Isolation and Characterization of *Irvingia gabonensis* Seed Contents and the Tableting Properties of its Gum Component

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ABSTRACT: This experimental work was designed to isolate, purify and estimate the fatty acids contents of *Irvingia gabonensis seeds* (IGS) and to evaluate the tableting properties of the gum constituent of the seed in metformin tablet. A known amount of the IGS was crushed and dispersed in purified water at a temperature of 80°C, Ethanol (90 %) was added, filtered and dried at 40°C. The fatty acid components were recovered using petroleum ether, while the gum was further purified with ethanol (90%). The fatty acid contents obtained were analyzed using an Agilent G1701 GC/MSD system. The gum content was evaluated using parameters such as: flow rate, angle of repose, bulk and tapped density and Carr's index. The gum was granulated with other excipients and metformin powder dried at 40°C. The granules were evaluated as was done for the gum and tablet compression done at 2.0 KN on a single punch tablet machine fitted with 12.5 mm diameter die size. The GC-MS revealed bioactive compounds mainly fatty acids– lauric acid (36.82%), myristic acid (31.52%), benzyl dodecanoate (9.06%) and palmitic acid (4.03%), n-decanoic acid, 1-(hydroxymethyl)-1,2-ethanediyl ester, tetradecanoic acid, 2-hydroxy-1,3-propanediyl ester, etc. The granule size distribution revealed size and compactness in the following order: Acacia gum > IGS-gum > Gelatin, and average granule size for the batches were found to be 500 µm. Evaluation of metformin tablets gave the following results: crushing strength, friability, and disintegration time for B7 and B8 (7.5 and 10 %w/v IGS-gum as binder) as 58 and 68 N, 1.03% and 1.01%, 20.00 and 26.00 min., respectively. B3and B4 (7.5 and 10 %w/v acacia were shown as gum as binder) 44 and 48 N, 1.10 and 1.03%, 20.00 and 23.50 min., respectively. It can be concluded that at 7.5 and 10 %w/v, IGS-gum proved to be a better binder than acacia in metformin tablets formulation.

Key words: *irvingia gabonensis seeds*, GC-MS, phytochemistry, fatty acids, gum, tablet binder

INTRODUCTION

Irvinga gabonensis is a tree known by names such as wild mango, African mango, bush mango or dika nut plant. The fruit comprises of succulent fibrous layer, stone shell and the seed which encloses two cotyledons.[1]

Irvinga seeds constitute an important part of the rural diet in Nigeria. The sun dried seeds are grounded into flour and used as soup thickeners. The white cotyledons are roasted and eaten and, the polymer content of the seed is used as viscosity enhancer in hot water.[2,3]

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Irvingia gabonensis tree bark powder has been employed to treat diarrhea and to stop lactation in women.[4,5] It is used orally to treat colic and dysentery.[6,7]

Analyzed protein content (amino acids) of *I. gabonensis* was reported as Alanine, Arginine, Aspartic acid, Cystine, Glutamic acid, Glycine, Histidine, Iso-leucine, Lysine, Methionine, Phenylalanine, Proline, Serine, Tryptophan, Threonine, Tyrosine, Valine.[9]

I. gabonensis fruits has also been reported to be rich in vitamin C.[10,11]

I. gabonensis and *I. wombolu* kernels grounded with a pestle and mortar is called 'dika bread' and it is consumed as soup or stew.[12,13] *I. gabonensis* seeds

(IGS) oil can be used such as in cooking oil or margarine, pharmaceuticals, cosmetics, and to make soap.[14,15,16]

Analyses of polysaccharides from IGS were reported to be a potential gum for industrial purposes.[16] Isimi *et al.*[17] have elucidated the gum as a possible emulsifying and suspending agent. The IGS mucilage compared with tragacanth in concentration up to 2 % w/v. At concentration above 2 % w/v, IGS mucilage formed stable emulsions.[17]

In this experimental work, the fat and carbohydrates component will be separated, analyzed and quantified. The purified carbohydrate (gum) will be evaluated as a binding agent in metformin tablet formulation.

MATERIALS AND METHODS

Materials. The following ingredients were used: metformin (Stanex Drugs & Chemicals, Pvt, Indian), lactose (Liaoyuama Pharm, China), corn starch, *I. gabonensis* seed (dika nut; obtained locally from commercial source in Nigeria), Acacia gum (standard grade), gelatin gum, talc and magnesium stearate, ethanol (BDH Chemicals, China), methanol (BDH Chemicals, China), isopropanol (BDH Chemicals, China).

Extractions of *I.* gabonensis gum and fat. Five hundred grams (500 g) of *I. gabonensis* seeds were crushed with the aid of electric blender. The fragmented granular materials were then dispersed in purified water maintained at 80^{o}C with constant stiring. Then 2% sodium metabisulphite was added and stored at room temperature for 24 hours.

