including vitamin E, Zinc, vitamin A and precious omega (omega 3 and omega 6) also known as the essential fatty acids (Orzolek *et al*., 2012). Fluted pumpkin oil is reddish brown in colour and has a unique flavour (Roberts 2012). In terms of health benefits, the oil contains essential fatty acids that help to maintain healthy blood vessels, nerves and tissues (Nwabanne 2012). Furthermore, it has also been reported that the oil has the potency to alleviate and avert prostrate and bladder problems and it is often prescribed for men of over fifty years that have prostrate problems (Nwabanne, 2012.).
Different methods such as mechanical extraction (hydraulic press and screw press), traditional extraction, super critical fluid extraction and solvent extraction are used to obtain oil from oilseeds. The solvent extraction method has become the most common method

of extraction of oil because of its high percentage of oil recovery from oilseeds. Solvent extraction bridges the gap between mechanical extraction which produces oil with high turbidity metal and water content and supercritical fluid extraction which is very expensive to build and maintain its facilities (Nwabanne, 2012). Fluted pumpkin seed contains valuable edible oil of medicinal and nutritional values; however, much work has not been done with a view to getting the level of solvents that would give the best oil after solvent extraction in terms of quantity and qualities. Therefore, the main objective of this study was to use solvent extraction method to extract oil from fluted pumpkin seed. The specific objective was to investigate the effect of different levels (100%, 80%, 60% and 40%) of three solvents (petroleum ether, n-hexane and methanol) on the extraction process (oil yield, extraction efficiency, extraction loss) and quality of extracted oil (acid value, iodine value, saponification value, peroxide value, refractive index and viscosity).

2. MATERIALS AND METHODS

2.1. Procurement and Preparation of Seeds

Matured fluted pumpkin pods (*Telifaria occidentalis*) were procured from the National Horticultural Research Institute (NIHORT), Ibadan, Nigeria. The pods were carefully cut open to expose the seeds which were embedded in an orange –yellowish fibrous material. The seeds were removed from the fruit and thoroughly washed with clean water to remove dirt and other impurities. The seeds were sun dried, sorted to get quality ones and then cracked manually to expose kernels needed for oil extraction. Kernels were further sun dried to an average moisture content of 7.25% (db). After the kernels were properly dried, they were fairly ground manually using laboratory mortar and pestle and sieved through laboratory test sieve (RO-TAP: ASTME11, AASHTOM92, HUMBOLDT, standard sieve) to obtain particle size of 1.7 mm.

2.2. Solvent Extraction Process

A uniform quantity of sieved kernels (200 g) was used throughout the experiment and was measured with a digital weighing balance (OHAUS 3001, accuracy: 0.001). Four levels of each solvent were measured and used to soak all the measured samples (sieved kernels) for a uniform time of twenty four hours in sterilized closed container. This was done at room temperature (25˚C) of the laboratory. Samples in solution were occasionally agitated manually in order to speed up the extraction process. The extraction operation was carried out at the Chemistry laboratory of University of Ilorin, Ilorin Kwara State, Nigeria in March 2015. Finally, the oil was decanted into sterilized plastic bottles, leaving slurry as residue.

2.3 Measurement of Output Parameters of Extraction Operation

The following output parameters were measured from the extraction operation

i. Oil yield
ii. Extraction efficiency
iii. Extraction loss

The equations for estimating (i-iii) were as found in Akinoso *et al.*, (2006a)

Oil Yield

The oil yield is defined as amount of oil recovered from a certain gram of the seed used and it can be expressed mathematically as:

$$OY\ (\%) = \frac{W_{OE}}{W_{OE}+W_{CK}} \times 100\% \qquad (1)$$

Where:
OY= oil yield
W_{OE} =Weight of oil extracted (g)
W_{CK} =Weight of cake (g)

Extraction Efficiency

The extraction efficiency is defined as optimum expressing capacity of the solvent and can be determined mathematically as:

$$EE\ (\%) = \frac{W_{OE}}{XW_{TS}} \times 100\% \qquad (2)$$

Where; EE= extraction efficiency
W_{OE} =Weight of oil extracted (g)

W_{TS} =Total weight of sample (g)
X =Oil content of seed (decimal)

Extraction Loss

The extraction loss is defined as the reduction in volume of the seed used. It is expressed mathematically as:

$$EL(\%)=\frac{W_{TS-(W_{oE+W_{CK}})}}{W_{TS}}\ x\ 100\% \qquad (3)$$

Where; EL= Extraction Loss
W_{OE} =Weight of oil extracted (g)
W_{CK} =Weight of cake (g)
W_{TS} =Total weight of sample (g)

2.4. Determination of Oil Quality

AOAC (2002) standard was used to determine the quality of extracted oil samples in terms of acid value, saponification value, peroxide value, iodine value, refractive index and viscosity.

