COMPARATIVE ANALYSIS OF ESSENTIAL OIL FROM NIGERIAN GINGER (*ZINGIBER OFFICINALE ROSCE*) AND OTHERS

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ABSTRACT
Ginger essential oil was extracted and analysed from a locally grown ginger using steam distillation and gas chromatography –mass spectrometer methods respectively. The proximate composition of the ginger rhizome used was determined. The results obtained were compared to an available data on Thailand and China ginger proximate compositions as well as their respective essential oils. The oil yield was 1.7% which consisted of α-Pinene 0.22%, α-Phallendrene 0.04%, β-Phellandrene 1.00%, β-Pinene 0.65%, δ-Terpinene 0.04%, β-Sesquiphellandrene 18.45%, Farnesene 6.48%, Germacrene D 3.58% and Zingibrene 30.1%, having α-Pinene, α-Phallandrene and Zingibrene in common with Thailand and China ginger essential oils. The proximate composition of the ginger rhizome used was found to be Moisture content 88.53%, Ash content 2.47%, Lipids content 16.67%, Crude Fibre content 8.53%, Crude Protein 9.50% and Carbohydrates 62.50%. The ginger used was found to contain percentage lipids of 16.67% which is significantly higher compared to 7.78% and 9.00% Lipids content of Thailand and China gingers respectively, making it a good choice for oil extraction.

Keywords: *Ginger, Essential Oil, Gas Chromatography, Steam Distillation, Proximate Composition.*

Introduction

Essential oil refers to any concentrated, hydrophobic (immiscible with water), typically lipophilic (oil or fat soluble) liquid of plants that contains highly volatile aroma compounds and carries a distinctive scent, flavor, or essence of the plant. This large and diverse class of oils is also referred to as volatile oils, ethereal oils, aetherolea, or simply as the "oil of" the plant from which they were extracted (Ranitha *et al.,* (2013). Wide applications of ginger essential oil in medicine, food and cosmetics industries as well as the existence of different varieties, grown under different conditions have led to different studies of the essential oil. Although the variety and the age of the rhizome at harvest and distillation affect the composition and the yield of the essential oil and hence its flavor, the major factor that determines its value in the international market is its origin.

West African gingers, known for their stronger, more pungent and coarser flavors, of which Nigeria ginger is one, are the least studied among the varieties. Because of the applications of ginger essential oil in medicine and food industries and the compositional differences due to origin, there is the need for extraction and better understanding of the composition of West African ginger, which is the least studied so far. Currently, local production of essential oils is insignificant; nearly 100 per cent of the essential oils used by the local industries in Nigeria are imported. Research statistics from the Raw Materials Research and Development Council (RMRDC) indicates that a local demand of over 100,000kg annually is made, a figure that could be met through local production efforts.

Reports have it that Nigeria spent about $14m on importation of Essential oils between June and December 1994 alone. The export potential of essential oils is also very high as the market is presently dominated by the Chinese and Australians who are making significant income from this product in the international market. According to the United Nation's commodity trade figures, world trade in essential oils stood at $2bn in 2005. Apart from the numerous uses of essential oils, essential oils production also offer wide business opportunities to small-scale industrialists to invest in a viable area that guarantees speedy return on investments (Abraham, 2014).

MATERIALS AND METHODS.

Locally grown freshly harvested ginger rhizomes were obtained from Mr Kissinger's farm at Gidan sani village, Jaba local government area of Kaduna state, the ginger rhizomes were graded, sorted, split and sundried to reduce the moisture content to about 30%. The sample was then crushed using mortar and pestle.

Essential Oil Extraction Procedure

200g of the graded, cleaned, sundried and crushed ginger with the moisture content of about 30% was poured into the round bottom flask. 300ml of water was measured using a beaker and was poured carefully into the round bottom flask containing the crushed ginger sample, the mixture was properly mixed so as to allow for easy reaction. After which the other soxhlet extractor components (extraction chamber and condenser) were assembled, the valves that control the flow of cool water into the condenser were opened, the pressure pump was turned on and the heating mantle was turned on to a temperature of 90^0C. The setup was observed until the mixture began to boil. The boiling was allowed to continue, the vapour now containing the essential oil was condensed in the condenser and kept dropping into the extraction chamber until it got to a level that it was about to flush back into the round bottom flask then the heating mantle was turned off . The condensate now containing water (hydrosol) at the bottom and a small layer of the essential oil was collected into the separating funnel, after some time the water (hydrosol) was allowed out and the essential oil was collected into an air-tight bottle. The process was repeated until essential oil was no more realized.

