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Effect of Degradation on The Chemical Components of IpomeaBatatas Leaves And Stem

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Abstract:
Background: *Investigations have been carried out on green plants with medicinal potency including Ipomea batatas leaves from which several organic compounds have been isolated. This research work presents the chemical constituents of the fresh and degraded leaves of Ipomea batatas.*
Materials and Methods: *The samples were collected fresh and some parts were left to degrade. The organic components of the fresh and degraded Ipomea batatas were extracted using dichloromethane; hydro-distilled and the chemical compositions were investigated using the infrared and the GC-MS spectroscopy.*
Results: *The result revealed the presence of terpenoids, diterpene alcohols, alkenes, ketones, fatty acid and fatty acids esters in the various extracts of Ipomea batatas leaves. The major compounds in the hydro-distilled fresh extract were phytol and fatty acids also, the compositions of the fatty acid esters present in the degraded extract were higher than the fresh extract. 11-octadecenoic acid methyl ester constituted 54.56% of the biodegraded extract along with other fatty acid esters discovered have known anti-oxidative and antimicrobial activities. Therefore, the antioxidant and antimicrobial activities of Ipomea batatas leaves will most likely increase as it biodegrades because of the presence of high percentage of fatty acids esters.*
KeyWords:*Ipomea batatas, biodegradation, fatty acids, antioxidant, phytol.*

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I. Introduction

Medicinal plants contain substances which may be used for therapeutic purposes [1] or as precursors to the synthesis of useful medicinal products, and several research studies carried out on them have shown that they contain certain organic compounds that are capable of producing physiological effects in humans. Tannins, alkaloids, carbohydrates, terpenoids, steroids and flavonoids are some of these bioactive substances [2] among others present in medicinal plants. In most cases, these substances may not be essential to the plant producing them but they are of great importance to the wellbeing of individuals and communities we live[2]. Pregnant women and nursing women in some parts of Africa opts for medicinal plants as alternative medicine because of its affordability and availability. Medicinal plants are widely used as spices, teas and food [3]. They are generally used in traditional medicine for the treatment of many diseases[4].

Ipomea batatas is commonly referred to as sweet potato. It is a known member of the morning glory family, a dicotyledonous root vegetable plant. The tuber is large, starchy, with a unique sweet taste and it is a common staple food in Nigeria. About 2,503,000metric tonnes of sweet potatoes is produced and consumed in Nigeria annually.

The several attempts have been made to isolate the organic components of *Ipomea batatas*, the first attempt to isolate phenolic acids from sweet potato was carried out by [5] and it revealed that chlorogenic acid was present in the roots. Sweet potato peels were also reported to contain chlorogenic acid, isochlorogenic acid, caffeic acid and neochlorogenic acid[6][7].

Ipomea batatas leaves are consumed as vegetable and are also used for therapeutic purposes[8][9], these have aroused the interest of researchers to investigating the organic components. The leaves are rich in protein, dietary fibre and in essential vitamins such as Vitamin B, C and E[10]. IpomeaIpomeabatatas leaves have been reported to have antioxidation, anti-mutagenicity, anti-inflammation and anticarcinogenesis activities and anthocyanin and polyphenolic compounds have been isolated from it. The pounded leaves are used for treating boils and acne[11]. They also contain more total polyphenols than any other commercial vegetables, including sweet potato roots and potato tubers[12].

Generally different parts of *Ipomea batatas* are known to possess antiulcer, antioxidant, hypoglycemic, anti-inflammatory, antimutagenicity, antifungi, antimicrobial and other biological activities[13][11][14] which have encouraged its use traditionally for medicinal purpose[15]. [16] reported that Ipomea batatas is also a rich source of lipid-loving phytochemicals. Phenolics such as 3,5-di-O-caffeoylquinic acid and 4,5-di-O-caffeoylquinic acid have been reported to be predominant in *Ipomeaabatatas* leaves which were not depleted by steam cooking compared to other vegetables[17].

Several known polyphenols and other phytochemicals have been isolated from different parts of Ipomea batatas[18]. β-sitosterol, stigmasterolglucoside, gentisic acid and protocatechuic acid were isolated from the petroleum ether of *Ipomea batatas* leaves[19], and tetracosane, myristic acid, β-sitosterol, β -carotene, daucosterol and quercetin was isolated from the ethanolic extract[20].

Degradation generally identified by change in colour from green to brownish green also determines the chemical composition of vegetables and its edibility. The chlorophyll composition stability in green vegetables is determined by pH, temperature, presence of salts, enzymes and surface-active ions. As plants degrade, the chlorophyll reduces[21].

This research presents the effect of degradation on *Ipomea batatas* leaves by comparing the difference in the organic components of the fresh and degraded leaves.

II. Material And Methods

Collection of Sample

The leaves of *Ipomea batatas* were collected from a garden at Sanrab Ilorin, Kwara State. The leaves were collected fresh and chopped into smaller sizes for effective extraction. It was then authenticated at the Department of Plant Science, University of Ilorin.

