

REGULAR ARTICLE

Molecules and functions of *aesculus chinensis bunge* bark volatiles

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ABSTRACT

This paper analyzes the organic solvent extracts of *Aesculus chinensis Bunge Bark* using TG and Py-GC-MS. The pyrolysis products were analyzed by GC-MS. The results showed that the extracts of *Aesculus chinensis Bunge Bark* contain a large number of biologically active components, including hydrocarbons, acids, ethers, alcohols, and phenols. The main components in the extract of *Aesculus chinensis Bunge Bark* are healthy and abundant; the main representatives of the active ingredients are Scopoletin Vanillin, Eugeno, Pyridine, p-Cresol, Indoles, Maltol and Furfural. There are potential applications in bioenergy, biopharmaceuticals, cosmetics, skin care products, and spices.

Keywords: *Aesculus chinensis Bunge Bark*; TG; Py-GC-MS

INTRODUCTION

Natural wood is a low cost and abundant material that has been used as a structural material for construction and furniture construction for thousands of years. Partial removal of lignin and hemicellulose from natural wood, followed by hot pressing, causes the cell wall to collapse completely and Naturally fully densified wood with highly aligned cellulose nanofibers (Song, et al., 2018; Fratzl, 2018). With age, the time when trees can sustain timber production remains an open question (Sillett, et al., 2015; Tollefson, 2017; Wu, et al., 2016; Ranaivoson, et al., 2017). Biomass is a renewable energy source that can be used as a substitute for fossil fuels for the production of heat energy. Wood biomass is currently the most energy-efficient energy source (Janevski, 2016; Organization, 2002). Using woody biomass as an energy source for social, economic and environmental aspects, it has been found that burning wood particles is beneficial (Nishiguchi and Tabata, 2016; Golos and Kaliszewski, 2015), thermochemical conversion of biomass is a promising technology because biomass is an environmentally friendly fuel (Eseyin et al., 2015). Wood's lignocellulosic biomass is abundant, natural and renewable materials, and forest residues are the changes

in bark ash content of post-harvest and post-harvested wood (including tree tops and bark) compared to wood parts (Abdul Halim and Yong, 2017; Haruna and Hanafiah, 2018). Great. Wood usually has a relatively low ash content, while bark has a rather high ash content (Abe, Yamada and Ohno, 2014; Álvarez, Reyes-Sosa and Díez, 2016; Nosek, Holubcik and Jandacka, 2015). Forest biomass is one of the renewable energy sources used to generate electricity, the feasibility and cost of using forest biomass to generate electricity depend on the long-term availability, cost and quality of biomass, improve the efficiency of power plants, manage forest management, and reduce transport distances (Atikuzzamman et al., 2018; Abdur Razzak et al., 2018; Fahim and Sathi, 2018). May reduce the respiratory effects of bioenergy systems (Shabani and Sowlati, 2013; Weldu, Assefa and Jolliet, 2017). The dramatic increase in U.S. wood energy consumption (16 times growth in 2060) and the high global GDP growth scenario will transform U.S. forest land into a large carbon source by 2050. This can be achieved by increasing the use of wood to promote energy use. (Nepal, et al., 2012; Roy and Corscadden, 2012). Charcoal biomass charcoal is used as an alternative fuel in direct carbon fuel cells. Wood biomass is carbon-free and recycled. In the future, wood biomass enhancement can

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also be used as a solvent (Ahn, et al., 2013; Wu et al., 2015; Muhammad, Man and Mohamad Azmi, 2012).

With the strengthening of people's awareness of environmental protection, the harm of organic volatiles VOCs to the environment has received increasing attention (Chen, 2003). The generation and release of volatile degradation products during mild pyrolysis of wood is important for better understanding of the thermal degradation mechanism (Candelier, et al., 2013; Bryś, et al., 2016). There are many beneficial volatiles in wood. For example, the volatiles in Chinese fir contain many beneficial components, especially various terpenoids. Most of them have good physiological activity and aromatherapy, such as antibacterial, anti-inflammatory, and antimony (Devora Isirdia et al, 2017; Fu and Liu, 2017; Guerrini et al, 2018; Kim et al, 2018; Marvi et al, 2016; Yang et al, 2017). Antitussive, and relieve psychological tension and fatigue, it feels natural, relaxed, comfortable, happy, etc (Sun, Peng and Zhang, 2004); Some may also release a large amount of methanol, formic acid, acetic acid, aldehydes and terpenes during the drying process of *Pinus massoniana*. The concentration of VOCs emitted from the exhaust of *Pinus massoniana* during drying is relatively large and has a certain degree of environmental impact. Impact (Lan, 2007); Some organic volatiles of trees will attract some pests and cause tree death (Martini, et al., 2015). In this paper, we study the use of FT-IR, GC-MS, TG and Py-GC-MS techniques to study the organic volatiles of *Aesculus chinensis* Bunge Bark for research and explore its potential as a sustainable energy source.