Essential Oil Yield

A petri-dish was washed thoroughly and carefully then dried in an oven for a few seconds after which it was removed and placed in a dessicator to cool for a while. The weight of the petri-dish was taken using the electric weighing balance and was recorded as W_1. A 200g of the crushed ginger sample that was to be used for the extraction was added to the petri-dish, the new weight (weight of sample + weight of container) was taken using the electric weighing balance and was recorded as W_2 The air-tight bottle that was to be used for the collection of the essential oil to be extracted was weighed using the electric weighing balance and the weight was recorded as W_3. After the extracted essential oil was collected into the bottle, the new weight (weight of bottle + weight of essential oil) was taken and recorded as W_4.

Finally the percentage of the essential oil yield was computed as according to the relation reported by Pin *et al*; (2009):

$$\% \text{ Essential Oil Yield} = \frac{Weight\ of\ Essential\ Oil}{\text{Weight of Ginger}} \times 100 \qquad (1)$$

$$= \frac{W_4 - W_3}{W_2 - W_1} \times 100$$

Analysis of the Essential Oil

The chemical analysis of the extracted ginger essential oil was carried out using Gas chromatography- mass spectrometer. The read out of the peaks and the retention time where compared to known substances readout and the compounds were identified.

Proximate Composition

The proximate analysis of the ginger rhizomes used was carried out using the Standard methods as described by Onwuka (2005).

Proximate/Essential Oil Composition of Thailand and China Gingers

The proximate composition of Thailand and China ginger rhizomes as well as their respective essential oil composition was obtained from Misbah *et al.,* (2005).

RESULTS

From equation (1) the percentage essential oil yield was 1.7%. Table 1 shows the chemical compounds that were identified from the locally grown ginger.

Table 1: Composition of the extracted essential oil

S/No	Identified compounds	Concentration (%)
1	α-pinene	0.22
2	α-phallendrene	0.04
3	β-Phellandrene	1.00
4	β-pinene	0.65
5	δ-Terpinene	0.04
6	β- Sesquiphellandrene	18.45
7	Farnesene	6.48
8	Germacrene D	3.58
9	Zingibrene	30.10

The composition of ginger essential oil extracted from the Thailand and China ginger rhizomes are shown in Tables 2 and 3 respectively.

Table 2: Thailand Ginger Essential Oil Composition

Peak No	Identified compounds	Concentration (%)
5	α-pinene	3.59
6	α-phallendrene	2.84
7	Myrecene	4.58
8	β-pinene	0.74
9	γ-Terpinene	2.49
12	1,8-Cineol	3.87
13	Citral	5.39
15	Zingibrene	30.81

Table 3: China Ginger Essential Oil Composition

Peak No	Identified compounds	Concentration (%)
5	α-pinene	0.305
6	α-phallendrene	1.02

7	Myrecene	4.82
8	γ-Terpinene	2.88
9	1,8-Cineol	2.40
12	Citral	4.50
13	α-Terpinene	6.50
15	Zingibrene	8.00

The proximate composition of Thailand and China ginger rhizomes are shown on Table 4.

Table 4: Proximate compositions of Thailand and China gingers

Contents (%)	Thailand ginger	China ginger (%)
Moisture	89.20	88.00
Protein	12.25	6.67
Crude Fiber	6.00	15.00
Fat	7.78	9.00

The proximate composition of the locally grown ginger is shown in Table 5.

Table 5: Proximate Composition of the Ginger Used

Nutrients	Composition			Mean ± S.D
	Replicate 1	Replicate 2	Replicate 3	
Moisture	88.40%	88.70%	88.50%	88.53% ± 0.13
Ash	2.40%	2.10%	2.90%	2.47% ± 0.33
Lipids	19.00%	14.00%	17.00%	16.67% ± 2.06
Crude Fibre	8.70%	8.80%	8.10%	8.53% ± 0.31
Crude Protein	9.80%	9.20%	9.50%	9.50% ± 0.25
Carbohydrates	60.10%	65.90%	62.50%	62.80% ± 2.38

Discussion of Results

Comparative Analysis of Thailand, China and the Nigerian Ginger based on their Proximate Compositions

Comparing the moisture contents of the Thailand, China and Nigerian ginger which are; 89.2%, 88.00% and 88.53% respectively, shows that they all have approximately the same moisture contents but with the Thailand ginger having slightly higher moisture content. Looking at the protein contents which are; 12.25%, 6.67% and 9.50% for the Thailand, China and Nigerian ginger respectively shows that the Thailand ginger contains more protein followed by

Nigerian ginger and then the China ginger.
Considering the crude fibre contents of the Thailand, China and the Nigerian gingers which are; 6.00%, 15.00% and 8.53% respectively, the result shows that the Chinese ginger contains more crude fibre than both the Thai and Nigerian gingers. The result obtained for the lipid contents are; 7.78%, 9.00% and 16.67% for the Thai, Chinese and the Nigerian ginger respectively, thereby indicating that the Nigerian ginger rhizome is by far richer in lipids content which makes it the best choice for Oleorisin extraction.
The essential oil yield of 1.7% obtained in this study is lower than the value of 4.7% reported by Awang *et al*; (2014).