Chromatographic Apparatus and Spectroscopy Techniques

Thin layer chromatography (TLC) (silica gel GF254, 0.25mm Merck Germany), Infrared Spectroscopy (IR), Gas Chromatography-Mass Spectroscopy (GC-MS) was employed for the isolation and characterization of the organic components. The UV-lamp was used for visualization and in some cases complimented by spray techniques.

Extraction Procedure of the Plant Materials

The plant sample collected was divided into two parts, one part was dried at ambient temperature, and the other part was left to biodegrade. The dried part was further divided into two parts, 300g of the dried plant material was subjected to hydro-distillation, after which the organic components of the distillate was extracted with dichloromethane. The extract was concentrated, dried and filtered. The filtrate (IBF/HD) was concentrated and subjected to analyses. The second part (300g) of the dried plant was boiled directly for one hour and was left to cool, and then filtered. The organic components of the extract were then taken up in dichloromethane, filtered and concentrated. The resulting crude (IBF/DE) was subjected to analyses and diverse work-up.

The liquid that was produced from the biodegraded plant material was decanted and divided into two parts. One part was subjected to hydro-distillation and the organic components of the distillate were extracted using dichloromethane. The dichloromethane extract was dried using anhydrous magnesium sulphate, filtered and concentrated. The extract (IBB/HD) was further worked upon as described above.

The organic components of the second part was extracted directly using dichloromethane, the extract (IBB/DE) was also dried using anhydrous magnesium sulphate, filtered, concentrated and subjected to further analyses and work-up.

The organic components present in the crude extracted were then investigated, using Infrared and GC-MS spectroscopy.

III. Results And Discussion

Infrared Spectroscopic (IR) Analysis Results of the Extracts

The IR spectroscopic analysis of the fresh extracts (IBF/HD and IBF/DE) showed the presence of the hydroxyl (-OH) vibration at (3400 cm^{-1} and 3392 cm-^{1}) respectively, C-H stretching (2955, 2854, 2955, 2924, 2854,) cm^{-1} C=O (1712 and1728) cm^{-1} and C=C stretching. While in the spectrum of the biodegraded extracts (IBB/HD and IBB/DE) no C=C signal was seen but all others in the fresh extract were also present.

The GC-MS Analysis Result of the Extracts

The comparison of various peaks with the corresponding library hits showed that these compounds 4,11,11-trimethyl-8-methylene bicyclo[7,2,0]undec-4-ene (9.06%), caryophyllene oxide (13.9%), 6,10,14-trimethyl-2-pentadecanone (11.79%), 2-dodecen-1-yl(-)succinic anhydride (3.68%), hexadecanoic acid, methyl ester (6.68%), 9-octadecenoic acid, methyl ester (20.03%) and Phytol (34.89%) were present

It was observed that 9-octadecenoic acid, methyl ester (20.03%) and Phytol (34.89%) were the major compounds present in IBF/HD both constituting 54.92% of the total sample. The FTIR data of IBF/HD ascertain the presences of –OH (3400cm^{-1}), C-H stretching at (2955, 2854 cm^{-1}), C=O (1712 cm^{-1}), C=C (1595, 1516 cm^{-}

^{1}), C-H bend (1456, 1377 cm^{-1}) and the C-O stretching at 1030 which is likely the carbonyl of an ester. Thus, the FTIR data agrees with the various functional groups contained in the compounds suggested by the GC-MS data.

Phytol which is the major compound in IBF/HD is a diterpene, a member of unsaturated alcohol, which is a product of chlorophyll metabolism in plant[22], hence, phytol is expected in a green plant like Ipomea batatas leaves. Phytol is also known for some biological activities which include, inhibiting the growth of staphylococcus aureus[23], blocking of the teratogenic effects of retinol[24], pronounce antinociceptive effects[22]. Also, it functions as a precursor for vitamins E and K1 an antioxidant and a preventive agent against epoxide-induced breast cancer carcinogens. Also, 9-Octadecenoic acid, methyl ester which constitutes about 20.03%, had earlier been isolated from some plants, for example, Stercaliatoetida (java olive) leaves[25].

The GC-MS analysis of IBF/DE showed that 21 compounds were present, cyclodecanemethanol (16.37%), 9-octadecenoic methyl ester (10.41%) and beta phenyl ethyl acetate (8.59) were the major compounds (Table 1). Apparently, more compounds were extracted from the boiled leaves (21) compared to the hydro-distillate extract (IBF/DE) which had only seven compounds. Also, almost all the compounds present in IBF/HD are absent in the IBF/DE, except 9-octadecenoic acid methyl ester which is also one of the major compounds in IBF/HD.

The FTIR of IBF/DE also shows the presence of –OH stretching (3392cm-1), C-H (2955, 2924, 2852), C=O (1728, 1716), C=C (1662, 1606) and C-O stretch at 1097 &1047 which agrees with the various functional groups contained in the compounds suggested by GC-MS data.