A sufficient volume (4 L) of ethanol (90 %) was added to the dispersion and a solid mass of gum and fat precipitated out. The residue was dried in a hot air Oven at 40 ^{o}C for 20 min.

Defatting of IGS-gum. One hundred gram (100 g) of the gum-fat mixture from the previous experiment was placed in a clean beaker then 100 ml of pet. Ether was added with stirring. This process was repeaed until the gum was free of fat. A total volume of 600 ml of ether was expended. The solid particles (polymer) were dried in a oven at 40^{o}C for 30 min. The % yield was calculated using the formula:

$$\text{Percentage yield (\%)} = [\text{final weight} / \text{Initial weight}] \times 100 \quad \text{---------- (1)}$$

Recovering the fat from petroleum ether. The 600 ml pet. ether expended on extraction of the fats was transferred into a clean 1 L capacity beaker. The set up was left opened at room temperature for 72 h. During this period the pet ether evaporated leaving behind the semi solid mass (fats). The % yield was calculated using the fomula (1)

GC-MS analysis. Agilent G1701 Gas Chromatography / MSD system was employed in the analysis of IGS oil . The GC/MSD system consist of an AOC-20i auto-sampler with a Gas Chromatograph interfaced to a Mass Spectrometer which is furnished with a 5% diphenyl/95% dimethyl poly siloxane (Elite-5MS) in a 30 × 0.25 μm ID × 0.25 μm df capillary column. An electron ionization system, with an ionization energy of 70 eV was used for the GC-MC detection. And 99.9 % Helium gas at a flow rate of 1 ml/min was employed as a carrier gas at a spray volume of 2 μl. The system was operated at injector temperature of 250^{o}C and the temperature of the ion-source at 200^{o}C. The temperature of the oven was set to run from 100^{o}C rising at 4^{o}C/min to 300^{o}C. The mass spectra was recorded at 70 ev, at a scanning interval of 0.5 s. The relative percentages of each component was calculated from the mean peak area to the total areas. Turbo-mass Gold-Perkin-Elmer mass detector and Agilent G1701 GC/MSD ChemStation sorftware were used for analysis and Agilent IO labraries version 15.5 was used as library.

Phytocomponents identification. The results of GC-MS were interpreted with the aid of Agilent IO Libraries version 15.5 data base [National Institute Standard and Technology (NIST) containing above 62,000 patterns]. The spectra of the tests components were compared with spectra of standard components stored in the NIST library. The molecular weights,

names, and structures of the contents of IGS petroleum ether extract were determined.

Viscosity determination. Four different concentration of the polymer (0.5, 1.0, 1.5 and 2.0 %) were prepared and their viscosities were determined using Haakevisco tester (VT-01).

pH determination. Haakevisco 1 g of the gum was weighed and 120 ml of distilled water was added and stirred thoroughly to ensure complete dispersion of the gum. The pH of the gum solution was measured in triplicate with the aid of a pH meter (Metrohm 913, USA).

Evaluation of granules

Determination of bulk and tapped density. Bulk and tapped volumes of IGS-gum were determined by a simple method of tapping. A 50 g of the test polymer was placed in a 100 ml capacity graduated cylinder, the volume occupied was recorded as the bulk volume. The cylinder was then subjected to 100 tapping. The volume occupied after the exercise was taken as the tapped density. Bulk and tapped densities were computed as in equations 2 and 3.

$$Td = \text{weight of powder} / \text{Tapped volume} \quad \ldots..(2)$$

$$Bd = \text{weight of powder} / \text{Bulk volume} \quad \ldots...(3)$$

Where B_d and T_d represent bulk and tapped densities, respectively.

Hausner's ratio. Hausner's ratio (H) was obtained using equation 4.

$$H = \frac{Td}{Bd} \quad \ldots\ldots...(4)$$

Carr's compressibility index. Compressibility index was estimated by the equation 5 below.

$$\text{Carr's index (\%)} = \left(\frac{[Td-Bd]}{Td}\right) x100 \quad \ldots\ldots..(5)$$

Determination of flow properties of the dried polymer

Angle of repose. A clean glass funnel with stem length of 10 cm and diameter of 1.3 cm, and length 10 cm was clamped to a retort stand. A 50 g of IGS – gum was allowed to flow through a funnel onto a plain white paper placed on the bench. The height of the powder pile was measured and the radius of the circular base of the pile was determined. The angle of repose (θ) was computed with equation 6.

$$\theta = \tan\left(\frac{h}{r}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

Where 'θ' is the angle of repose, 'h' height of the powder pile and 'r' the radius of the circular base of the powder pile.

