Ethnobotanical Leaflets 14: 381-89. 2010.

Physicochemical Parameters and Antimicrobial Activities of Oil Extracted from Ginger

Abitogun A.S[1]. and Badejo O.F[2].

[1]Department of Science Laboratory Technology, Rufus Giwa Polytechnic, P. M. B. 1019, Owo, Ondo State, Nigeria

[2]Department of Food Science and Technology, Rufus Giwa Polytechnic, P. M. B. 1019, Owo, Ondo State, Nigeria

*Email: adeboabitogun@yahoo.com

Issued April 1, 2010

Abstract

Ginger rhizome was obtained in Owo, Ondo State, Nigeria. The rhizomes were prepared for use by sun-drying and milled to flour. A soxhlet apparatus was used for the extraction of the oil. The residual oil obtained was assessed for physicochemical parameters and fatty acid composition. The antimicrobial activities were carried out using four species of bacteria. The results of the assessment showed that: moisture content was 0.352%, specific gravity 0.97, refractive index 1.47, fire point 330^{o}C, flash point 240 ^{oC}, smoke point(185 ^{oC}, and turbidity 20jtu. Others were free fatty acid 2.37% (Oleic acid), acid value 4.74 % (Oleic acid), saponification value 213.18MgKOH/g oil, peroxide value 82.00Meq peroxide/Kg, iodine value 87.82 and the yield was 7.15%. The yield indicated that ginger rhizome was not a good source of oil. Also, the assessment indicated that the oil can supply essential fatty acid needed in the body. In conclusion, the oil possessed some inhibitory characteristics.

Key words: Ginger, extraction, oil, physicochemical, fatty acid composition, microbial activities.

Introduction

Lipids are important nutritional components in cereal, grain and seed of major fruits. They solubilized vitamins A, B ,E and K, which are necessary for proper maintenance of health and a source of essential fatty acids, thus contributing to several metabolic functions (Lawson 1995). Lipids can be referred to as heterogeneous collection of biochemical substances, which have in common the property of being soluble in organic polar solvent and insoluble or sparingly soluble in water (Gunstone, *et al*, 2004). The term lipids covers edible fats, oils and waxes of plants and animals origin and certain related

compounds, which includes phospholipids and steroid (Anonymous 2002). Some organic polar compounds that form part of the food store of the seeds, nuts and roots have deferring levels of food and medical values. This chemical constituent can be obtained from oily part of the seed and root when extracted (Lusas 2002).

The spice ginger is the underground rhizome of the ginger plant, known botanically as *Zingiba officinale*. This plant originates from Indian, China and Java, however, it is widely grown in African countries including Nigeria. Ginger is a perennial herb and grows to about 3-4 feet high with a thick spreading tuberous rhizome. Ginger produces clusters of white and pink flower buds that bloom into yellows. Every year it shoots up a stalk with narrow spread shaped leaves as well as white or yellow flowers growing directly from the root. It is a spice vegetable substances because they have a distinctive flavor and aromas, thus, they are used to season food. Other examples were dove, cinnamon, nutmeg, pepper, garlic, onion and curry (Guralink 1984). The characteristic odour and flavor of ginger is caused by a mixture of zingerone, shogaols and gingerols. The dried rhizome contains volatile oils and its extractives are the essentials oils and oleoresins, these extractives are reformulated to produce secondary products such as essence, emulsion and fat based spices (Health and Reinccius 1986). In Nigeria Ginger is used as spices and sometimes, they can be stewed in boiling water to make ginger tea and the oil from it are used for medical purposes (Bode 2003).