MATERIAL AND METHODS

Experimental materials

Samples were collected from the Xixia Forest District in Henan Province. The samples were processed into powders, and four extracts were respectively extracted with ethanol, methanol, benzene/ethanol (1:1) and ethanol/methanol (1:1), which were named C1, C2, C3, and C4 samples, respectively.

Experimental methods

TG Analysis: The samples of *Aesculus chinensis* Bunge Bark were analyzed by thermogravimetric analyzer (TGA Q50 V20.8 Build 34). The nitrogen release rate was 60 ml/min. The temperature program of TG started at 30°C and rose to 300°C at a rate of 5°C/min (Ge et al., 2017; Peng, et al., 2017; Jiang et al., 2017).

Py-GC-MS Analysis: Catalyzed and pretreated samples were analyzed by pyrolysis-gas chromatography-mass spectrometry (CDS5000-Agilent 7890B-5977A ISQ). Carrier gas for high purity helium, pyrolysis temperature

of 500°C, heating rate of 20°C/ms, pyrolysis time of 15 s. Pyrolysis product transfer line and injection valve temperature was set at 300°C; HP-5MS column; capillary column (60 m × 250 μm × 0.25μm); parallel mode, the split ratio 1:60, shunt speed 50 mL/min. The temperature of the GC program was raised from 40°C for 2 minutes, raised to 120°C at a rate of 5°C/minute and then raised to 200°C at a rate of 10°C/minute for 15 minutes. Ion source (EI) temperature of 230°C, the scanning range of 28 amu-500amu (Xu et al., 2018; Wang et al., 2018; Liu et al., 2018; Ge et al., 2018; Zhou et al., 2016).

RESULTS AND DISCUSSION

Analysis of TGA and DTG

Fig 1 shows the TGA and DTG curves of *Aesculus chinensis* Bunge Bark. The thermogravimetry measures the quality change and the rate of change of the schizocarps, and at the same time determines the broad application prospects of its resources (Peng et al., 2017; Li et al., 2017; Min et al., 2018; Jiang et al., 2018). Therefore, thermal stability analysis is also an effective method to evaluate the application of *Aesculus chinensis* Bunge Bark resources. In order to study *Aesculus chinensis* Bunge Bark, we conducted a TGA test, as shown in Fig. 1, TGA curve and DTG curve (Jiang, Ge and Peng, 2017; Ge

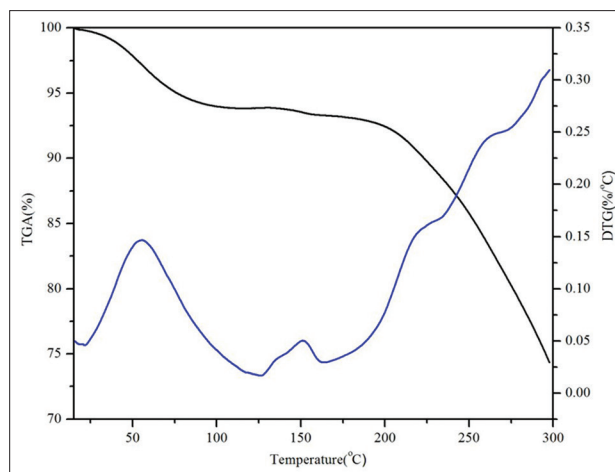


Fig 1. TGA and DTG thermal curves of *Aesculus chinensis*.