2.5. Data Analysis

All data obtained from the experiment were subjected to the statistical analysis of variance (ANOVA) in order to know the effect solvents levels on all the output parameters at significance level of P ≤ 0.05. The statistical software package used was SPSS 20.0.0 version.

3. RESULTS AND DISCUSSIONS

3.1. Results of ANOVA for Output Parameters

The results of analysis of variance (ANOVA) for all the output parameters are presented in Table 1. The table showed that petroleum ether had significant effect on: refractive index, oil yield and extraction efficiency; n-hexane had significant effect on: iodine value, oil yield, extraction efficiency and extraction loss; while methanol had significant effect on: viscosity, oil yield, extraction efficiency at P≤0.05. The interpretation of the results is that careful attention must be placed on all those outputs with asterisk (*) when the corresponding solvent is to be used for extraction of oil from fluted pumpkin seeds at P≤0.05. In another words, those outputs are most likely to be affected negatively during solvent extraction process at the probability level of 0.05.

Table 1: Results of ANOVA for Output Parameters

Outputs	Petroleum ether	N-hexane	Methanol
Acidic-value (Mg/KOH/g)	0.792	0.262	0.286
Peroxide-value (Meq/g)	0.928	0.826	0.095
Saponification-value(Mg/KOH/g)	0.739	0.860	0.093
Iodine (Mg/I/g)	0.552	0.004*	0.878
Refractive index	0.001*	0.076	0.670
Viscosity(cm/s)	0.193	0.519	0.021*
Oil yield (%)	0.000*	0.000*	0.001*
Extraction-efficiency (%)	0.000*	0.000*	0.001*
Extraction loss (%)	0.210	0.027*	0.215

***Significant at P ≤ 0.05**

3.2. Effect of Solvents and Levels on the Oil Yield

The effect of solvent levels on oil yield is shown in Figure 1. From the figure, it is clearly seen that n-hexane performed best, followed by petroleum ether and methanol at all levels of solvents. The highest value (20.917%) for oil yield was obtained for n-hexane at 60% and the least value of 5.935% oil yield was obtained for methanol at 40%. These values were less than 47.0% oil yield obtained by Akinoso *et al.*, (2006b) from palm kernel using mechanical extraction process. The observed variations obtained could be due to the fact that solvents have different chemical compositions which could affect their extractive potency.

3.3 Effect of Solvents and Levels on Extraction Efficiency

The effect of solvents and levels on extraction efficiency is shown in Figure 2. From the figure, it can be inferred that the extraction efficiency at 100% n-hexane has the maximum extraction efficiency of 96.7% and the least performance least is 40% methanol with an extraction efficiency of 27.6%. The maximum extraction efficiency obtained using 100% n-hexane was higher than 64% reported by Ajibola (1989) from palm kernel oil using hydraulic press.

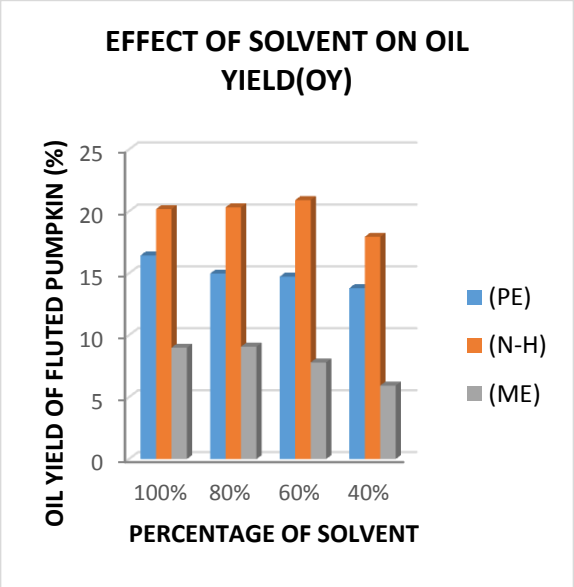

Figure 1: Oil Yield (OY)

