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Secondary metabolites of *Bagassa guianensis* Aubl. wood, a study of the chemotaxonomy of the Moraceae family.

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Abstract

In effort to explain wood durability of Moraceae plants family, a phytochemical study was undertaken on *Bagassa guianensis*. The phytochemical investigation of the ethyl acetate extract obtained from the heartwood led to the isolation of 18 secondary metabolites, including 6 moracins [the new 6-0-methyl moracin M (3), 6-O-methyl moracin N (4) and moracin Z (5); the known moracin M (1), moracin N (2) and moracin P (6)], 8 phenolic derivatives [the new (-)-epialboctalol (12), arachidin 4 (10) and the known alboctalol (11), trans-resveratrol (7), arachidin 2 (9), trans-oxyresveratrol (8) and artogomezianol (13)], the 3 known flavonoids steppogenin (14), katuranin (15), dihydromorin (16), the β-sitosterol (17) and the resorcinol (18). Comparison with literature data indicates that stilbenoids are presumably responsible for the natural durability of the wood. In addition, chemical composition points out that *B. guianensis* is closely related to *Morus* sp. in the phylogeny and should be placed within the Moreae s. s. tribe in the Moraceae family.

**Keywords:** *Bagassa guianensis*, Moraceae, secondary metabolites, stilbenes, moracins, flavonoids, natural durability
1. Introduction

Wood as a material is used extensively in construction and other applications where it can be degraded by many different organisms, mainly fungi and insects. However, some trees have specialized considerably long-lasting heartwoods. It has been demonstrated in the past that wood natural durability can be ascribed to the presence of extractives (Smith et al., 1989; Wang et al., 2005; Hsu et al., 2007), although structural components of the cell wall may also contribute to its resistance to biodegradation (Silva et al., 2007). Heartwood natural durability can also result from synergetic or additive effects of compounds with various modes of action (toxic, hydrophobic, free radical scavengers and so on) (Suttie and Orsler, 1996; Okitani et al., 1999; Schultz and Nicholas, 2000; Schultz et al. 2007; Binbuga et al., 2008). Future processes to preserve wood constructions may involve returning to mankind’s historical use of naturally durable heartwood as well as discovering eco-friendly wood protection agents inspired from long-lasting woods (Schultz et al., 2007).

Bagassa guianensis Aubl. (Moraceae) commercially known as tatajuba is a large rather infrequent unbuttressed canopy tree naturally occurring in French Guiana. Bagassa guianensis is a member of Moraceae family, which is divided in 5 unequal tribes when comparing the number of species in these tribes (Mabberley, 2002). Bagassa guianensis (the only member of its genus) was originally classified in the Artocarpeae tribe, but Weiblen genoma-based classifications have suggested recently that this species would better be included in Moreae tribe (Datweyler and Weiblen, 2004; Zerega et al, 2005).

Species in the Moraceae family have important economic and medicinal value. They are widely acknowledged as a rich source of bioactive secondary metabolites such as flavonoids,
stilbenes, triterpenoids and xanthones (Lee et al., 2009; Ngadjui et al., 2005; Han et al., 2006; Jayasinghe et al., 2008). Also, some of them like *Maclura pomifera* and *B. guianensis* are capable of specializing very long-lasting woods (Scheffer and Morrell, 1998; Schultz et al., 1995), although in the latter case, the substances responsible for this high durability were unknown. We therefore embarked upon identifying secondary metabolites of tatajuba wood that may responsible for its natural durability. In addition, our secondary goal here was to confirm (or refute) botanical classification of the *Bagassa* genus by chemotaxonomy.

2. Results and Discussion

The dried heartwood of *Bagassa guianensis* was extracted with ethyl acetate. This extract was fractionated by silicagel column chromatography to give 9 fractions. Subsequent preparative HPLC purifications of these fractions allowed us to isolate compounds 1-18 (figure 1).