Flow rate. Fifty grams (50 g) quantity of the IGS-polymer was allowed to flow through a glass funnel mounted on a retort stand. The time taken for complete flow powder was taken as flow time. An average of three readings were documented and the flow rate (g/sec) computed based equation 7.

$$\text{Flow rate}\left(\frac{g}{sec}\right) = \text{Weight of}\frac{\text{powder}}{\text{Time taken to flow}} \quad \ldots.\mathbf{(7)}$$

Particle size analysis. A simple method of sieve analysis was used (U.S.P 2003). A set of sieves: 850, 500, 355, 250, 180 µm and less than 100 µm in that order were arranged on a sieve shaker. Each batch of the test granules were placed on the top most sieve size 850 μm size. The machine was operated for 10 minutes. The weight of the granules retained on each sieve was determined.

Preparation of granules by wet granulation procedure. Four batches of granules consisting of Irvingia gabonensis gum as binder were prepared in different concentrations (2.5, 5.0, 7.5, 10.0 % w/v). Acacia gum and gelatin were employed as standard binder, while starch was used as a disintegrant (Table 1).

Evaluation of flow properties of the granules. The simple methods previously described for IGS-gum were employed. The tapped density, bulk density, Hauser's ratio, Compressibility index, flow rate and angle of repose were determined.

Granule size analysis. The same standard procedure as described under particle size analysis earlier was adopted.

Table 1. Composition of metformin tablets.

INGREDIENT	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
Metfomin(g)	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Lactose (g)	5.50	5.25	5.00	4.75	5.50	5.25	5.00	4.75	5.50	5.25	5.00	4.75
Corn Starch (g)	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Acacia (g/10 ml)	0.25	0.5	0.75	1.00	-	-	-	-	-	-	-	-
IGS-gum (g/10ml)	-	-	-	-	0.25	0.5	0.75	1.00	-	-	-	-
Gelatin (g/10ml)	-	-	-	-	-	-	-	-	0.25	0.5	0.75	1.00
Talc (g)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
MG Stearate (g)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25

Note: fifty (50) tablets per batch.

Tablet compression. Tablets were compressed with 2.0 KN force on a single punch (Erweka, AR 400, Germany) tableting machine. Expected tablet gross weight is 650 mg (containing 500 mg API) using 12.5 mm flat faced punch size.

Evaluation of compressed tablets

Tablets hardness. Tablet hardness was measured as crushing strength. Average crushing strength of six (6) tablets was determined with the aid of a Monsanto hardness tester.

Tablet friability. The ability of tablets to withstand handling and rigors of transportation was measured as abrasion or friability test. A friability tester (Erweka, TA 3 R, Germany) was used. Initial weight of ten (10) tablets was recorded. The tablets were subjected to the test by setting the friabilator at 25 r.p.m for 4 min. The tablets were de-dusted and the final weight was taken. Average of three experiments was used for computation of friability (%) (eq. 8)

$$\text{Friability (\%)} = \left(\frac{[WI - WF]}{WI}\right) \times 100 \quad \ldots\ldots\ldots\ldots (8)$$

Where, W_I represent the weight of 10 intact tablets before the experiment and W_F weight of the tablets after friability experiment.

Determination of tablet dimension. Thickness and diameter of six (6) randomly selected tablets were measured with the aid of vernier caliper. Average weight and standard deviation were determined.

Determination of disintegration time. Disintegration time of six (6) tablets were determined with the aid of disintegration apparatus (Erweka, ZT3, Germany). The mean and standard deviation was also computed.

Weight uniformity. Twenty (20) tablets were selected randomly and weighed individually. Deviation of each tablet from the mean of these tablets was determined and the results interpreted according to the B.P 1980 standard.

RESULTS

Figure 1 shows the GC chromatogram of compound present in the IGS extract. Twelve (12) phytocompounds were identified as shown in table 1.

When the GC chromatogram was compared with the Agilent IO library, eight (8) of the peaks were identified as : leuric acid -36.82 %, myristic acid – 31.52 %benzyl dodecanoate – 9.06 %, palmitic acid – 4.03 %, lauric acid, myristic acid and palmitic acid (figures 2 A to K).

