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Effect of Seasonal Variation on the Chemical Composition of Leaf Essential Oil of *Aframomum Latifolium* (K. Schum) Obtained from Southwest Nigeria

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Abstract: This study was aimed at investigating effect of seasonal variation on yield and chemical composition of leaf essential oil of *Aframomum Latifolium* over a period of twelve months. Fresh leaves of this plant were subjected to hydrodistillation every month for a period of twelve months using an all glass Clevenger apparatus. The volatile oil obtained each month was analyzed by means of gas chromatography/mass spectrometry (GC/MS). The percentage oil yield ranged between 0.03 – 0.15 % v/w for the twelve treatments. Twenty compounds were identified in the volatile leaf oil obtained over a period of twelve months and oxygenated monoterpene was the most dominant constituent. Cajeputol, an oxygenated monoterpene has the highest percentage in the twelve treatments (39.40 – 45.61%). The effect of seasonal variation was established in the yield of the volatile oil in this study as the maximum yield (0.11%) (v/w) was recorded in November. There is a sudden disappearance of limonene in august and September and a rise in the level of cajeputol between august and November. The volatile oils obtained were rich in cajeputol (45.61%) and α-pinene (20.97%) and these compounds had been documented to be a cough suppressant, anti-inflammatory and anti-microbial agents.

Keywords: Seasonal Variation, *Aframomum Latifolium*, Essential Oil, Cajeputol, α-pinene

1. Introduction

In the olden days, plants were generally used as a basis of food and medicine [3, 16] but nowadays 70% of the entire drugs in the worlds market are linked with natural product and this makenature the basis of drug development. Many plant metabolites have been isolated from marine organism, bacteria and plants and this has made man to discover nature as a dynamic biochemical factory where both primary and secondary metabolites are generated biosynthetically.

Studies conducted on medicinal plantsalongside their chemical constituents accounted for various activities and confirmed the enduring curative potential of plant medicines [4]. Herbs obtained from plants have been converted into decoctions, powder, tincture and even food; these have been found to interact positively with human body thereby producing beneficial effect in terms of health promotion.

Interestingly, it has been discovered that vertebrates other than man eat someplants as self medication when they are sick [8, 11]. The observation of eating manners in wild animals has led to the discovery of plants with healing potentials. The study of self-medication observed in animals led to a new approach in drug discovery for man. For example, new antimalaria compound was isolated from *Trichiliarubenscens* leaves due to a behavioral study on chimpanzees from a natural population in Uganda [6].

Ethno-botanical studies conducted throughout Africa substantiate that indigenous plants are the chief constituents of traditional African medicines [7]. It has been documented that naturally occurring metabolites exhibit superior biochemical specificity and chemical variety compared to synthetic drugs [10, 14].

Most odiferous plant contains volatile oil and the oil is also referred to as concentrate, essential oil, etheric oil or aetheroleum is a complex blend of essential constituents produced by living organisms. They are so called because of their ability to evaporate when subjected to heat which makes them different from fixed oils. Essential oils are odoriferous in nature and commonly found in the plant kingdom, in unique pants parts like secretory hairs, glands, ducts and resin ducts [2, 5, 20]. There are several factors affecting composition of volatile oils, environmental factors like mode of extraction, relative humidity, irradiance, photo period, location, soil composition, climate and plant cultivation methods have immenseimpact on the volatile oil quality and composition [21]. One of the prominent factors influencing the quality of volatile oils is harvest time [13]. The developmental stage of the plants largely affects the quantity of volatile oil composition. Early or late harvest of crops is linked to the low yield of volatile oil content as over mature and immature crop leads to poor yield of herbs and oil content. It has been reported that to get a high yield of volatile oils, it is preferable to harvest the plant after flowering so as to acquire high quantity of the oil [21].

Aframomum latifolium is a herbaceous perennial plant. It belongs to the family zingibraceae, all the part of the plant is aromatics, it is not cultivated in Nigeria but occurs in the wild. *Aframomumme legueta* is the most popular in the genus and it resembles *A. latifolium*. *Aframomum latifolium* is not as aromatic and peppery as *A. melegueta*but the seed in the fruit is consumed as fruit and the decoction of the leaf is used in treating cough [18]. The essential oil is found to be active against fungi, gram positive and negative bacteria [18].

Literature on the essential oil composition of this plant is scarce in Nigeria and due to the ethno-botanical use of the plant, there is a need to study the effect of seasonal variation on the yield and percentage composition of the constituents of the leaf essential oil of this plant over a period of twelve months and hence the need for this study.