**Figure 1** Compounds 1-18 isolated from *Bagassa guianensis* (Moraceae). (a) New compounds; (b) New names.

Compounds 1 to 6 shared several common spectral characteristics. The $^1$H and $^{13}$C NMR spectral data (Table 1) indicate the presence of two independent aromatic systems with a 3,5-dihydroxyphenyl and a substituted benzo-furan. For example, 3 exhibited the 3,5-dihydroxyphenyl with characteristic $^1$H spectrum composed of one doublet at $\delta$ 6.78 for H-2’/H-6’ and a triplet at $\delta$ 6.25 for H-4’. These protons are coupled to each other with a $^4J$ coupling of 2.1 Hz. In addition, $^{13}$C spectrum indicates the presence of two equivalent aryl hydroxyl groups at $\delta$ 159.7. The 3,5-dihydroxyphenyl moiety was linked to C-2 by the observation of a long range $^1$H-$^{13}$C correlation between H-2’/H-6’ and C-2 at $\delta$ 156.5. The second aromatic system appeared characteristic of a 6-monosubstituted benzo-furan with
signals of protons H-4, H-5 and H-7 being a broad doublet at $\delta$ 7.43 ($J = 8.5$ Hz), a doublet of doublet at $\delta$ 6.85 ($J = 8.5$ and 2.0 Hz) and a doublet at $\delta$ 7.09 ($J = 2.0$ Hz), respectively. On the furan ring H-3 gives a doublet at $\delta$ 6.95 ($J = 0.6$ Hz) due to a long range $^3J$ coupling with H-7 (confirmed by the presence of crosspeak between H-3 and H-7 on COSY NMR spectrum). When compared to moracin M (1), it became obvious from signal at $\delta$ 3.85 (3H, s) and the presence of crosspeak at $\delta$ 56.2 in the $^1H-^{13}C$ HSQC spectra that compound 3 was a moracin M methyl ether. The $^1H-^{13}C$ long-range HMBC spectra gave a crosspeak with C-6 at $\delta$ 159.6 unambiguously placing the methoxy group on C-6. HREIMS of 3 allowed us to ascertain molecular formula $C_{15}H_{12}O_4$ further confirming that we had isolated the new 6-O-methyl-moracin M (3).

Table 1 $^1H$ and $^{13}C$ NMR spectroscopic data for moracins 3-5 in CD$_3$OD

Compound 4 was isolated as yellowish amorphous powder. The HREIMS indicated a molecular formula $C_{20}H_{20}O_4$ deduced from the ion peak at $m/z$ 325.1437 [$M + H]^+$ (calcd 325.1434). The $^1H$ and $^{13}C$ NMR spectral data of 4 were closely related to those of moracin N (2) (Lee et al., 2001) except for the replacement of hydroxyl group by a methoxy group as described for the above compound 3. Indeed, the $^1H$ NMR data of 4 (Table 1) demonstrated the presence a methoxy group on C-6 in the benzofuran ring, with a signal at $\delta$ 3.88 (3H, s), a crosspeak at $\delta$ 56.2 in the $^1H-^{13}C$ HSQC experiment and a crosspeak with C-6 at $\delta$ 157.4 in the $^1H-^{13}C$ long-range HMBC spectra. This novel molecule was named 6-O-methyl-moracin N.
Compound 5 was isolated as an amorphous brown powder. The molecular formula $C_{20}H_{22}O_5$ was deduced from the HREIMS at $m/z$ 343.1542 [M + H]$^+$ (calcd 343.1540). The $^1$H- and $^{13}$C-NMR spectral data of 5 were closely related to those of 6-O-methyl-moracin N (4) (Table 1). The main difference was observed in the prenyl moiety at C-5. The double bond is absent in 5 and it was unambiguously established that side chain at C-5 is hydrated and is therefore a 3-hydroxy-3-methylbutyl group, with the upfield shifts of methylene group H-1’’ from $\delta$ 3.34 to $\delta$ 2.73 and the apparition of a methylene H-2’’ at $\delta$ 1.74 in place of the vinyl proton at $\delta$ 5.52; in addition, the two methyl groups H-4’’ and H-5’’ became equivalent at $\delta$ 1.27 (Table 1). The $^1$H-$^{13}$C long-range HMBC spectra exhibited a crosspeak between the methylene group H-1’’ and H-2’’ with C-5 at $\delta$ 128.6 proving the linkage C-1’’/C-5 between the 3-hydroxy-3-methylbutyl moiety and the benzofuran ring. This molecule is a hydrate of 6-O-methyl-moracin N and was named moracin Z.