The pungent taste of ginger is due to non volatile phenyl propernoid derived compounds, particularly gingers and shogoals which form gingerols when ginger is dried or cooked. Zingerone is also produced from gingerols during this process; this compound is less pungent and has a spicy sweet aroma (Govindarajan 1982). Photochemical studies showed that the plants is rich in a large number of substances including zingiberene, bisabolene, also gingerols and shogaols Masucla *et al.*, (2004), Jolad *et al.*, (2005). These compounds have been reported to display diverse biological activities such as antioxidant (Jolad *et al*., 2005) and anti-inflammatory as reported by Frondoza *et al*., (2004) and Young *et al*., (2005). Ginger is one of the most commonly used herbal supplements and it's substantially use in folks remedies for difference medical conditions has been documented. Traditionally ginger has been used to treat a wide range of ailments including gastrointestinal disorder such as stomach aches, abdominal spasm, nausea and vomiting as well as in arthritis and motion sickness (Langner *et al*., 1998 and White 2007).

There are studies on the medicinal values, proximate composition, antioxidant activities of ginger therefore, the study looks into the physicochemical properties, fatly and composition as well as microbial activities of ginger rhizome oil.

Material and Methods

The ginger rhizome used for this study was obtained Owo, Ondo State of Nigeria. The ginger rhizome

was washed, dried and milled to flour using attrition machine. The oil was extracted using standard soxhlet extraction method. The solvent was recovered by simple distillation and the residual oil collected was called crude ginger oil, this crude ginger oil was used for analytical work (AOAC 1990). The moisture content and specific gravity were determined according to AOAC (1990), while the refractive index was measured using Abbey Refractometer coupled with thermometer (ASTM 1985). The colour was determined using lovibond tintometer in half inch cell. The colour was calculated based on the expression (5R + Y) – B, where R stands for red pigments, Y for yellow pigments and blue for blue pigments. The flash point, fire point were measured using Gallenkamp Authomatic pensky – Martens flash points and fire points taster with thermometer, the smoke point was determined using clevland open cup apparatus. The temperature at which turbidity is first detectable was also measured using Palm tester turbidity tube (ASTM 1985).

The chemical parameters of the crude oil were determined using standard method AOAC. (1990). the parameters determined were; free fatty acid, acid value, saponification value, peroxide value, and iodine value. Analytical test method for fatty acid methyl esters were analyzed using Agilent 6890 series. Gas chromatography filled with a flame ionization detector and enhanced integrator, nitrogen gas was used as carrier gas. The column initial temperature was 250^0C moving at 12^0C per minute to a final temperature of 300^0C, while the injection and the detector were maintained at 250^0C and 300^0C respectively. The peaks were compared with standard fatty acid methyl ester (ASTM 1985).

Antibacterial activities

Bacterial Strain

Klebsiella pneumoniae, Strephylococcus aureus, Escherichia coli and Pseudomonas aeruginosa were obtained from the culture collections of the Federal Medical Centre, Owo, Ondo State, Nigeria.

Media and Inocula

Nutrient agar was used as basal medium. The test strains were cultured over night at 37^0C in Nutrient agar, and then colonies obtained were suspended in nutrient broth to obtain homogenous suspension of the inocula.

Disc Diffusion Method

The agar disc diffusion method was employed for the determination of antimicrobial activities of the tested oil sample as described by Harrigan and McCancc (1979). A suspension of the tested micro organism (0.1ml) was spread on the solid media plates. Sterile filter paper disc (5min in diameter) were soaked with about 159 litres of each of the oil sample and placed on the inoculated plates and were incubated at 37^0C for 24 hours, the diameters of the inhibition zones were measured in millimeters. All tests were carried out in duplicates and their mean values were recorded.

Results and Discussion

Table 1 depicts the physicochemical parameters of crude Ginger oil. Physicochemical characteristics of oils are those characteristics for the confirmation of the identity and edibility of oil. The identity characteristics determined were; specific gravity, refractive index, moisture content, iodine value saponification value and fatty acid composition, while the quality characteristics determined were; moisture content, colour, free fatty acid, acid value, and peroxide value. There are traces of moisture in the oil. The colour was determined to be 38units. The high colour might be as a result of high red pigment of the oil. However, the colour can be reduced during further processing. The yield was 7.15 ±2.70%. The oil content was low in compare with 31.45% reported for *Luffa cylindrical* (Abitogun and Olumayede 2008). However, the oil content was higher than 2.9% reported for pigeon pea (Oshodi and Eperigin 1993).