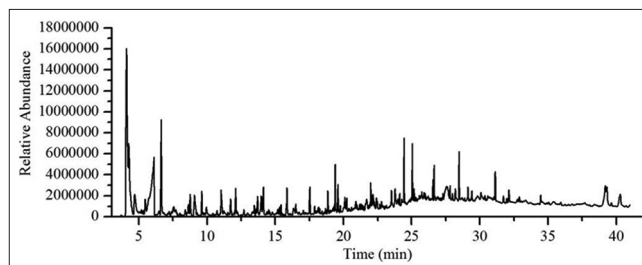


Fig 2. Total ion chromatograms of *Aesculus chinensis* Bunge Bark by Py-GC-MS.

Table 1: Py-GC-MS analysis of aesculus chinensis bunge bark

No.	Retention time (min)	Peak area (%)	Component
1	3.70	0.04	2-Pentanamine
2	4.09	8.33	Ethyne, fluoro-
3	4.26	4.20	1,4-Dioxane-2,6-dione
4	4.70	1.44	Diazene, dimethyl-
5	4.92	0.18	Acetic acid, methyl ester
6	5.06	0.25	1,3-Cyclopentadiene
7	5.18	0.24	Propanal, 2-methyl-
8	5.30	0.20	1-Propanol
9	5.46	0.69	2,3-Butanedione
10	5.71	0.88	Acetic acid
11	5.73	0.17	Acetic acid
12	6.11	5.53	Acetic acid
13	6.47	0.32	(Z)-1,3-Butadien-1-ol
14	6.64	2.61	2-Propanone, 1-hydroxy-
15	6.84	0.11	Ethanone, 1-cyclopropyl-
16	7.10	0.08	Acetamide, N-(aminoiminomethyl)-
17	7.14	0.04	3-Butenoic acid
18	7.22	0.19	2,3-Pentanedione
19	7.41	0.21	1,2-Ethanediol
20	7.55	0.53	Furan, 2,5-dimethyl-
21	7.66	0.07	Propanoic acid
22	7.69	0.06	Propanoic acid
23	7.71	0.13	Propanoic acid
24	7.94	0.05	Acetamide, N-2-propynyl-
25	8.01	0.07	Propanoic acid, 2-oxo-, methyl ester
26	8.40	0.26	1H-Pyrrole, 1-methyl-
27	8.54	0.09	N,N-Dimethylaminoethanol
28	8.61	0.30	Pyridine
29	8.76	0.71	Pyrrole
30	9.07	0.99	2-Propanone, 1-hydroxy-
31	9.27	0.13	2-Butenal, 2-methyl-, (E)-
32	9.61	0.60	Propanoic acid, 2-oxo-, methyl ester
33	9.77	0.10	Cyclopentanone
34	9.94	0.28	3-Amino-s-triazole
35	10.02	0.07	4-Methyl-3,7,9-trioxabicyclo (4,2,1) nonane
36	10.39	0.07	3-Furaldehyde
37	10.46	0.05	1H-Pyrrole, 1-ethyl-
38	10.61	0.03	Pyrrolidine
39	10.66	0.04	Pyridine, 2-methyl-
40	10.74	0.15	Pyrazine, methyl-
41	10.92	0.05	2-Vinylethyl acetate
42	11.03	0.56	Furfural
43	11.08	0.37	2-Cyclopenten-1-one
44	11.23	0.16	1H-Pyrrole, 3-methyl-
45	11.30	0.09	1-Butene, 3-methyl-
46	11.53	0.11	1H-Pyrrole, 3-methyl-
47	11.72	0.52	2-Furanmethanol
48	11.99	0.09	Benzene, 1,3-dimethyl-
49	12.09	0.57	2-Propanone, 1-(acetyloxy)-
50	12.20	0.17	2(3H)-Furanone, 5-methyl-
51	12.60	0.02	Carbamic acid, phenyl ester
52	12.69	0.13	Cyclopent-4-ene-1,3-dione
53	12.96	0.04	Styrene
54	13.32	0.14	2-Butenoic acid, methyl ester, (E)-
55	13.46	0.30	2-Cyclopenten-1-one, 2-methyl-

(Contd...)