The ash and carbohydrate content of the Nigerian ginger used in the experiment as obtained in the analysis are; 2.47% and 62.80% respectively. The proximate composition of Thailand, China and Nigerian ginger are illustrated in Fig 1.

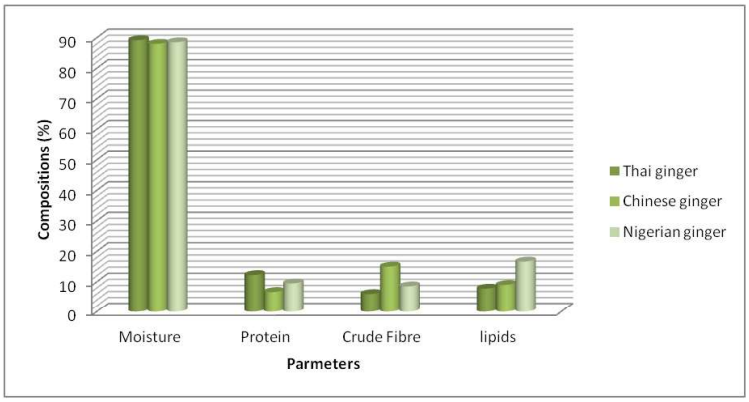

Fig 1: Bar Chart showing the Proximate Compositions of Thai, Chinese and Nigerian ginger

Comparative Analysis of the Essential Oils Composition
The result showed that the percentage composition of the identified compounds in Thailand ginger essential oil were α-Pinene 3.59, α-Phallandrene 2.84, Myrecene 4.58, β-Pinene 0.74, γ-Terpinene 2.49, 1,8-Cineol 3.87, Citral 5.39 and Zingibrene 30.81%. The percentage composition of the major compounds that were identified in the essential oil extracted from China ginger were α-Pinene 0.305, α-Phallandrene 1.02, Myrecene 4.82, γ-Terpinene 2.88, 1,8-cineol 2.4, α-Terpinene 6.5, Citral 4.5, and Zingibrene 8.0%. The percentage composition of the major compounds that were identified in the essential oil extracted from Nigerian ginger were α-Pinene 0.22, α-Phallendrene 0.04, β-Phellandrene 1.00, β-Pinene 0.65 δ-Terpinene 0.04 β-Sesquiphellandrene 18.45, Farnesene 6.48, Germacrene D 3.58, and Zingibrene 30.1%. The result showed that the essential oil extracted from the Thailand, china and Nigerian ginger have the following compounds in common α-pinene, α-phallandrene and Zingibrene. Thailand and Nigerian ginger essential oils have β-pinene in common. The following major compounds were also identified in Nigerian ginger essential oil only; β-Phellandrene, δ-Terpinene, β-Sesquiphellandrene, Farnesene and Germacrene D. The result obtained shows that Zingibrene is the predominant constituent of ginger essential oil (Ranitha, *et al.,* (2013).
The percentage composition of the compounds that are present in both the Thailand ginger essential oil, China ginger essential oil and Nigerian ginger essential oil are illustrated in Fig 2.

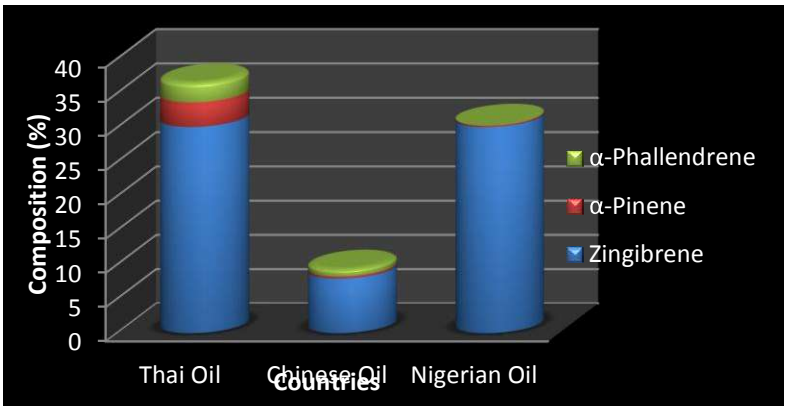

Fig 2: Bar Chart showing the compounds present in Thailand, China and Nigerian ginger essential oils.

Conclusion

This study has shown that Nigerian ginger essential oil contains a very good percentage of Zingibrene which is the compound responsible for flavouring, thereby making it a very good choice for aromatherapy and other applications. A good percentage of essential oil can be extracted from Nigerian ginger which makes it a good choice for essential oil extraction.

The study also revealed that ginger rhizomes contain a very high percentage of moisture, therefore for longtime storage the moisture content of ginger rhizomes should be reduced. Nigerian ginger contains a higher percentage of lipids, thus making it a very good choice for Oleorisin production.

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