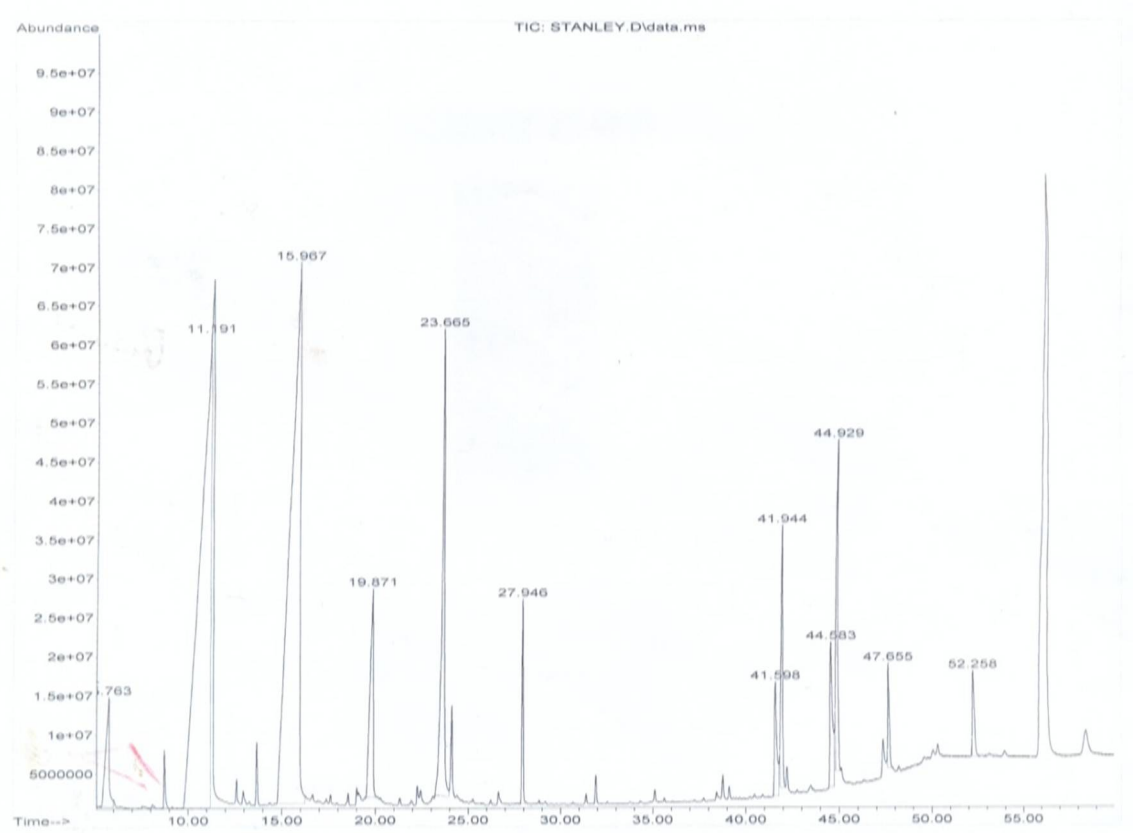

Figure 1. Chromatogram of phytocompounds spotted by GC-MS in the IGS fats.

Table 1. GC-MS identified phytocompounds in the IGS fats.

No	RT	Name of compound	Molecular formula	MW	Peak area (%)
1	5.76	Capric acid (n-Decanoic acid)	$C_{10}H_{20}O_2$	172	2.09
2	11.19	lauric acid (n-Dodecanoic acid)	$C_{12}H_{24}O_2$	200	36.82
3	15.97	myristic acid (n-Tetradecanoic acid)	$C_{14}H_{28}O_2$	228	31.52
4	19.87	palmitic acid (n-hexadecanoic acid)	$C_{16}H_{32}O_2$	256	4.03
5	23.67	benzyl dodecanoate	$C_{19}H_{30}O_2$	290	9.06
6	27.95	benzyl dodecanoate	$C_{19}H_{30}O_2$	227	2.11
7	41.60	Dodecanoic acid, 1-(hydroxymethyl)-1,2-ethanediyl ester	$C_{27}H_{52}O_5$	456	1.75
8	41.94	1-(hydroxymethyl)-1,2-ethanediyl ester, Dodecanoic acid	$C_{27}H_{52}O_5$	456	2.01
9	44.58	1-(hydroxymethyl)-1,2-ethanediyl ester, Dodecanoic acid	$C_{27}H_{52}O_5$	456	2.24
10	44.93	Tetradecanoic acid, 2-hydroxy-1,3-propanediyl ester	$C_{31}H_{60}O_5$	512	5.28
11	47.66	2-hydroxy-1,3-propanediyl ester, Tetradecanoic acid	$C_{31}H_{60}O_5$	512	1.96
12	52.26	1,2,3-propanetriyl ester, Dodecanoic acid	$C_{39}H_{74}O_5$	638	1.13

Phytocompounds identified in the IGS fats are shown in Figure 2.