2. Materials and Methods

Plant Material and Isolation of Essential Oil

The plant sample was collected from Kajola local government area of Oyo state, between March 2019 and February 2020. Fresh sample was collected on the first day of every month. Fresh sample of the leaves of this plant (500g) was harvested, washed and blended with a fast rotating blender. The pulp obtained each month was subjected to hydro-distillation using an all glass Clevenger apparatus according to European pharmacopoeia 2008. The oils collected were kept in the refrigerator without further treatment before gas chromatography-mass spectrometry (GC-MS) analysis.

The chemical composition of the volatile oil was analyzed using GC/Ms technique, SHIMADZU GC/MS QP 2010 plus (SchimadzuCorporation, Japan) mass spectrometer was used for the analysis. The machine possess polar doubled capillary and non-polar column (25.0m x 0.25µm internal diameter 0.25µm film thickness). Helium of high purity was used as a carrier gas at a flow rate of 0.99ml/min, starting and final temperatures of 60°C and 280°C and heated isothermally for 6 min, solvent cut time was set at 3 min, E. I. mode was 70 eV while linear velocity for the column was set at 36.8cm/s. Chemical components of these oils were identified on the basis of their individual retention time with a reference to homologous series of n-alkenes in the robust NIST Library 2014. The mass spectra fragmentation of the compounds was compared to the available data [1, 9, 15].

3. Result and Discussion

Table 1. *Fractional composition of the volatile constituents of the leaf of Aframomum Latifolium.*

Month of harvest		***March***	***April***	***May***	***June***	***July***	***August***
Treatment	Retention Index						
% yield (V/W)		0.07	0.06	0.06	0.05	0.04	0.03
Compound	*Percentage Composition of Various Components*						
Cyclofenchene	729	4.89	4.14	4.01	5.81	4.01	6.14
β-Thujene	873	0.17	0.38	0.47	0.50	0.41	-
Nopinene	943	0.17	0.45	0.49	0.74	0.77	0.49
α-pinene	948	19.49	19.01	14.40	12.71	10.69	17.10
α-phellandrene	969	0.41	0.66	-	-	-	4.69
Limonene	1018	0.79	0.41	1.40	0.31	1.90	-
Isoamylvelerianate	1054	0.74	0.40	0.29	-	-	-
Cajeputol	1059	40.50	40.10	40.01	39.40	45.40	45.00
L-trans-pinocarveol	1131	0.57	0.19	0.14	0.47	0.61	0.41
L-terpinen-4-ol	1137	2.61	2.19	3.41	-	-	1.49
α-Terpineol (-)	1143	1.64	1.41	1.70	1.79	1.81	1.57

Month of harvest		*March*	*April*	*May*	*June*	*July*	*August*
Peperitone	1158	0.21	0.33	0.19	0.41	0.41	0.41
Aromadendrene	1386	-	-	0.91	-	1.49	1.79
γ-Elemene	1431	3.79	4.00	3.87	3.84	1.41	4.09
O-meth-8-ene-methol, alpha-dimethyl-1-vinyl-(1s, 2s, 4R)	1522	0.11	0.71	-	0.11	-	-
Globulol	1530	1.77	1.41	-	2.33	1.12	2.09
Ledol	1530	-	-	0.49	0.70	0.77	0.71
Spathulenol	1536	0.61	0.49	-	-	-	-
Total		78.47	74.09	70.87	69.12	70.80	85.98

Month of harvest		*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*
Treatment	Retention Index						
% yield (V/W)		0.08	0.09	0.11	0.14	0.13	0.15
Compounds	*Percentage Composition of Various Components*						
Cyclofenchene	729	7.82	6.04	6.31	6.84	5.43	5.60
β-Thujene	873	0.63	0.14	0.14	0.23	0.41	0.44
Nopinene	943	0.71	0.78	0.64	0.61	0.60	0.47
α-pinene	948	20.97	20.79	20.41	20.01	20.17	19.81
α-phellandrene	969	6.09	6.00	-	-	-	-
Limonene	1018	-	0.13	1.19	1.10	1.42	1.07
Isoamylvelerianate	1054	0.73	0.61	0.59	0.60	0.71	0.71
Cajeputol	1059	45.05	45.61	45.01	40.70	40.74	40.21
L-trans-pinocarveol	1131	0.61	0.61	0.67	0.61	0.60	0.41
L-terpinen-4-ol	1137	3.00	2.96	2.41	2.56	2.70	2.44
α-Terpineol (-)	1143	1.44	1.01	1.14	0.79	-	-
Peperitone	1158	0.43	0.41	0.44	0.49	0.14	0.17
Aromadendrene	1386	2.90	2.43	-	-	-	-
γ-Elemene	1431	4.94	4.11	4.10	1.91	-	4.19
O-meth-8-ene-methol, alpha-dimethyl-1-vinyl-(1s, 2s, 4R)	1522	0.44	0.41	0.32	0.44	0.17	0.19
Globulol	1530	2.32	2.01	2.22	2.09	2.33	2.22
Ledol	1530	0.90	0.74	0.41	0.47	-	-
Spathulenol	1536	0.92	0.84	0.86	0.49	0.61	0.67
TOTAL		99.92	95.63	86.88	79.94	76.03	78.62