The specific gravity and refractive index were determined to be 0.91 and 1.47 respectively. The refractive index is the degree of the deflection of a beam of light that occur when it passes from one transparent medium to the other. It increases with the length of chains and with the number of carbon atom present (Pearson 1976), therefore, the refractive index of 1.47 determined for the sample is evidence that the sample might be long carbon chain with double bond. The result of the flash, smoke and fire points were; 240^0C, 185^0C and 330^0C respectively. This implies that the oil has a combustion characteristic. These values compares favourably with the value reported foe crude soybean oil (Salunke *et al*., 1992). The value obtained for free fatty acid and acid value were; 2.27±0.5 and 4.74 ±0.34% Oleic acid respectively. Free fatty acid and acid value are the measure of amount of fatty acid which is insoluble in water. Since most fatty acid present in neutral oil are not soluble in water, some are relatively high, while some are relatively low fatty acid (Lillian 1978).

The low free fatty acid and acid value was an indication that the oil can be refined to edible vegetable oil. However, the free fatty acid compares favourably with 1-2.8%Oleic acid reported for crude soybean oil by Salunkhe *et al*., (1992). Saponification value measures the numbers of milligrams of Potassium hydroxide require saponifying 1g of oil. The oil with low molecular weight fatty acid will consequently have high saponification value (Pearson 1976). The saponification value of 213.18 ±1.8Mg KOH/100g obtained for the sample suggests that the sample might be low molecular fatty acid triglyceride. Thus, it may not find application in soap and sampoo industries. However this value is higher than 179.52Mg KOH/100g reported for *Luffa* bean oil (Abitogun and Olumayede 2008). The unsaturated glyceride of oil is the ability to absorb a definite amount of iodine (Gunstone 2004). The iodine value was 87.82±1.32. This shows that the oil is non-drying oil and apart from this, it implies that the oil is more of unsaturated acid and it does not congeal at ordinary temperature. Peroxide value measures the degree of rancidity in oil (Bernardini 1973, Gunstone 2004). The result of the peroxide value was 82.00±2.12Meq peroxide/Kg. This implies that the oil is susceptible to oxidative rancidity. It

also gave an insight to presume that the oil contain high level of unsaturated hydrocarbon thus, it might not be stable in air at ordinary temperature.

Table 2 presents the fatty acid composition of ginger oil. The fatty acid detected and there values were; caprylic 1.37%, capric 4-14%, lauric 8.93%, myristic 3.75%, palmitic 23.96%, stearic 3.50%, arachidic 0.90% and lignoceric 2.28% acids. Others were; oleic 23.09%, linoleic 23.09% and lnolenic acids 5.64%. The summary of fatty acids in the oil was as follows; total saturated fatty acid was 45.12%, while the total unsaturated fatty acids were 51.64%. The fatty acids that were not detected and those with infinitesimal values form the 3.24% difference. Palmitic, oleic and linoleic acids dominate the fatty acids. Early experiments showed that palmitic, myristic and lauric acids raised plasma cholesterol more than those with either shorter or longer chains (Bonanome and Grundy 1988). It has been re-established that stearic consumption is associated with lower level of total and low density lipoprotein cholesterol than those on similar intakes of palmitic acid. Indeed the cholesterol-lowering effect was similar to that seen in oleic acid. The effect of lauric acid is less pronounced than those of myristic and palmitic acids (Cox 1999). However, saturated fatty acid plays an important role in the structure of tissue as reported by Gunstone *et al*., (2004). The high level of lnoleic and oleic acids confirm that the oil is liquid oil than solid oil; hence, it cannot easily congeal at ordinary temperature. It also implies that the consumption of this oil can prevent the risk of heart problems.