Table 1: The Major Organic Components of the Dichloromethane Extract of the Fresh and Biodegraded *Ipomea batatas* Leaves and Stem

S/N	IBF/DE	RI	IBB/DE	RI
1	Cyclodecanemethanol	1743	11-Octadecenoic acid methyl ester	2077
2	9-Octadecenoic acid methyl ester	2085	Hexadecanoic acid, methyl ester	1878
3	1-Hexadecanol	1854	4-Methyl phenol	1014
4	Beta-Phenylethylacetate	1259	Octadecenoic acid	2077
5	Heneicosanoic acid, methyl ester	2375	1,3-Dihydro, 2H-indo-2-one	1210
6	Acetic acid, methyl ester	785	Phenol	901
7	12-Methl-E,E-2,13 –Octadecadien-1-ol	2104	3-Octadecene	1818
8	Pentadecanoic acid	1814	1,Pentadecene	1502
9	I,3-Cyclopentadiene	824		
10	2,6,10,15-Tetramethyl heptane	1852		

IBF/DE- Dichloromethane extract of fresh *Ipomea batatas* leaves and stems
IBB/DE- - Dichloromethane extract of biodegraded *Ipomea batatas* leaves and stems

The GC-MS analysis of IBB/HD revealed that 15 compounds were present, and the major compounds are 4-methylphenol (25.12%) and Phytol (15.90%). The FTIR data accounted for some functional groups in the compounds suggested by GC-MS [O-H (3429), aliphatic C-H (2956, 2926, 2856), C=O (1714), C-O (1093, 1018) but C=C and N-H functional group present in some compounds were not accounted for. Comparing the fresh hydro-distillate (IBF/DE) and the biodegraded hydro-distillate extract (IBB/HD), more compounds were found in the IBB/HD (15 compounds) compared to (IBF/HD) with seven compounds. Also, the %composition of phytol which was the major compound in IBF/HD (34.89%) dropped in IBB/HD (15.90%) which may be as a result of biodegradation.

Table 2: The Major Organic Components of the Dichloromethane Hydro Distillate Extract of the Fresh and Biodegraded *Ipomea batatas* Leaves and Stem

S/N	IBF/HD	RI	IBB/HD	RI
1	Phytol	2045	Phytol	2045
2	9-Octadecenoic acid	2085	4-Methyl phenol	1014
3	Caryophyllene oxide	1507	Phenol	901
4	6,10,14-Trimethyl-2-pentadecanone	1754	5H-1-pyridine	1023
5	4,11,11-Trimethyl-8-methylenebicyclo[7.2.0]undec-4-ene	1494	1-Heptadecanol	1954
6	Hexadecanoic acid	1878	Methyl 7,9-tridecadienyl ether	1505
7	2-Dodecen-1-yl(-)succinic anhydride	2159	4,11,11-Trimethyl-8-methylenebicyclo[7.2.0]undec-4-ene	1494
8			3-Methyl-1H-indole	1264

IBF/HD- Dichloromethane hydro distillate extract of fresh *Ipomea batatas* leaves and stems
IBB/HD- Dichloromethane hydro distillate extract of biodegraded *Ipomea batatas* leaves and stems

The GC-MS data of IBB/DE shows that it contains 8 compounds which are, alkenes, ketones, fatty acid and fatty acid esters, but the major compound is 11-Octadecenoic acid, methyl ester which has a percentage composition of 54.56%. The FTIR data accounted for some functional groups present in the compounds suggested by GC-MS [O-H (3371, 3313, 3244, 3192), aliphatic C-H (2956, 2852), C=O (1710), C-O (1103, 1045) but C=C and N-H functional groups present in some compounds were not accounted for.

The mass spectrum result of 11-octadecenoic acid methyl ester revealed the presence of molecular ion peak at m/z 296, corresponding to the molecular formula $C_{19}H_{36}O_2$ which shows two degrees of unsaturation in the analyzed compound.

11-Octadecenoic acid, methyl ester, along with other fatty acid esters present in *Iris germania* were reported to be potent against antioxidant and antimicrobial activities [25]. These compounds were also found to be present in Ipomea batatas stem and leave according to this study.

IV. Conclusion

From this research work, the components of the fresh and biodegraded Ipomea batatas were investigated using the infrared and the GC-MS spectroscopy. The GC-MS analysis result revealed the presence of terpenoids, diterpene alcohols, alkenes, ketones, fatty acid and fatty acids esters in the various extracts of Ipomea batatas stems and leaves. The major compound in the hydro-distilled fresh extract is phytol which was expected for a green plant like Ipomea batatas leaves because it’s a product of chlorophyll metabolism in plants, but the %composition of this compound reduced in the biodegraded hydro-distillate extract. Also, it was discovered that fatty acid esters were present in Ipomea batatas fresh extracts, but their concentration were higher in the biodegraded extracts

11-octadecenoic acid methyl ester constituted 54.56% of IBB/DE along with other fatty acid esters. [26] discovered that Ipomea batatas has anti-oxidative and antimicrobial activities and [27] revealed that the presence of 11-octadecenoic acid methyl esters and other fatty acid esters in plants will make them potent for antioxidant and antimicrobial activities. Therefore we can conclude that the antioxidant and antimicrobial activities of Ipomea batatas leaves will most likely increase as it biodegrades because of the presence of high percentage of these fatty acid esters.

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