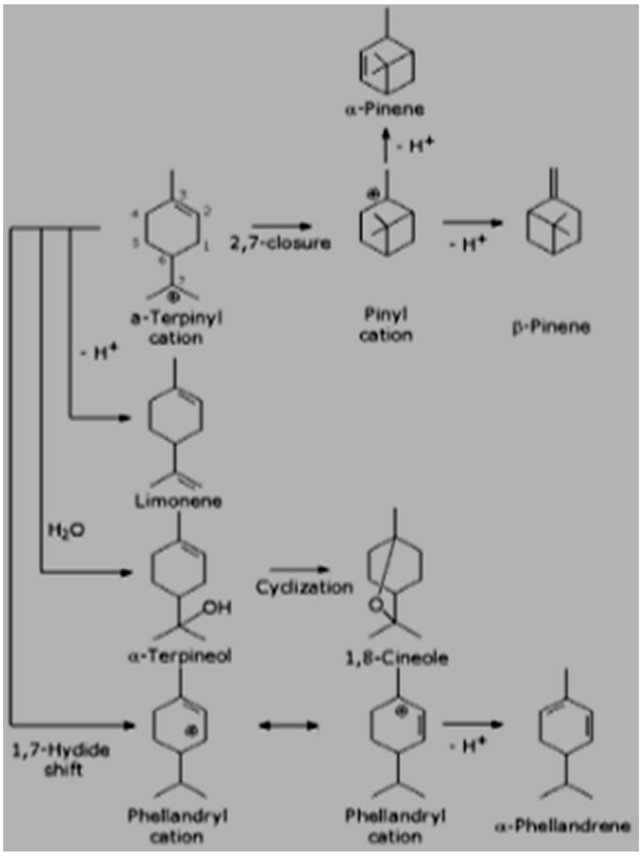
Hydro-distillation of fresh leaves of *Aframomum latifolium* produced a pale yellow essential oil with a strong fragrance; eighteen components were identified in the twelve treatments analyzed each month for a period of one year. The result showed that the content of the essential oil varied throughout the months and seasons of the year (Table 1). The yield as shown in table 1 varies significantly between January and December.

The oil yields of the twelve treatments generally ranged from 0.04% -0.15% (v/w) with the highest yield recorded in February (0.15%) v/w and the lowest in July (0.04%) v/w. The lower yield of the volatile oil in July may be linked to the volume of rainfall at this month and subsequent presence of moisture content in the leave as a result of high relative humidity which is known to reduce the volatile oil production as a result of surplus water [6]. Furthermore, the amount of sunlight in July is always very small and this affects the quality and quantity of the volatile oil [19].

Effect of seasonal fluctuation was also established in the volatile oil contents of this study as the maximum oil content was recorded between august 2019 and February 2020 (86.88 – 99.92%), these high volatile oil content in these months may be attributed to medium humidity and high sunlight which affects the vegetative growth of the plant.

There is a sudden disappearance of limonene in August and September and a rise in the level of cajeputol between August and November. Cajeputoland α-pinene are the constituents in the volatile oil with the highest percentage 45.61% and 20.97% respectively.

Cajeputol which is also known by a variety of synonymous 1,8-cine-ol, eucalyptol and 1,8-epoxy-p-methane has a fresh mint-like smell and a spicy cooling taste used in traditional medicine as a cough suppressant [23] and this corroborates the use of the decoction of the leaf of this plant in southwest Nigeria in the treatment of cough [18]. α-pinene which is still prominent in the volatile oil (20.97%) is an anti-inflammatory and antimicrobial agent [17, 18, 22]. From table 1, it could be seen in November, December and January of the sudden disappearance of α-phellandrene and an increase in the percentage composition of cajeputol, it could be seen that there is a relationship between the formation of α-pinene, limonene, α-terpineol and α-phellandrene as shown in figure 1.



Source: Larayetan, 2018.

Figure 1. *Biosynthetic pathway of some of the constituents of Aframomum latifolium.*

4. Conclusion

Season brings about chemical disparity in oil yield and oil content of this plant. It can be seen that between the months of August and November that *A. latifolium* produce better and quality volatile oil. The leaves of this plant possess volatile oil which differs in quality and quantity as a result of seasonal fluctuation. It is important for researchers and all the people using herbs to know the season with the highest quantity and quality of volatile oil. Further research should be conducted on the essential oil obtained from each month to ascertain the effect of seasional variation on the biological activities of these volatile oils.

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