Spectral data along with HREIMS of 1, 2 and 6 allowed us to determine and ascertain by comparison with literature data that we had also isolated moracin M (1) (Basnet et al. 1993, Zhou et al., 1999), moracin N (2) (Lee et al. 2001) and moracin P (6) (Dat et al., 2009).

Stilbenoids trans-resveratrol (7) (Lee et al. 2001; Su et al., 2002), trans-oxyresveratrol (8) (Likhitwitayawuid and Sritularak, 2001; Lee et al., 2001; Su et al., 2002; Li et al., 2007), arachidin 2 (9) (Orsini et al., 2004) and artogomezianol (13) (Likhitwitayawuid and Sritularak, 2001) were identified by comparison of the respective spectral and chemical data with those described in the literature (Figure 1).

Compound 10 was a colorless syrup with molecular formula $C_{19}H_{22}O_4$ as deduced from the HREIMS at $m/z$ 315.1592 [M + H]$^+$ (calcd 395.1591). The $^1$H spectral data of 10 were closely
related to those of arachidin 2 (9) (Table 2) and suggested a stilbenoid compound with a para-
disubstituted aromatic ring A, a trans double bond between the aromatic rings, and a
1‘,3’,4’,5’-tetrasubstituted aromatic ring B. Ring A is symmetrical, with 2 doublets at δ 7.32
\((J = 8.7 \text{ Hz}, \text{H-2/H-6})\) and δ 6.75 \((J = 8.7 \text{ Hz}, \text{H-3/H-5})\). The trans configuration of the double
bond can be ascertained by the very large coupling constant between the two protons at δ 6.90
\((J = 16.5 \text{ Hz}, \text{H-} \alpha)\) and δ 6.74 \((J = 16.5 \text{ Hz}, \text{H-} \beta)\), and the B ring is symmetrical as well and
was characterized by a singlet at δ 6.46 \((\text{H-2’/H-6’})\). In the same way as we identified a
hydrated side chain in the moracins series, the main difference here between 9 and 10 is in the
side chain in position 4’, the double bond of which is also hydrated. This has been established
by the observation of methylene group H-1’’ at δ 2.66 instead of δ 3.28 and the apparition of
a second methylene H-2’’ at δ 1.68. In addition, the two methyl groups H-4’’ and H-5’’
became equivalent at δ 1.25. The chromatography collected quantities was too low to observe
heteronuclear \(^1\text{H}-\text{\^{13}}\text{C} \text{HSQC / HMBC correlations and direct } \text{\^{13}}\text{C chemicals shifts by}
\text{\^{13}}\text{C/DEPTQ sequence. However, the above-described data in comparison with those of}
arachidin 2 are sufficient to ascertain identification of compound 10 as trans-4’-(3-hydroxy-3-
methylbutyl)-oxyresveratrol. We named this new compound arachidin 4.

Table 2 \(^1\text{H} \text{ and } \text{\^{13}}\text{C NMR spectroscopic data for stilbenes } 9 \text{ and } 10 \text{ in CD}_{3}\text{OD}