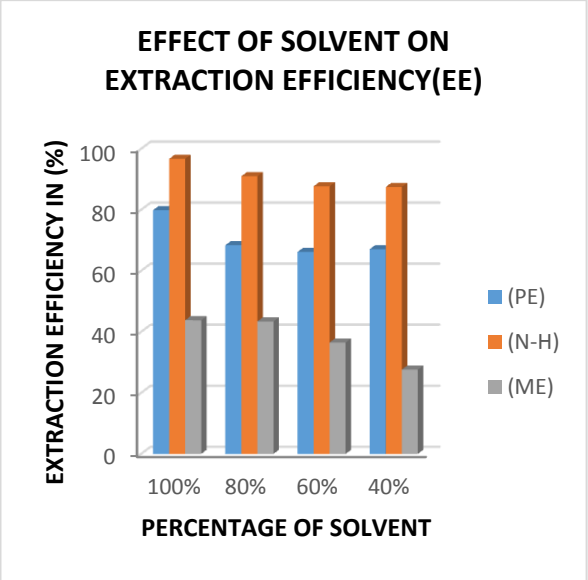

Figure 2: Extraction Efficiency

PE… Petroleum ether, N-H... n-hexane and ME… Methanol

3.4 Effect of Solvents and Levels on Extraction Loss

The effect of solvents and levels on extraction loss is shown in Figure 3. The figure showed that inferred that the extraction loss was high at 60% n-hexane with the value 16.122% and 40% n-hexane had the lowest extraction loss of 2.495%. The extraction losses experienced could largely due to human factor in handling the samples during the extraction operation.

3.5 Effect of Solvents and Levels on Acidic Value

The effect of solvents and levels on acidic value is shown in Figure 4. From the figure, it was observed that petroleum ether performed best with the acidic values between 3.16-3.18 Mg/KOH/g at all levels of solvents. Extraction with methanol had high acidic values between 14.10-14.22 Mg/KOH/g which is too high for edible oil. The values obtained for acidic value using petroleum ether was close to

3.48Mg/KOH/g reported by Muibat *et al.*, (2011).

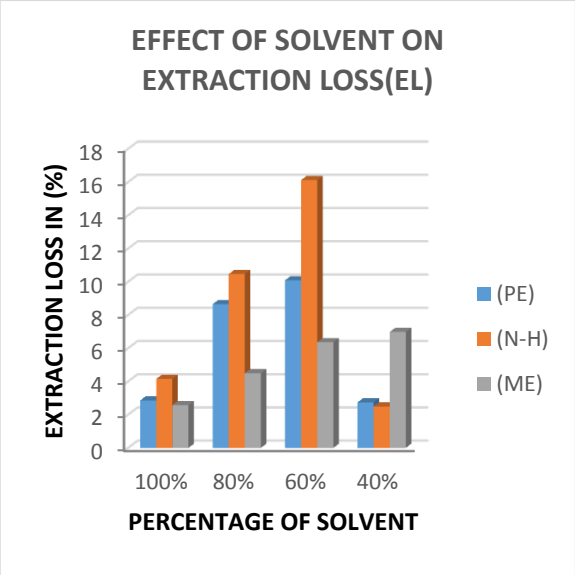

Figure 3: Extraction Loss (EL)

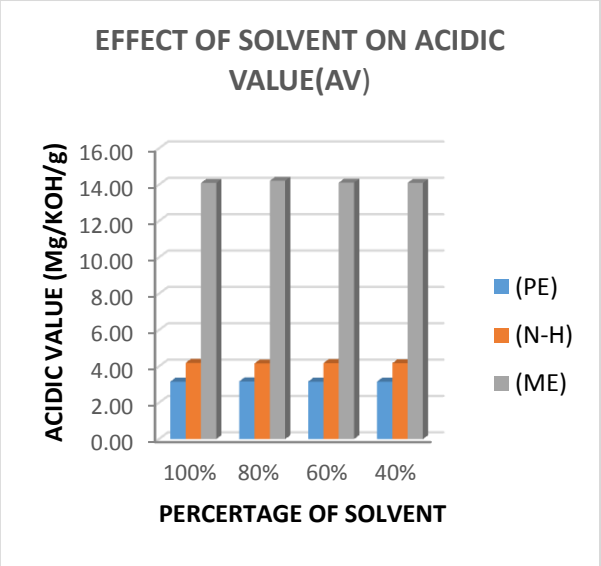

Figure 4: Acid Value (AV)