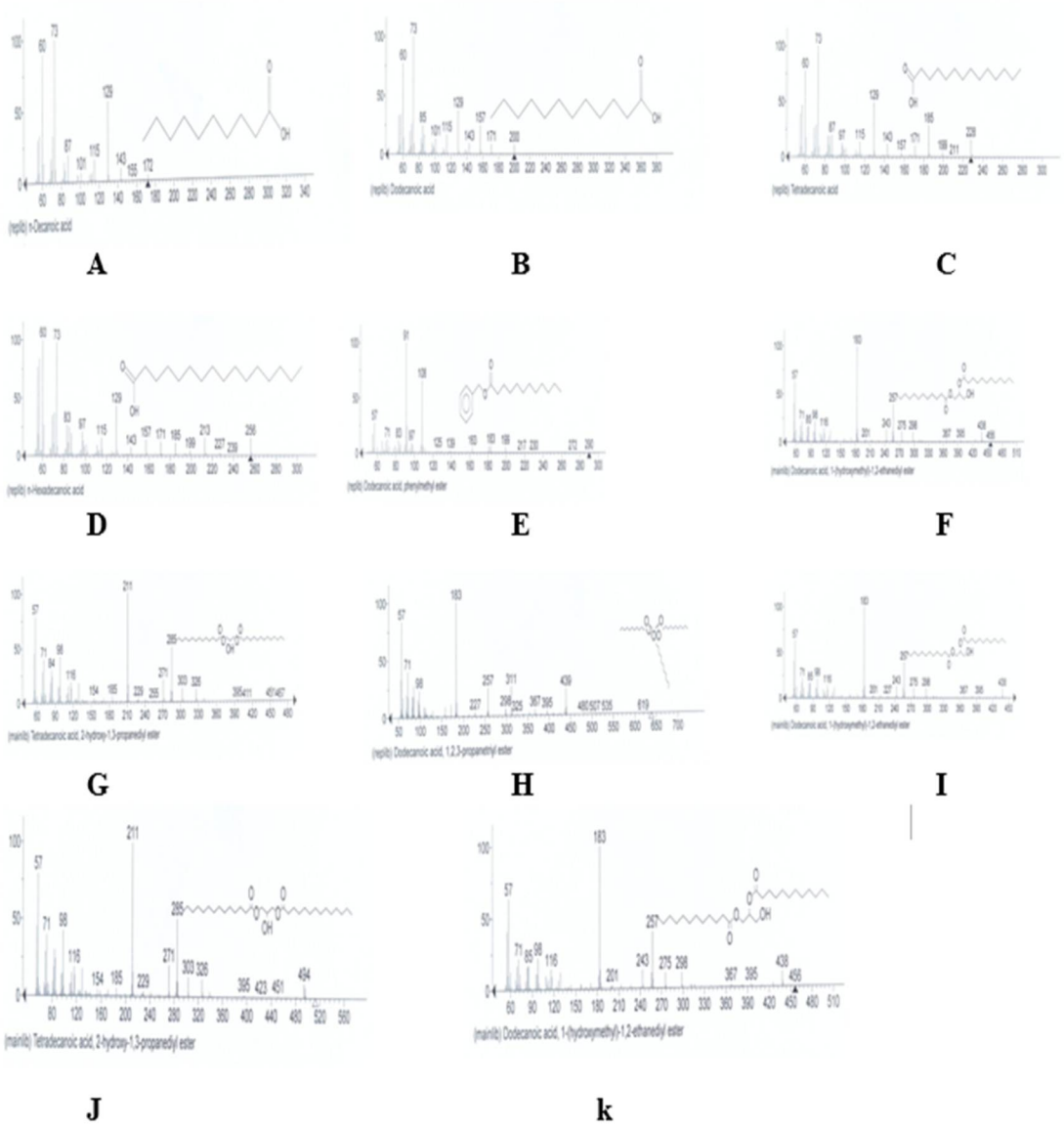

Figure 2. Major compounds in IGS extract. A (Decanoic acid), B (Dodecanoic acid), C (tetradecanoic acid), D (Hexadecanoic acid), E (Decanoic acid, phenylmethyl ester), F (Dodecanoic acid, 1-(hydroxylmethyl)-1,2-methyl ester), G (Tetradecanoic acid, 2-hydroxy-1,3-propanediyl ester), H (Dodecanoic acid, 1,2,3-propanetriyl ester), I (Dodecanoic acid, 1-(hydroxymethyl)-1,2-ethanediyl ester), J (Tetradecanoic acid, 2-hydroxy-1,3-propanediyl ester), K (Dodecanoic acid, 1,2,3-propanetriyl ester) structures spotted by GC-MS in the IGS fats.

The 95% ethanol extract and the Petroleum ether defatted gum are shown in Fig. 2.

Table 2 illustrates the average weight of IGS-gum and fats recovered from seed, while Table 3 shows the viscosity range with different concentrations of the gum. It could be seen that the viscosity increases along with increase in concentration at a fixed shear rate (50 r.p.m).

Evaluation of the physicomechanical properties of the gum yielded results in table 4

Table 2. Physical Properties of *I. gabonensis* seed (IGS).

Weight of IGS after 95 % ethanol extraction	Weight gum after defatting	Weight of fats
100 g	28.45 g	64.5 g

Table 3. Viscosity of *I. gabonensis* gum (IGS-gum).