Table 3 shows the antibacterial activity of ginger oil. The diameters of inhibition in (mm) were measured, the result for each organism were; *staphylococcus aureus* (15±1.6), *Klebsiella eshericha* (10 ±2.2), *Pseudominas aeruginosa* (10±1.2) and *Escherichia coli* (8±1.5). The highest activity was recorded in *Staphylococcus aureus* while *Escherichia coli* recorded the lowest activity. The oil has inhibitory power over *Staphylococcus aureus* and less effect on the remaining organisms. The inhibitory characteristics are as a result of the presence of saturated fatty acids that is myristic, lauric and palmitic acids. However, the antimicrobial activities were in agreement with antimicrobial effects of ginger reported by Akoachere *et al.*, (2002).

In conclusion, the results of the assessment on ginger rhizome oil revealed that the yield of 7.05% was low; this suggests that the rhizome may not be a good source of oil. The result also revealed that the oil can supply essential fatty acid to the body. Finally, the oil has inhibitory characteristics over bacteria.

References

Abitogun, A. S. and Olumayede, O. (2008). Extraction and characterization of *Luffa cylindrical* oil**.** *Nig. Jour. of Applied Sc*. 26, 112-115.

Akoachere J.F., Ndip R,N. and Chenw. E.B. (2002). Antimicrobial effect of *Zingier officinale* and *Garcinia kola* on respiratory tract parthogens. *East. Afr. Med. J.* 79 (11), 588- 592.

Anonymous (2004). Sunflower production and management. Manitoba Agriculture, Food and Rural Initiatives /crops /oilseeds /bgd01301. litml.

AOAC (1990). *Official method of analysis*. Association of Official Analytical Chemist, (AOAC). Washington DC. USA. Pp 1250-1255.

ASTM (1985). American Society for Testing Materials ,ASTM pub. Pp. 31-36, 40-48.

Benerdini, E. (1973). Oil and fat technology, Publishing House Technologic S.R.L., Rome, Pp 69-101.

Bode A. (2003). Ginger is effective inhibitor of HCT 116 human colorectal carcinoma in vivo. Paper presented at the Cancer Prevention Research Conference, Phoenix, AZ.

Bonanome and Grundy (1988). Effect of dietary stearic acid on plasma cholesterol and lipoprotein level , *Journal of Medicine* 318, 1244-1247.

Cox, C., Sutherland, W., Ball, M., and Mann, J. (1996). Response of plasma lithosterol concentration to change in the quality of dietary fat in man woman. *European Journal of Nutrition* 50, 358-361.

Frondoza C.J., Sohrabi A., Polostsky A., Pham P.V., Hungerford D.S. and Lindmark, L. (2004). An in-vitro screening assay for inhibitors of proinflimmatory mediators herbal extracts using human synoviocyte cultures. *In-vitro Cell Dev. Biol Anim*. 40, 95-101.

Govindarajan V.S. (1982). Ginger chemistry, technology and quality evaluation; Part 1 and 2, CRC, *Crit..Rev. Food Sci. Nutr*. 17, 1-79 and 189-258.

Gunstone, F.D., Harwood, J.L. and Padley, F.R.(2004). *The lipids handbook* , 2nd Edn. Champman and Hall, London.

Guralink D.B. (1984). *Webster's New World Dictionary of American Language*, 2nd College Edition. Simon and Schuster, New York. Pp 1692.

Harrigan W.F. and McCance, M. E. (1979). *Laboratory Methods in Food and Dairy Microbiology*, 2nd Edn. Academic Press, London, pp. 182.

Health H.B. and Reineccius, G. (1986). *Flavouring Materials of Natural Origin : Flavour Chemistry and Technology*. The AVI Pub. Co., Inc. WestPoint, Couu.pp 158.