3.6. Effect of Solvents and Levels on Peroxide Value

The effect of solvents and levels on peroxide value is shown in Figure 5. From the figure, it was noticed that the peroxide value for n-hexane was the lowest between (0.79-0.81) Meq/g and methanol had the highest peroxide value between (0.90-0 91) Meq/g. This is less than that recorded by Muibat *et al*., (2011)

3.7. Effect of Solvents and Levels on Iodine Value

The effect of solvents and levels on iodine value is shown in Figure 6. The figure showed that n-hexane performed best follow by petroleum ether. The iodine value of n-hexane was between (103.7-104.4)Mg/I/g which is less than 123.83Mg/I/g recorded by Nwabanne (2012) using n-hexane.

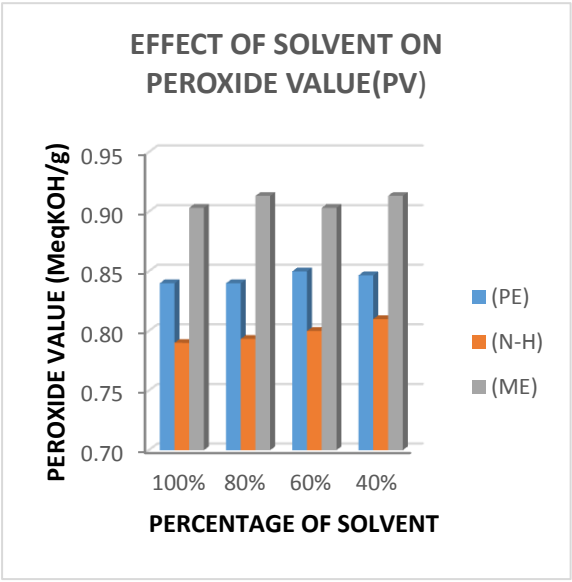

Figure 5: Peroxide Value (PV)

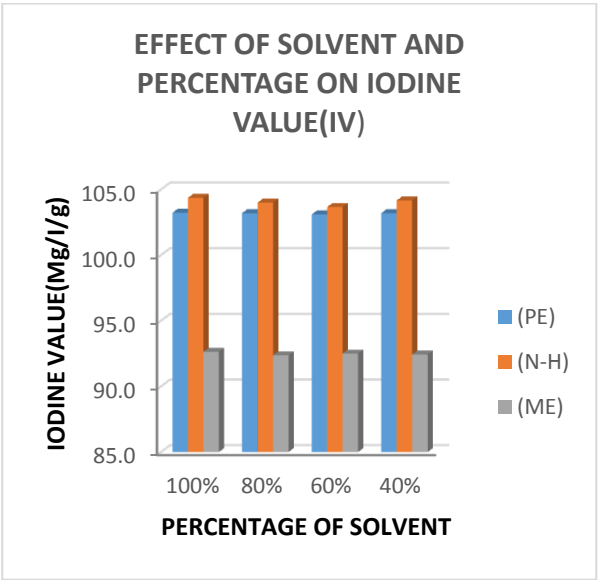

Figure 6: Iodine Value (IV)

3.8. Effect of Solvents and Levels on Saponification Value

The effect of solvents and levels on saponification value is shown in Figure 7. From the figure, it was observed that the saponification values for petroleum ether and n-hexane performed better than methanol. The values of saponification value using petroleum ether was between (154.2-154.3g) Mg/KOH/g. This value is less than 162.69 Mg/KOH/g recorded by Nwabanne (2012) when n-hexane was used for oil extraction from the same seed.