Table 1: (Continued)

No.	Retention time (min)	Peak area (%)	Component
56	13.59	0.13	Ethanone, 1-(2-furanyl)-
57	13.71	0.59	2(5H)-Furanone
58	13.96	0.72	Diisoamyl ether
59	14.13	0.86	2-Cyclopenten-1-one, 2-hydroxy-
60	14.38	0.09	Pyridine, 3,5-dimethyl-
61	14.52	0.13	2(5H)-Furanone, 5-methyl-
62	14.60	0.07	2,5-Furandione, dihydro-3-methylene-
63	14.78	0.09	Cycloheptanone
64	15.02	0.04	Thiazole, 4,5-dihydro-2-methyl-
65	15.09	0.06	1,4-Pentanediol
66	15.17	0.16	2,3-Pentanedione
67	15.31	0.26	2-Furancarboxaldehyde, 5-methyl-
68	15.42	0.22	2-Cyclopenten-1-one, 3-methyl-
69	15.54	0.03	Pyridine, 2-ethenyl-
70	15.80	0.11	1-(Dimethylamino) pyrrole
71	15.86	0.68	Phenol
72	16.06	0.05	Hexanoic acid
73	16.32	0.10	Aziridine, 2-methyl-3-(1-methylethyl)-, trans-
74	16.35	0.28	3-Amino-1,2,4-triazole-5-carboxylic acid
75	16.50	0.28	3-Cyclobutene-1,2-dione, 3,4-dihydroxy-
76	16.58	0.14	2-Furanone, 2,5-dihydro-3,5-dimethyl
77	16.75	0.10	1H-Pyrrole, 2-ethyl-4-methyl-
78	17.06	0.11	6-Azacytosine
79	17.16	0.05	Tricyclo[4.2.1.1 (2,5)]decane
80	17.22	0.06	2-Cyano-1-hexene
81	17.29	0.05	1,3-Dimethyl-1-cyclohexene
82	17.38	0.05	2-Propyl-1-pentanol, pentafluoropropionate
83	17.54	0.79	1,2-Cyclopentanedione, 3-methyl-
84	17.73	0.04	3-Heptyne, 2,2-dimethyl-
85	17.88	0.25	2-Cyclopenten-1-one, 2,3-dimethyl-
86	18.02	0.10	4-Methyl-5H-furan-2-one
87	18.16	0.28	1,3-Dioxol-2-one, 4,5-dimethyl-
88	18.25	0.15	Phenol, 2-methyl-
89	18.42	0.09	2-Cyclopenten-1-one, 2-hydroxy-3,4-dimethyl-
90	18.58	0.06	Ethanone, 1-(1H-pyrrol-2-yl)-
91	18.68	0.15	2,5-Dimethylfuran-3,4(2H,5H)-dione
92	18.75	0.05	Acetophenone
93	18.85	0.58	p-Cresol
94	19.01	0.10	2-Cyclopenten-1-one, 3-ethyl-
95	19.09	0.06	Heptanoic acid
96	19.12	0.07	Valeraldehyde, 2,2-dimethyl-, oxime
97	19.21	0.19	Furyl hydroxymethyl ketone
98	19.28	0.20	6-Amino-1,3,5-triazine-2,4(1H,3H)-dione
99	19.39	0.90	Phenol, 2-methoxy-
100	19.47	0.08	Cyclohexanol, 2,2-dimethyl-
101	19.59	0.83	Diazene, [1-(2,2-dimethylhydrazino) ethyl] ethyl-
102	19.77	0.22	Propanoic acid, 2-chloro-, pentyl ester
103	19.99	0.17	3-Pyridinol
104	20.03	0.09	3-Pyridinol
105	20.10	0.56	Maltol
106	20.25	0.43	2-Cyclopenten-1-one, 3-ethyl-2-hydroxy-
107	20.39	0.13	10-Methylundecan-4-olide
108	20.47	0.13	5-[3-Methyl-2-furyl] hydantoin
109	20.59	0.18	(1,4,4-Trimethyl-cyclohex-2-enyl)-acetic acid
110	20.69	0.09	10-Methylundecan-4-olide

(Contd...)

Table 1: (Continued)