Compounds 11 and 12 both isolated as brownish syrups presented the ion peak at \textit{m/z}
489.1540 [M + H] \text{ in HREIMS indicating that they are isomers with molecular formulas}
\text{C}_{28}\text{H}_{24}\text{O}_{8}\text{ (calcd 489.1544)}. The \(^1\text{H-NMR allowed us to identify a 3,5-dihydroxyphenyl group}
and two distinct 2,4-dihydroxyphenyl groups in both compounds. By comparison of the
respective spectral and chemical data with those described in the literature, compound 11 was
identified as alboctalol (Bates et al., 1997). Compound 12 has an $[\alpha]_D^{20}$ value of -7.4° (c 0.004, CH$_3$OH). It was clear that 12 was a diastereoisomer of 11 with equivalent H-18/H-22 protons at $\delta$ 6.01 (Table 3). In 11, H-18/H-22 pair gives a doublet at a strong upfield shift of $\delta$ 5.77 typical of the $\pi$-stacking effect of the neighboring 2,4-dihydroxyphenyl groups. In addition, on this aliphatic ring, the main differences with 11 are on methylene H-5 and methines H-6, H-7 and H-8. H-5$_{ax}$ at $\delta$ 3.19 exhibited a broad triplet with large couplings ($J = 13.7$ Hz) with the gem H-5$_{eq}$ and the vicinal H-6 suggesting that the 6-aryl group should be equatorial and proton H-6 axial. This observation was corroborated by the multiplicity of H-5$_{eq}$ signal at $\delta$ 2.72. This signal is a doublet of doublet with a large coupling constant $J = 15.6$ Hz with H-5$_{ax}$ and a small coupling constant $J = 3.0$ Hz with H-6$_{ax}$. Signal of H-6$_{ax}$ at $\delta$ 3.51 is a broad triplet of doublet with two large coupling constants $J = 11.6$ Hz with H-5$_{ax}$ and H-7 and a small coupling constant $J = 2.1$ Hz with H-5$_{eq}$. This pattern indicates that the 7-aryl group is equatorial and H-7 axial. H-7$_{ax}$ at $\delta$ 3.41 exhibited one doublet of doublet with one large coupling constant ($J = 11.3$ Hz) with H-6$_{ax}$ and a second rather large coupling constant ($J = 8.2$ Hz) with H-8 indicating that the 8-aryl group might be equatorial and proton H-8 axial. These assumptions were confirmed by NOESY experiment with cross peaks observed between H-5$_{eq}$ and H-6$_{ax}$, H-6$_{ax}$ and H-8$_{ax}$, H-6$_{ax}$ and H-18, H-8$_{ax}$ and H-22 and between H-5$_{ax}$ and H-16, H-7$_{ax}$ and H-16, H-7$_{ax}$ and H-28 (Figure 2). All data permitted to confirm that we had isolated a new epimer of alboctalol (11) therefore named (−)-epialboctalol (12).

Table 3 $^1$H and $^{13}$C NMR spectroscopic data for distilbenes 11 and 12 in CD$_3$OD

Figure 2 Pertinent NOE interactions observed for (−)-epialboctalol (12) from NOESY experiment
In addition to these moracins and stilbenoids, we isolated flavanones steppogenin (14) (Lee et al., 2001), katuranin (15) (Lee et al., 2001) and dihydromorin (16) (Su et al., 2002), together with β-sitosterol (17) (Basnet et al., 2003, Aldrich Library of 13C and 1H FT NMR spectra, 1992) and resorcinol (18) (Aldrich Library of 13C and 1H FT NMR spectra, 1992). These known compounds were identified by comparison of the respective spectral and chemical data with those described in the literature.

Essentially three classes of compounds were isolated in this study: moracins, stilbenes and flavanones. Only resorcinol 18 and β-sitosterol 17 do not belong to these classes. These two compounds are widely distributed in nature and cannot be viewed as chemotaxonomic markers.

Moracin N, M and P have been isolated before from Morus alba. In general, it was found from the literature that Morus genus is purveyor of moracins (Tagasuki et al., 1979; Hirakura et al., 1986; Basnet et al., 1993; Nguyen et al., 2009). The only one exception is the isolation of moracin M from Artocarpus dadah (Su et al., 2002).