%w/v of IGG	Viscosity (mPas)
0.50	<55.0 ± 5.0 mPas
1.00	75.0 ± 2.0 mPas
1.50	130 ± 5.0 mPas
2.00	250 ± 1.0 mPas

The pH of *I. gabonensis* is 6.00

The table 6 below showed the results of physicomechanical properties of various tablets of metformin formulated using IGS-gum as binder and both acacia gum and gelatin as standard binders.

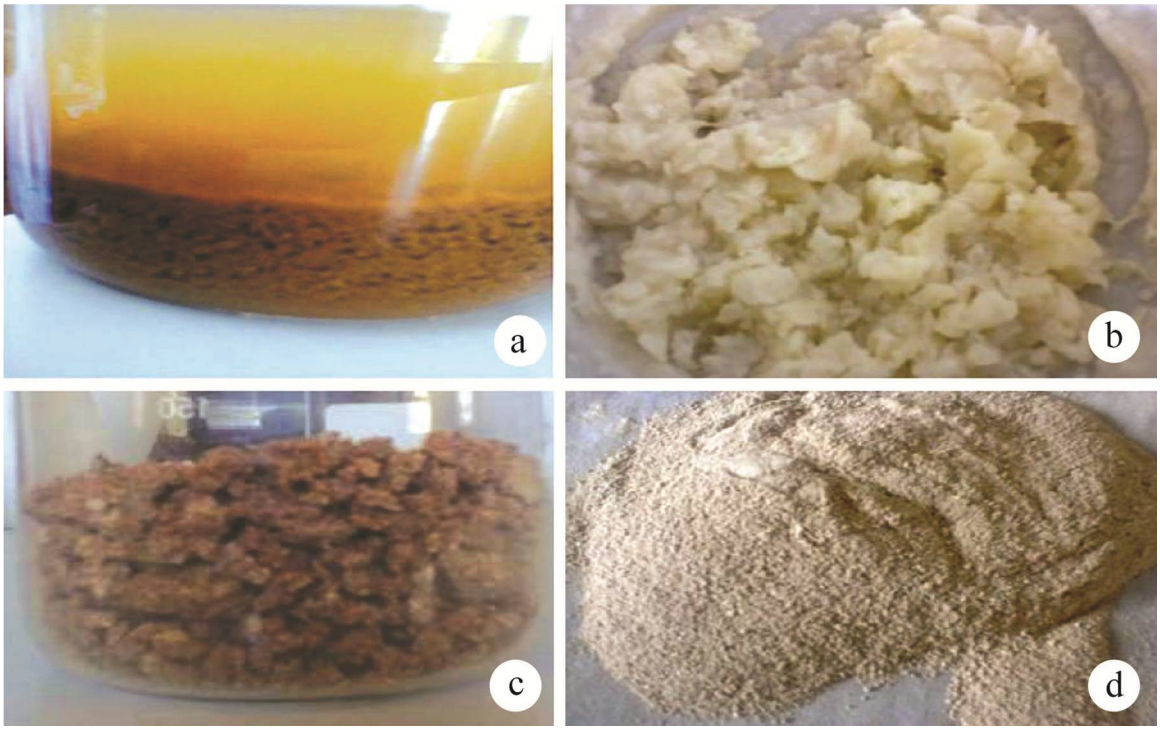

Figure 3. Ethanolic precipitate of Irvingia seed (a), Petroleum ether added to dried IGS granules (b), recovered fat form the petroleum ether (c) and dried granules of IGS-gum (d)

Table 4. Physicochemical properties of *I. gabonensis* seed gum.

Material	Average flow rate (g/sec) n=3	Average angle repose (o) n=3	Bulk density (g/cm^3)	Tapped density (g/cm^3)	Compressibility index (%)	Hausner's ratio
IGS-gum Powder	2.80± 0.2	25.30 ± 0.1	0.230	0.310	26.00 %	1.50

The gum granules exhibited good flow property as indicated by the angle of repose value of 25.30 %, while the Car's index value is a reflection of inherent poor compressibility property of IGG.

The granule size distribution of irvingia gum as compared with acacia gum and gelatin as standard binders. Figure 7 showed that acacia showed average granule size for the binders to be around 500 µm.

The granules were evaluated as was done for the gum (table 5).