No.	Retention time (min)	Peak area (%)	Component
111	20.75	0.13	Formaldehyde, methyl(2-propynyl) hydrazone
112	20.82	0.16	1,4-Benzodioxin, octahydro-2-methylene-, trans-
113	20.90	0.40	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-
114	20.99	0.21	3(2H)-Furanone, dihydro-5-methyl-
115	21.06	0.12	Tetracyclo[5.3.0.0<2,6>.0<3,10>]deca-4,8-diene
116	21.19	0.30	2H-Pyran-2-one, tetrahydro-3,5-dimethyl-
117	21.30	0.23	Phenol, 4-ethyl-
118	21.34	0.12	5,8-Decadien-2-one, 5,9-dimethyl-, (E)-
119	21.41	0.17	2-Butenoic acid, 3-amino-, ethyl ester
120	21.50	0.16	Octanoic acid
121	21.69	0.94	2-Penten-1-ol, (E)-
122	21.89	0.26	Pentyl acetoacetate
123	21.95	0.12	7-Thiabicyclo[4.2.1]nonane
124	22.00	0.57	Creosol
125	22.07	0.10	4,7,7-Trimethyl-5-(tetrahydropyran-2-yloxy)-bicyclo[2.2.1]heptan-2-one
126	22.15	0.87	Catechol
127	22.27	0.32	Catechol
128	22.42	0.40	1,4:3,6-Dianhydro-.alpha.-d-glucopyranose
129	22.47	0.21	Benzofuran, 2,3-dihydro-
130	22.66	0.28	Heptadecanal
131	22.80	0.33	2,3-Anhydro-d-mannosan
132	22.85	0.12	2-Isopropoxyphenol
133	22.91	0.15	chrysanthemyl 2-hydroxy-3-methylbutanoate
134	23.05	0.13	Carbamic acid, (4-nitrophenyl)-, phenylmethyl ester
135	23.16	0.26	2-Cyclohexen-1-one, 3,4,4-trimethyl-
136	23.26	0.14	5,6,6-Trimethyl-5-(3-oxobut-1-enyl)-1-oxaspiro[2.5]octan-4-one
137	23.29	0.10	Benzene, 1,3-dimethoxy-2-nitro-
138	23.35	0.11	7-Oxabicyclo[4.1.0]heptane, 2-methylene-
139	23.42	0.15	1,2-Benzenediol, 4-methyl-
140	23.51	0.95	1,2-Benzenediol, 3-methoxy-
141	23.78	0.78	Phenol, 4-ethyl-2-methoxy-
142	23.85	0.28	Isopropylphosphonic acid, dimethyl ester
143	23.95	0.22	1,3,5,7-Cyclooctatetraene
144	24.00	0.55	1,2-Benzenediol, 4-methyl-
145	24.13	0.41	Indole
146	24.27	0.58	4-Acetoxy-1,2,3,5,6,7,8,8a-octahydroazulene
147	24.44	1.48	2-Methoxy-4-vinylphenol
148	24.51	0.09	8-Tetradecyn-1-ol
149	24.56	0.41	Globulol
150	24.72	0.31	2,4-Diaminophenol
151	24.78	0.25	Benzenemethanol, .alpha.-ethynyl-
152	24.82	0.28	Pyran, tetrahydro-2-(3-bromo-5,5-dimethyl-2-cyclohexenyl) oxy-
153	24.89	0.25	1H-Isoindole-1,3(2H)-dione, 3a, 4,5,7a-tetrahydro-4-hydroxy-3a-methyl-2-phenyl-, [3aR-(3a.alpha.,4.beta.,7a.alpha.)]-
154	24.96	0.41	1,4-Benzenediol, 2-methyl-
155	25.05	1.30	Phenol, 2,6-dimethoxy-
156	25.18	0.68	Eugenol
157	25.28	0.31	3-Amino-2,6-dimethoxypyridine
158	25.33	0.39	Phenol, 2-methoxy-4-propyl-
159	25.44	0.30	9-Borabicyclo[3.3.1]nonane, 9-(1-ethylbutyl)-
160	25.47	0.13	1H-Imidazole-4-methanol, 5-methyl-
161	25.50	0.11	2,4-Hexadiene, 2,5-dimethyl-
162	25.57	0.68	1-Benzoxepin-2(3H)-one, octahydro-
163	25.67	0.39	11-Bromoundecanoic acid
164	25.74	0.52	Indole, 3-methyl-

(Contd...)