Among stilbenes, trans-oxyresveratrol was isolated from various plants including Morus sp. and Artocarpus sp. (Hirakura et al, 1986; Su et al, 2002; Shimizu et al., 1998; Song et al, 2009). Trans-resveratrol was isolated from many sources including the Moraceae Cudrania javanensis classified today as Maclura cochinchinensis (Murti et al., 1972, Chapman & Hall, 2006). The distyldene artogomezianol 13 is a constituent of Artocarpus gomezianus roots and albolactol 11 was isolated from heartwood of Morus alba (Likhitwitayawuid and Sritularak 2001, Ferlinahayati et al., 2008).
Regarding flavonoids, it has been described that many Moraceae can produce steppogenin (El-Sohly et al., 1999; Su et al., 2002; Sheu et al., 2005). Katuranin was also isolated from various biological sources in Morus and Maclura genera (El-sohly et al., 1999, Lee at al., 2009) and dihydromorin was isolated from Morus, Artocarpus, and Maclura genera (Shimizy et al., 1998, El-Sohly et al., 1999, Su et al., 2002).

It has been hypothesized before that stilbenes are the major types of compounds isolated from Moraceae and may be useful chemotaxonomic markers (Rowe and Conner, 1979). Also, Schultz has shown that stilbenoids play an important role in the high natural durability of Maclura pomifera wood (Schultz et al., 1990). Stilbenes are known as fungicide, termicides and bactericide (Hart and Shrimpton, 1979; Likhitwitayawui and Sritularak, 2001; Javasinghe et al., 2004), and may also exhibit antioxidant properties (Dani et al., 2008; Iacopini et al., 2008; Luo et al., 2005). If it is reasonable to believe that stilbenes are responsible for Bagassa guianensis heartwood natural durability based on literature precedents, stilbenes can be considered as a secondary chemotaxonomic marker here indicating that Bagassa is related to Morus, Artocarpus, and Maclura genera. In Weiblen classification, Artocarpus belongs to the Artocarpeae tribe and Maclura belongs to the Moreae sensu largo tribe, and both Moreae and Artocarpeae tribes are rather closely related genetically.

The peculiarity of B. guianensis in comparison with other Moraceae is the very high proportion of moracins. In this matter, it can be hypothesized that Bagassa genus is closely related to Morus and that moracins are specific to these two genera. These findings are in agreement with Weiblen genetic-based classification where both Bagassa and Morus belong to the Moreae sensu stricto tribe. It should be mentioned that the Sorocea genus, which also belongs to the Moreae s. s. tribe, has been investigated before in the literature and apparently
does not contain moracins (see for example Ferrari et al., 2003; Ross et al., 2008). This observation speaks in favor of a very close relationship between Bagassa and Morus.

3. Concluding remarks

Studies of defensive wood chemicals in Bagassa guianensis allowed us to identify large amount of diversely functionalized stilbenes presumably responsible for wood natural durability. In addition, it was found based on the presence of moracins that Bagassa is very closely related to Morus genus, therefore corroborating Weiblen phylogenetic classification where B. guianensis belongs to the Moreae s. s. tribe rather than to the Artocarpaceae tribe.