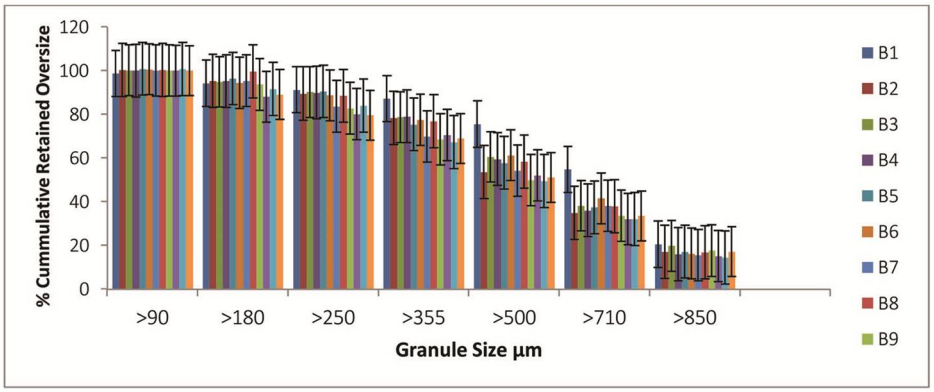

Figure 4. Size distribution (µ) vs. Cumulative retained oversize for metformin granules (%).

B_1[2.5% AG] ; B_2[5.0% AG] ; B_3[7.5% AG] ; B_4[10.0% AG] ; B_5[0.25% IGS-gum] ; B_6[5.0%IGS-gum] ; B_7[7.5% IGS-gum] ; B_8[10.0% IGS-gum] ; B_9[2.5% Gelatin] ; B_{10}[5.0% Gelatin] ; B_{11}[7.5% Gelatin] ; B_{12}[10.0% Gelatin]

Table 5. Physicochemical characteristics of metformin granules.

Binder	Batches	% of binder	Average flow rate (g/sec) n=3	Average angle of repose (o) n=3	Bulk density (g/cm3)	Tapped density (g/cm3)	Compressibility index (%)	Hausner's ratio
	B1	0.25	1.40	38.84	0.460	0.641	27.00	1.40
AG	B2	0.50	1.96	31.55	0.460	0.650	28.00	1.39
	B3	0.75	1.84	36.35	0.490	0.651	20.00	1.00
	B4	1.00	1.02	36.98	0.660	0.670	28.00	1.40
	B5	0.25	2.12	27.07	0.450	0.601	26.11	1.40
	B6	0.50	2.92	31.84	0.460	0.610	23.00	1.30
IGS-gum	B7	0.75	2.08	27.61	0.450	0.620	27. 00	1.38
	B8	1.00	1.18	32.74	0.490	0.681	28. 00	1.39
	B9	0.25	2.37	32.78	0.510	0.631	19. 00	1.24
Gelatin	B10	0.50	2.32	31.84	0.520	0.650	20. 00	1.30
	B11	0.75	1.95	32.46	0.530	0.650	18. 00	1.25
	B12	1.00	1.94	37.31	0.540	0.702	23. 00	1.40

Note: AG (acacia gum), IGS-gum, GN (Gelatin)

Table 6. Physicomechanical properties of metformin tablets.

Binder	Batch	Binder material (% w/v)	Tablet weight (g)	Hardness (N) n=6	Mean thickness (mm) n=6	Friability n=3	Content uniformity (g)	Disintegration time (mins) n=6
	B1	2.5	0.64 ± 0.03	32.0 ± 0.5	0.34 ± 0.01	1.20 ± 0.20	0.490 ± 0.01	14.20 ± 2.0
AG	B2	5.0	0.64 ± 0.02	38.0 ± 0.5	0.35 ± 0.01	1.20 ± 0.10	0.490 ± 0.00	18.00 ± 2.5
	B3	7.5	0.65 ± 0.03	44.0 ± 0.0	0.34 ± 0.02	1.10 ± 0.10	0.495 ± 0.00	20.00 ± 0.0
	B4	10.0	0.65 ± 0.01	48.0 ± 0.2	0.34 ± 0.00	1.03 ± 0.00	0.499 ± 0.00	23.50 ± 0.5
	B5	2.5	0.65 ± 0.01	37.0 ± 0.1	0.35 ± 0.01	1.10 ± 0.20	0.495 ± 0.00	15.10 ± 0.3
IGS-gum	B6	5.0	0.65 ± 0.01	54.0 ± 0.1	0.35 ± 0.01	1.10 ± 0.10	0.498 ± 0.01	18.10 ± 0.3
	B7	7.5	0.65 ± 0.00	58.0 ± 0.4	0.35 ± 0.00	1.03 ± 0.03	0.500 ± 0.00	20.00 ± 0.3
	B8	10.0	0.65 ± 0.00	68.0 ± 0.5	0.34 ± 0.01	1.01 ± 0.01	0.500 ± 0.00	26.00 ± 0.3
	B9	2.5	0.65 ± 0.01	87.0 ± 0.2	0.34 ± 0.01	1.02 ± 0.02	0.495 ± 0.01	23.12 ± 0.3
Gelatin	B10	5.0	0.65 ± 0.01	97.0 ± 0.0	0.34 ± 0.00	1.02 ± 0.00	0.500 ± 0.00	30.11 ± 0.3
	B11	7.5	0.65 ± 0.00	105.0 ± 0.0	0.35 ± 0.00	0.40 ± 0.00	0.505 ± 0.05	42.50 ± 0.4
	B12	10.0	0.65 ± 0.00	115.0 ± 0.5	0.35 ± 0.00	0.20 ± 0.00	0.500 ± 0.00	60.00 ± 0.0