Table 1: (Continued)

No.	Retention time (min)	Peak area (%)	Component
165	25.78	0.32	4,5,6-Trimethyl-2-pyrimidone
166	25.86	0.32	meta-Methoxybenzenethiol
167	25.91	0.44	Vanillin
168	25.99	0.47	3-Allyl-6-methoxyphenol
169	26.11	0.31	1S,3R,4S,5R,6S-1-Hydroxy-2,2,3,4,5,6-hexamethyl-8-oxo-7,9-dioxatricyclo[4.2.1.0 (3,5)] nonae
170	26.15	0.24	Tetrahydroionone
171	26.21	0.58	4-Nitro-3-picoline-N-oxide
172	26.33	0.41	Benzenamine, 3-methoxy-
173	26.44	0.43	1-Tetradecene, 14-bromo-
174	26.55	0.62	3,5-Dimethoxy-4-hydroxytoluene
175	26.64	0.96	trans-Isoeugenol
176	26.72	0.37	Spiro[4.5]decan-7-one, 1,8-dimethyl-8,9-epoxy-4-isopropyl-
177	26.84	0.48	Bicyclo (3.3.1) nonane-2,6-dione
178	26.92	0.46	Bicyclo[3.1.0]hexane-6-methanol, 2-hydroxy-1,4,4-trimethyl-
179	26.99	0.30	Bicyclo[3.1.0]hexane-6-methanol, 2-hydroxy-1,4,4-trimethyl-
180	27.08	0.36	Oleic Acid
181	27.19	0.31	12-Methyl-E, E-2,13-octadecadien-1-ol
182	27.29	0.52	5-Hepten-3-yn-2-ol, 6-methyl-5-(1-methylethyl)-
183	27.59	2.17	.beta.-D-Glucopyranose, 1,6-anhydro-
184	27.61	1.20	D-Allose
185	27.81	0.75	Benzene, 1,2,3-trimethoxy-5-methyl-
186	27.99	0.38	2-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-
187	28.20	1.53	Dodecanoic acid, 1-methylethyl ester
188	28.48	1.30	2,3,5,6-Tetrafluoroanisole
189	28.64	0.46	2-Hydroxy-2,4,4-trimethyl-3-(3-methylbuta-1,3-dienyl) cyclohexanone
190	28.70	0.68	10-Methyldodec-2-en-4-olide
191	28.88	0.32	Benzofuran-4(5H)-one, 6,7-dihydro-, oxime
192	29.12	1.08	Phenol, 2,6-dimethoxy-4-(2-propenyl)-
193	29.25	0.27	Pyrazole-5-carboxylic acid, 1-ethyl-4-nitro-
194	29.41	0.96	Benzeneethanamine, 2-fluoro-4,5-dimethoxy-.beta.-hydroxy-N-isopropyl-
195	29.82	1.70	1-Chloroeicosane
196	30.08	1.30	5,7-Dimethyl-1,3-diazaadamantan-6-one Hydrazone
197	30.37	0.60	2-Pentadecanone, 6,10,14-trimethyl-
198	30.59	0.55	4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol
199	30.70	0.29	2,4,5-Tri-O-acetyl-3,6-di-O-methyl-D-mannonitrile
200	30.75	0.39	Octyltrichlorosilane
201	30.85	0.51	2-Trimethylsilyl-1,3-dithiane
202	31.02	0.43	1,3-Benzenediol, 2,5-dimethyl-
203	31.12	0.98	(E)-2,6-Dimethoxy-4-(prop-1-en-1-yl) phenol
204	31.72	0.63	D-Norleucine, N-isobutoxycarbonyl-, ethyl ester
205	31.97	0.35	Ethanone, 1-(4-hydroxy-3,5-dimethoxyphenyl)-
206	32.12	0.70	4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol
207	32.25	0.19	2(3H)-Naphthalenone, 4,4a, 5,6,7,8-hexahydro-1-methoxy-
208	32.76	0.45	Tetrazolo[1,5-a] pyrimidine, 6-(3-hydroxy-2-oxopropyl)-
209	32.88	0.37	2-Pentanone, 1-(2,4,6-trihydroxyphenyl)
210	33.03	0.29	Cyclotetradecane
211	33.20	0.28	Hexadecenoic acid, Z-11-
212	33.35	0.56	Oleic Acid
213	34.46	0.31	Neophytadiene
214	34.56	0.24	cis-7, cis-11-Hexadecadien-1-yl acetate
215	34.90	0.10	2-Cyclohexen-1-one, 3-(3-hydroxybutyl)-2,4,4-trimethyl-
216	35.05	0.09	Pentadecanoic acid
217	35.39	0.26	Docosanoic acid
218	35.93	0.08	E-8-Methyl-9-tetradecen-1-ol acetate

(Contd...)