4. Experimental

4.1 General experimental procedure

The $^1$H and $^{13}$C-NMR spectra were recorded on a Bruker Avance DRX500 spectrometer ($^1$H-500.13 MHz) equipped with a 5 mm triple resonance inverse Cryoprobe TXI ($^1$H-$^{13}$C-$^{15}$N), with z gradient. Spectra were recorded with 1.7 mm NMR capillary tube in 40 µL of 99.99% CD$_3$OD solvent ($\delta_{^1H}$ 3.31 ppm - $\delta_{^{13}C}$ 49.00 ppm) at 300 K. The $^1$H (500 MHz) and $^{13}$C NMR (125 MHz) data are reported in ppm downfield from tetramethylsilane. Coupling constants are in Hz and s stands for singlet, d for doublet, t for triplet, q for quartet, m for multiplet and br for broad. Hydrogen connectivity (C, CH, CH$_2$, CH$_3$) information was obtained from edited HSQC and/or DEPTQ-135 experiments. Proton and carbon peak assignments were based on 2D NMR analyses (COSY, NOESY, HSQC and HMBC). HREI-MS were performed using a QStar Elite mass spectrometer (Applied Biosystems SCIEX, Concord, ON, Canada) equipped with an ESI source operated in the positive ion mode. The capillary voltage was set at 5,500 V, the cone voltage at 20 V and air was used as the nebulizing gas (20 psi). In this hybrid instrument, ions were measured using an orthogonal acceleration time-of-flight (oa-TOF)
mass analyzer. Analyst software version 2.1 was used for instrument control, data acquisition and data processing. The accurate mass measurements were performed in triplicate with two internal calibrations. Direct sample introduction was performed at a 5 µL/min flow rate using a syringe pump. The UV spectra were recorded on a Perkin-Elmer Lambda 5 spectrophotometer. Optical rotations were measured with a Perkin-Elmer 241 polarimeter equipped with a sodium lamp (589 nm) and a 1 dm cell. The HPLC separations were performed on a Supelco Discovery® HS PEG column (250 × 21.1 mm, 5 µm) using a Waters system equipped with a W600 pump and a W2996 photodiode array absorbance detector. The samples were injected manually through a Rheodyne injector and the flow rate was 15 mL.min⁻¹. Silica gel 60 (35-70 µm) and analytical TLC plates (Si gel 60 F 254) were purchased from SDS (France). All other chemicals and solvents were analytical grade and purchased from SDS (France).

4.2 Plant Material

Bagassa guianensis was collected in Régina, French Guiana. A voucher specimen is kept at the herbarium of Cayenne (CAY-RA13), French Guiana.

4.3 Extraction and isolation

The dried powdered heartwood of Bagassa guianensis (140 g) was extracted with ethyl acetate (3 × 500 mL) at room temperature to give a crude extract which was fractionated first on a silica gel column chromatography with polarity gradient of hexane/ethyl acetate mixtures: 80/20; 50/50; 20/80; 0/100. 9 fractions numbered F1 to F9 were obtained. Fractions F1 to F5 were purified on HPLC with a linear gradient of hexane/isopropanol, by the following method: 70:30 changing over 2 min to 60:40, then to 40:60 at 10 min and pure isopropanol at 15 min and remaining as is for 5 min. The fractions F6 and F9 were analyzed and purified with an isocratic method: 30:70 hexane/isopropanol. These methods allowed us to isolate moracin M₁ (6.2 mg; w/w 0.019%), moracin N₂ (6.7 mg; w/w 0.020%), 6-O-
methyl-moracin M 3 (3.3 mg; w/w 0.010%), 6-O-methyl-moracin-N 4 (9.1 mg; w/w 0.027%),
moracin Z 5 (5.2 mg; w/w 0.016%), moracin P 6 (1.2 mg; w/w 0.003), trans-resveratrol 7
(12.6 mg; w/w 0.038%), trans-oxyresveratrol 8 (112.3 mg; w/w 0.343%), arachidin 2 9 (5.1
mg; w/w 0.015%), arachidin 4 10 (0.4 mg; w/w 0.001%), alboctalol 11 (0.5 mg; w/w
0.001%), (−)-epialboctalol 12 (5.4 mg; w/w 0.016%), artogomezianol 13 (12.7 mg; w/w
0.038%), steppogenin 14 (11.5 mg; w/w 0.035%), katuranin 15 (1.5 mg; w/w 0.004%),
dihydromorin 16 (20.4 mg; w/w 0.062%), the β-sitosterol 17 (8.4 mg; w/w 0.025%) and the
resorcinol 18 (1.8 mg; w/w 0.005%). Compounds 1-6, 9-10 and 17-18 were obtained from
the purification of the fractions F1-F5 while compounds 7-8 and 11-16 were isolated from the
fractions F6-F9.

### 4.3.1 6-O-Methylmoracin M (3)

Yellowish amorphous powder; HR-EIMS [M + H]+ m/z 257.0805 [M + H]+ (calcd 257.0808);

1H and 13C NMR (500 MHz; CD3OD) see table 1.