Jolad S.D., Lantz R.C., Solyom A.M., Gem G.J., Bates R.B. and Timmerman, B. N. (2005). Commercial processed dry ginger (*Zingiber officinale*); Composition and effects on LPS-stimulated PGE2 production. *Phytochem* **96**, 207-210.

Lagner E., Greifenberg S., Gruenwald, J. (1998). Ginger history and use. *Adv. Ther.* **15**, 25-44.

Lawson, H. (1995). *Food: oils and fats*, Chapman and Hall, New York, NY.

Lillian H.M. (1978). *Food Chemistry*, Van Norstrand, Reinhold New York, pp 12-60.

Lusas E.W.(2000). Oil seeds and oil bearing materials. Pp. 297- 362. In: *Handbook of cereal*

science and technology, K. Kulp and J.G. Ports, Jar (Ed). Marcel Delkker, Inc. New York

Masuda Y., Kikuzaki H., Hisamoto M. and Nahatani N. (2004). Antioxidant properties of gengerol related compounds from ginger. *Biofactors* 21, 293-296.

Oshodi A.A. and Ekperigin, M. M. (1989). Functional properties of pigeon pea (*Cajanus cajan*) flour. *Food Chem*. **34,** pp 187-191.

Pearson, D. (1976). *The Chemical Analysis of Foods* ,7th Edn. Churchill Livingstone, pp 6-14, 200-222.

Salunke, D.K., Chavan, R. N., Adsule, N. and Kadan, S. S. (1992). *World oil seeds, chemistry, technology and utilization*. Van Nostrand Rheinhold, New York.

White, B. (2007). Ginger: An overview, *Am. Fam Physician* **75**, 1698-1691.

Young, H. Y., Luo, Y. L., Cheng, H. Y., Hsieh, W. C., Liao J. C. and Peng, W. H. (2005). Analgesic and anti-inflammatory activities of gingerol. *J. Enthnophamacol*, **96**, 207-210.

Table 1: Physicochemical parameters of Ginger Oil.

Parameters	**Results**
Specific gravity	0.91
Refractive index	1.47
Moisture Content (%)	0.52 ± 0.20
Fire points (^{0}C)	330 ± 2.00
Flash point (^{0} C)	240 ± 1.50
Smoke point (^{0} C)	185 ± 2.50
Turbidity (jtu)	20 ±2.00
Melt point (^{0} C)	-18.00 ±0.10
Colour (units)	38.00 ±0.00
Acid value (% Oleic Acid)	4.74 ±0.34
Free Fatty Acid (% Oleic Acid)	2.37 ± 0.57
Saponification value (Mg KOH/g oil)	213.18±3.20
Iodine value	87.82±1.32
Peroxide value (Meq Peroxide/kg)	82.00±2.12
Yield (%)	7.05 ±2.70

Mean± Standard deviation of triplicate

Table 2: Fatty Acid Composition of Ginger Oil.

Fatty Acid Methyl Ester	Fatty Acid	Carbon Number	Result (%)
Cary late	Caprylic	8:0	1.3
Capritate	Capric	10:0	4.14
Lauritate	Lauric	12:0	8.93
Myristate	Myristics	14:0	3.75
Palmitate	Palmitic	16:0	20.96
Stearate	Stearic	18:0	3.50
Arachidonate	Arachidonic	20:0	0.19
Lignocerate	Lignoceric	24:0	2.28
Oleate	Oleic	18:1	22.09
Linoleate	Linoleic	18:2	23.91
Linolenate	Linolenic	18.3	5.64

Table 3: Antimicrobial activities of Ginger Oil.

Test Organisms	Zone of inhibition (mm)
Klebsiella pneumonia	10 ±2.2
Staphylococcus aureus (BT 331)	15 ±1.6
Pseudomonas aeruginosa (BT 334)	10 ±1.2
Escherichia colu (BT 333)	8 ±1.5