Table 1: (Continued)

No.	Retention time (min)	Peak area (%)	Component
219	36.75	0.06	p-Phenylenediamine, N-benzylidene-N'-phenyl-
220	37.09	0.02	Pyrimidine-5-carbonitrile, 3,4-dihydro-6-(dimethylaminophenyl)-2-mercapto-4-oxo-
221	37.17	0.03	19-Norandrost-4-en-3,17-dione (8.beta.,9.beta.,10.alpha.)
222	37.70	0.08	p-Phenylenediamine, N-benzylidene-N'-phenyl-
223	38.41	0.06	cis-1-Chloro-9-octadecene
224	39.20	1.19	n-Hexadecanoic acid
225	39.31	1.00	Scopoletin
226	39.64	0.14	Dibutyl phthalate
227	40.28	0.87	Scopoletin

et al., 2018; Jiang, Ge and Peng, 2017). From the figure, we can see that the weight loss process of pyrolysis can be divided into three stages. The first stage is between 16-98°C, which is the stage of water evaporation (Peng et al., 2016; Xie et al., 2018; Lourençon et al., 2014). The weight loss of the sample is small, and the weight loss is mainly caused by the loss of biomass. Water-induced. The second stage is between 98 and 198°C. It is a preheating solution transition stage (Ge, et al., 2017; Peng, et al., 2017; Ge et al., 2018). The differential curve at this stage is relatively flat, indicating that the pyrolysis rate is relatively stable, and the sample begins to show obvious weightlessness. The weight loss is mainly due to the inside of the sample. A small amount of polymer depolymerization and reorganization occurred (Ge et al., 2017; Fu et al., 2009; Li et al., 2017). The third stage is between 198-300°C. During the combustion of the remaining components, the cellulose and hemicellulose in *Aesculus chinensis* Bunge rapidly cleave and generate a large amount of volatile gases and cause weightlessness as the temperature rises (Li et al., 2017; Peng et al., 2018). These three stages show different properties with different kinetic parameters and reaction mechanisms. The final residual mass is 74.34% (Ouyang et al., 2016; Peng et al., 2016), between 16-280°C. *Aesculus chinensis* Bunge Bark has a thermogravimetric weight of only about 15%. It has less thermal weight loss, a smaller mass change, and a lower rate. The TG test showed that *Aesculus chinensis* Bunge Bark has good processing performance and great potential for resource utilization (Chen, et al., 2017; Ge, et al., 2017).

Analysis of Py-GC-MS

According to the Py-GC-MS analysis results (Table 1), a total of 227 compounds were detected, of which the highest levels were: Ethyne, fluoro- (8.33%). 1,4-Dioxane-2,6-dione (4.20%). Diazene, dimethyl-(1.44%). Acetic acid (6.58%). 2-Propanone, 1-hydroxy-(2.61%). Pyrrole (0.71%). 2-Propanone, 1-hydroxy-(0.99%). Diisoamyl ether (0.72%). 2-Cyclopenten-1-one, 2-hydroxy-(0.86%). 1,2-Cyclopentanedione, 3-methyl-(0.79%). Phenol, 2-methoxy-(0.90%). Diazene, [1-(2,2-dimethylhydrazino)

ethyl]ethyl - (0.83%). Catechol(0.87%). 1,2-Benzenediol, 3-methoxy-(0.95%). Phenol, 4-ethyl-2-methoxy-(0.78%). 2-Methoxy-4-vinylphenol(1.48%). Phenol, 2,6-dimethoxy-(1.30%). beta.-D-Glucopyranose, 1,6-anhydro-(2.17%). Benzene, 1,2,3-trimethoxy-5-methyl-(0.75%). Dodecanoic acid, 1-methylethyl ester(1.53%). 2,3,5,6-Tetrafluoroanisole(1.30%). Phenol, 2,6-dimethoxy-4-(2-propenyl)-(1.08%). Benzeneethanamine, 2-fluoro-4,5-dimethoxy-beta.-hydroxy-N-isopropyl-(0.96%). 1-Chloroeicosane(1.70%). 5,7-Dimethyl-1,3-diazaadamantan-6-one Hydrazone(1.30%). (E)-2,6-Dimethoxy-4-(prop-1-en-1-yl)phenol(0.98%). n-Hexadecanoic acid(1.19%). Scopoletin(1.00%).