### 4.3.2 6-O-Methylmoracin N (4)

Yellowish amorphous powder; HR-EIMS [M + H]+ m/z 325.1437 [M + H]+ (calcd 325.1434);

1H and 13C NMR (500 MHz; CD3OD) see table 1.

### 4.3.3 Moracin Z (5)

Yellowish amorphous powder; HR-EIMS [M + H]+ m/z 343.1542 [M + H]+ (calcd 343.1540);

1H and 13C NMR (500 MHz; CD3OD) see table 1.

### 4.3.4 Arachidin 4 (10)

Colorless syrup; HR-EIMS [M + H]+ m/z 315.1592 [M + H]+ (calcd 315.1591); 1H and 13C
NMR (500 MHz; CD3OD) see table 2.

### 4.3.5 (−)-Epialboctalol (12)

Brownish syrup; [α]D20 7.4° (c 0.004, CH3OH); HR-EIMS [M + H]+ m/z 489.1540 [M + H]+
(calcd 489.1544); 1H and 13C NMR (500 MHz; CD3OD) see table 3.
The 3 known moracins M (1), N (2) and P (6) and the other known compounds 7-9, 11, and 13-18 were identified by comparison of their physical and spectral data with those reported in the literature.

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References


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**Figures and legends**

**Moracins**

![Moraclin structures](image)

1. H H Moracin M
2. H Prenyl Moracin N
3. Me H 6-O-Methyl-moracin M
4. Me Prenyl 6-O-Methyl-moracin N
5. Me 3-Hydroxy-3-methylbutyl Moracin 2

**Stilbenoids**

![Stilbenoid structures](image)

7. H H trans-Resveratrol
8. OH H trans-Oxyresveratrol
9. H Prenyl Arachidin 2
10. H 3-Hydroxy-3-methylbutyl Arachidin 4

**Flavanones**

![Flavanone structures](image)

14. H OH Steppogenin
15. OH H Katuranin
16. OH OH Dihydromorin

**Others**

17. β-Sitosterol
18. Resorcinol

**Figure 1** Compounds 1-18 isolated from *Bagassa guianensis* (Moraceae). (a) New compounds; (b) New names.
Figure 2 Pertinent NOE interactions observed for (−)-epialboctalol (12) from NOESY experiment.
Tables

Table 1 $^1$H and $^{13}$C NMR spectroscopic data for moracins 3-5 in CD$_3$OD

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<td>-</td>
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</tr>
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<td>6.77, d (2.1)</td>
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<td>-</td>
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</tr>
<tr>
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<td>3.34, brd (7.3)</td>
<td>26.7</td>
<td>2.73, m</td>
</tr>
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</tr>
<tr>
<td>3''</td>
<td>-</td>
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<td>1.27, s</td>
</tr>
<tr>
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<td>1.74 brs</td>
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Table 2 $^1$H and $^{13}$C NMR spectroscopic data for stilbenes 9 and 10 in CD$_3$OD

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<th>Atom</th>
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<th>$^13$C</th>
<th>$^1$H (J in Hz)</th>
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<td>6.75, d (8.7)</td>
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<td>116.5</td>
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<td>7.32, d (8.7)</td>
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<td>3</td>
<td>158.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>116.5</td>
<td>7.31, d (8.6)</td>
<td>7.32, d (8.7)</td>
</tr>
<tr>
<td>5</td>
<td>128.6</td>
<td>7.31, d (8.6)</td>
<td>7.32, d (8.7)</td>
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<td>6.90, d (16.5)</td>
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</tr>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3'$</td>
<td>116.0</td>
<td>-</td>
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<tr>
<td>4'$</td>
<td>157.2</td>
<td>-</td>
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<td>6.46, s</td>
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Table 3 $^1$H and $^{13}$C NMR spectroscopic data for distilbenes 11 and 12 in CD$_3$OD

<table>
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<tr>
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<td>2.53, dd (16.3, 4.3)</td>
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</tr>
<tr>
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<td>108.1</td>
<td>6.19, d (2.2)</td>
</tr>
<tr>
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<td>-</td>
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</table>