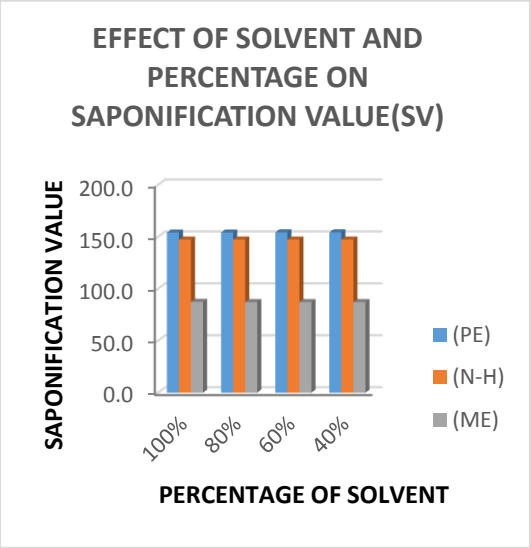

Figure 7: Saponification Value (SV)

3.9.Effect of Solvents and Levels on Refractive Index

The effect of solvents and levels on refractive index is shown in Figure 8. The figure showed that the refractive index of petroleum ether and n-hexane performed better than methanol. The values of refractive index of n-hexane and petroleum ether were between (1.4232-1.4324). This is close to (1.45-1.49) obtained by Eckey, 1954 for some fats in the nuts family

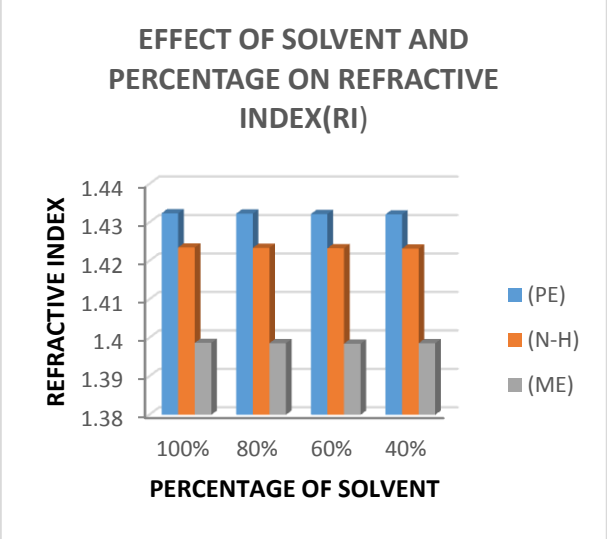

Figure 8: Refractive Index (RI)

3.10. Effect of Solvents and Levels on Viscosity

The effect of solvents and levels on viscosity is shown in Figure 9. From the figure, it is clearly seen that n-hexane and petroleum ether performed better than methanol. However, the value of viscosity was not below 1.5 cm/s in all cases.

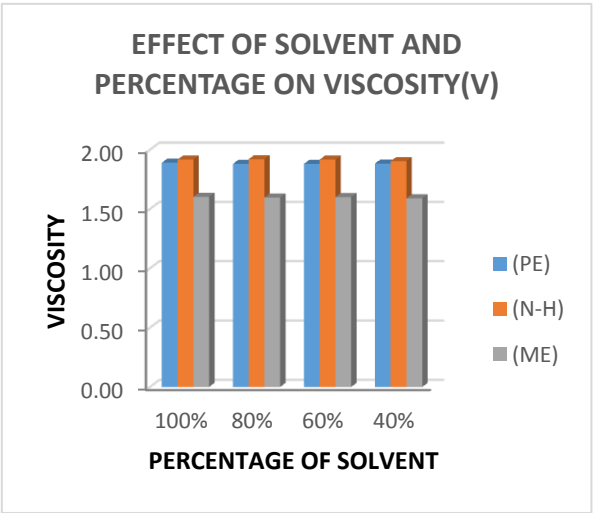

Figure 9: Viscosity (V)

4. CONCLUSIONS

Based on the study, the following conclusions were made; the lower the level of solvents the lower the output parameters. Generally, 100% level of all the solvents used gave better results in terms of oil yield, extraction efficiency, extraction loss and oil qualities.

It is recommended that more solvents should be used to see their effects on the qualitative and quantitative parameters of the oil. Also, other methods of oil extraction like the use of hydraulic press and screw press should be adopted and the results should be compared with results of this study.

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