Analysis of function

The *Aesculus chinensis* Bunge Bark products have certain human health functions. The analysis of *Aesculus chinensis* Bunge Bark using GC-MS and Py-GC-MS techniques has yielded related compounds, and by consulting relevant literature and reports, we have obtained the proven active ingredients of human health. Scopoletin regulates blood pressure and has antibacterial activity (Gnonlonfin, Sanni and Brimer, 2012). It can be used to treat bronchial diseases and caudal horns, regulate hormone balance, and help relieve anxiety and depression. In addition, studies have reported that Moxa Coccinea has analgesic, anti-inflammatory and antioxidant effects (Jamuna et al., 2015), blood pressure lowering and antispasmodic effects, especially antitumor (Liu et al., 2012; Tabana et. al., 2016; Seo et al., 2016; Zhao et al., 2012) and its activity in the prevention and treatment of hyperuricemia (Yao et al., 2012), has currently attracted widespread attention at home and abroad. It can prevent alcohol-induced Hepatic lipid accumulation (Lee et al., 2014), insecticidal activity, acaricidal activity, antibacterial activity, growth regulation, and induction of plant resistance (Hino, Okazaki and Miura, 2014).

Vanillin is a food flavoring agent, has the fragrant smell of vanilla beans and milky desire. It is an indispensable important raw material in the food additive industry. Foreign vanillin has a wide range of applications and is widely

used in the production of pharmaceutical intermediates. Used for plant growth promoters, bactericides, lubricant defoamers, electroplating brighteners, and conductive agents for printed circuit boards (Fache, Boutevin and Caillol, 2016; Kaur and Chakraborty, 2013). Eugeno can be used as a modifier and fixatives, use colored soaps to add fragrance, use for antibacterial and lower blood pressure (Kong et al., 2013). Eugeno is a potent anesthetic (Roubach et al., 2015). Eugeno can also inhibit the growth of melanoma (Ghosh et al., 2015). Among the many derivatives of Pyridine, some are important drugs, and some are vitamins or enzymes. An important part of. The pyridine derivative isoniazid is an oral anti-tuberculosis drug, bactericide, fungicide, and organic synthesis (Moraski et al., 2015; Ayieko et al., 2014).

p-Cresol is used in organic synthesis and p-Cresol sulfate and indoxyl sulfate play an important role in renal injury (Sun, Hsu and Wu, 2013). Intestinal absorption of p-cresol and independence from renal function in patients with chronic kidney disease Is related to cardiovascular disease. Intestinal metabolism and p-cresol uptake may be therapeutic targets for reducing the risk of cardiovascular disease in patients with renal insufficiency (Poesen et al., 2014). Indoles are naturally occurring and synthetic, with a wide range of biological activities, unusual and complex molecular structures occur in their natural derivatives (Inman & Moody, 2012). Indole naphthyridinones is an inhibitor of the bacterial Enoyl-ACP reductase FabI and FabK (Seefeld et al., 2015). Indole-3-acetic is an important plant hormone that has the ability to control plant development in a beneficial and harmful manner (Zhao, 2012; Duca et al., 2014). Maltol pretreatment effectively reduced alcohol-induced oxidative damage in a dose-dependent manner. Maltol seems to have promising antioxidant and anti-inflammatory abilities (Han et al., 2015). Maltol stimulated kainic acid the neuroprotective effects of oxidative damage in the brain of mice (Kim et al., 2013), Maltol has potential as a novel neuroprotective agent for oxidative stress-related eye diseases (including glaucoma) (Hong et al., 2014). Furfural provides a promising and abundant platform for lignocellulosic biofuels (Lange et al., 2012).

CONCLUSIONS

From the above test results, it can be concluded that The TGA is divided into two stages: the first stage is the evaporation of water at low temperature, the second stage is caused by a small amount of depolymerization and reorganization of the polymer, and the third stage is the stage of coke passing through the aerobic combustion in the high temperature stage. Below 300°C, only a small amount of hemicellulose, cellulose and lignin are pyrolyzed.

In the Py-GC-MS test, 227 compounds were identified in *Aesculus chinensis Bunge Bark*. From the above studies, it can be seen that the active ingredients of *Aesculus chinensis Bunge Bark* have antibacterial, antitumor and insecticidal activities and can be used as lignocellulosic biofuels, etc. Therefore, *Aesculus chinensis Bunge Bark* has better high-grade resource utilization, and the sustainable development of material resources has broad prospects.

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