Note: AG (acacia gum), IGS-gum (Irvingia gum), Gelatin

The results obtained (table 6) were expressed as mean values for the hardness, friability and disintegration time. Taken these three parameters into consideration, the results yielded at binder concentrations of 7.5 and 10 % for the test binder and the reference standard are as follow: B7 and B8 (having 7.5 and 10 %w/v IGS-gum as binder) were: 58 N and 68 N, 1.03 % and 1.01 %, 20 and 26 min., respectively. B3and B4 (contain 7.5 and 10 %w/v acacia gum as binder) 45 and 48 N, 1.10 and 1.03 %, 20.00 and 23.50 min., respectively; B11 and B12 (having 7.5 and 10 % w/v gelatin as binder) 105 and 115 N, 0.04 and 0.02 %, 42.50 and 60.00 min, respectively.

DISCUSSION

GC of the IGS petroleum ether extract identified 12 phytocompounds, show in Figure 1. The plant seed fats were mostly saturated fatty acids and they include capric acid (n-decanoic acid), n- dodecanoic (lauric acid), n-tetradecanoic (myristic) acid, n-hexadecanoic acid (palmitic acid), benzyl dodecanoate, dodecanoic acid, 1-(hydroxymethyl)-1,2-etandiyl ester, tetradecanoic acid, 2-hydroxy-ester 1,3-propanediyl (Figure 2). Some fatty acids contents could not be resolved, but their mass spectra showed the presence of benzyl dodecanoate, 1-(hydroxymethyl)-1,2-ethanediyl ester of dodecanoic acid, 2-hydroxy-1,3-ester propanediyl and tetradecanoic acid as shown in Figure 2. The most abundant phytocompounds among them are lauric acid, and myristic acid (Table 1).

Lauric, palmitic and myristic acids are bioactive molecules proven to exhibit antibacterial and antifungal properties.[18,19] Thus, IGS fat could be a reliable source of safe antibacterial and antifungal drug. More so myristic acid possesses emulgent property and it is useful as surfactant in soap making. It also has larvicidal and repellent activity.[20] Palmitic acid possessed anti-inflammatory[21], antioxidant, insecticidal, anti-androgenic, haemolytic, 5-alpha reductase inhibitory activities[22] and potent larvicidal activities against mosquitoes.[23] As a result of these important pharmacological activities, IGS fats could be an economical source of natural drugs for pharmaceutical companies.[24]

Figure 4 shows more compact granules with increase concentration of gum for all batches of the test and standard gums. The percent retained cumulative granule sizes for B1 to B8 favours more of >180 to 355 µm than FB-B12. While, granule sizes >500 to 850 µm favoured B5 to B8 than B1 to B4 and FB to B12. The results reflect a better granule size distribution for IGS-gum granules than AG and Gelain. The cohesiveness of the former is better and higher than the latter.

From table 6, the binding strength of the test polymer (IGS-gum) and standard polymer (AG and Gelatin), is reflected by crushing strength, friability and disintegration. The stronger the binder the stronger the bonding functionality and higher the crushing strength hence, longer the disintegration time. From the result obtained, IGS-gum and AG gave acceptable tablets at binder concentration of 7.5 and 10 % w/v concentration, while Gelatin gave acceptable compact at 2.5 and 5.0 % w/v. The polymer functionality or binding strength resulting from bond summation is higher for Gelatin than IGS-gum and AG, this is the reason while Gelatin is used at lower concentration than AG and other pharmaceutical grade binders. Tablets weights variation (table 6) showed that batches of metformin tablets formulated with IGS-gum formed more compact tablets than those made with acacia as binder but were comparable with those made with gelatin binder. The tensile strength and disintegration time of the resulting tablets increased with the concentration of the test and standard binder, whereas, friability decreased. IGS-gum used as binder in this experimental work proved to impact more functionality to tablets properties than acacia gum by yielding better and acceptable hardness, friability, and disintegration time.

CONCLUSION

I. gabonensis seeds contains various bioactive compounds and polymer as major constituent. For the fact that there is global economy recession, and the scarcity of foreign exchange confronting many developing and under developed nations, these nations will benefit from local pharmaceutical excipient in other to be self-reliance. The results of this experiment indicates that *Irvingia gabonensis* seed fatty acids contents and gum are highly beneficial to local pharmaceutical industries. The IGS-gum as binder in concentration range, 7.5 to 10 % w/v is appropriate for formulation of conventional tablets having acceptable mechanical and stable properties.

CONFLICT OF INTEREST

There was no any conflict of interest what soever, and every cited phrase and references has been dully acknowledged.

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