

Clinical Applications, Active Components and Mechanisms of Haemostatic Effects of Charred Chinese Medicines

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Abstract: Charred traditional Chinese medicines have been used to stop bleeding since ancient times. To date, they are often applied to treat purpura, metrorrhagia, upper gastrointestinal bleeding, postoperative hemorrhage of mixed hemorrhoids, and hemorrhoids bleeding. Conventional oral decoction is still a predominate application form. It is noteworthy that a new and original application form of charred herbs has occurred in the treatment of upper gastrointestinal bleeding. Different from the conventional oral decoction, the micron-sized rhei radix et rhizome carbonisatus was sprayed on the surface of the lesion through gastroscopy to stop upper gastrointestinal bleeding. Active tannins, calcium ions, flavonoids and anthraquinones play a role in a part of charred herbs to stop bleeding. The emergence or increase of active components may lead charred herbs to significantly better haemostatic effects than uncharred ones, especially the emergence of activated carbon and novel carbon dots. This underlines a big need to char herbs at first before their clinical use. It leads to a new issue how to char herbs properly for maximum active components, which is related to the quality control of charred herbs. Hence, the optimum charring methods should be explored in depth for different herbs in the future. Furthermore, modern research indicates the haemostatic mechanisms of charred herbs are related to their ability to activate coagulation pathways, enhance platelet systems and/or inhibit fibrinolysis systems.

Keywords: Charred Herbs, Carbonized Herbs, Haemostatic Effects, Stop Bleeding, Carbon Dots

1. Introduction

Traditional Chinese medicines have made important contributions to the health care of Chinese people. However, they need to be processed properly for better effects before clinical use. A special process, charring herbs to carbon, has been applied to stop bleeding in clinic for a long time in Chinese history. To date, they are still used extensively to a various of bleeding diseases. A lot of modern pharmacological animal experiments proved the haemostatic effects of charred herbs. Nevertheless, the scientific reason why the herbs need to be charred in advance to stop bleeding is still unclear. It has been intriguing an increasing number of researchers. Their research focuses on the change of active components after herbs charred and the haemostatic mechanisms of charred

herbs. Therefore, our review is aimed to summarize and analyze the clinical applications, active components and haemostatic mechanisms of charred herbs, and further explore the scientific reason of the question above.

2. Clinical Applications

The applications to stop bleeding of charred medicinal materials have a very long history in China. They were recorded in a series of distinguished works from Qin Han dynasties to date (Table 1). The earliest records can be traced back more than 2000 years ago in *Fifty-Two Prescriptions*, *Sheng Nong's Herbal Classic* and *Synopsis of The Golden Chamber*. Since then, nearly all past dynasties have inherited and developed the application of charred medicine. The latest Chinese Pharmacopoeia (2020 edition) also confirmed the

usage of charred herbs to stop bleeding. There are 27 items recorded in total, five out of which are recorded outstandingly, including *cirsii japonici herba carbonisata*, *crinis carbonisatus*,

schizonepetae herba carbonisata, *schizonepetae spica carbonisata*, *dryopteridis crassirhizomatis rhizoma carbonisatum* (Figure 1).

Table 1. Respective records of haemostatic herbs.

dynasty	distinguished works	Respective records of haemostatic herbs
Qin and Han	<i>Fifty-Two Prescriptions (Wushier Bingfang)</i> <i>Sheng Nong's Herbal Classic (Shennong Bencao Jing)</i>	char human hair to stop bleeding char shellfish to stop bleeding
Liang	<i>Synopsis of the Golden Chamber (Jingui Yaolue)</i> <i>Famous Doctors' Records (Mingyi Biehu)</i>	char vaccaria segetalis, sambucus chinensis and cortex mori to stop bleeding char human hair to stop bleeding
Tang	<i>Thousand-Golden-Prescriptions for Emergency (Beiji Qianjin Yaofang)</i>	char cornu antelope to treat postpartum hemorrhage
Song	<i>Newly Revised Materia Medica (Xinjiu Bencao)</i> <i>Classified Materia Medica (Zhenglei Bencao)</i>	char human hair to stop bleeding char sheep shank to stop intestines bleeding
Yuan	<i>Miraculous Book of Ten Prescriptions (Shiyao Shenshu)</i>	<i>Ten Ashes Powder</i> : char <i>cirsii japonici herba</i> , <i>cirsii herba</i> , <i>platycladi cacumen</i> , <i>nelumbinis folium</i> , <i>imperatae rhizoma</i> , <i>rubiae radix et rhizoma</i> , <i>rhei radix et rhizoma</i> , <i>gardeniae fructus</i> , <i>moutan cortex</i> , <i>trachycarpi petioles</i> to stop bleeding
Ming	<i>Compendium of Materia Medica (Bencao Gangmu)</i>	char vaccaria segetalis, sambucus chinensis and cortex mori to stop bleeding
Qing	<i>The Source of The Herbal Classic (Benjing Fengyuan)</i> <i>Seeking Truth from Herbal (Bencao Qiuzhen)</i>	char <i>schizonepetae herba</i> to treat postpartum hemorrhage char <i>schizonepetae tenuifolia</i> , <i>gardenia jasminoides ellis</i> or <i>phellodendron amurense</i> to stop bleeding
Now	Chinese Pharmacopoeia (2020)	<i>cirsii japonici herba carbonisata</i> , <i>crinis carbonisatus</i> , <i>schizonepetae herba carbonisata</i> , <i>schizonepetae spica carbonisata</i> , <i>dryopteridis crassirhizomatis rhizoma carbonisatum</i> to stop bleeding



Figure 1. Examples of charred herbs.

studies of charred herbs from 2000 to 2021 in Table 2 indicates their wide clinic application and positive effect to stop bleeding. They are frequently used to treat purpura, metrorrhagia, upper gastrointestinal bleeding, postoperative hemorrhage of mixed hemorrhoids, and hemorrhoids bleeding. The applications to stop nasal bleeding, fundus bleeding, and bleeding after tooth extraction can be found, as well. All of them received significantly better therapeutic effects than the routine treatment of control groups. For an example, charring human hair to stop bleeding is the earliest description about charred herbs to our knowledge, which is still recorded in Chinese Pharmacopoeia (2020 edition) as *crinis carbonisatus*. In clinic, it is used to stop bleeding after tooth extraction individually nowadays, as well as treat purpura and metrorrhagia, combined with other charred herbs (Table 2). A novel nanofiber containing charred human hair has been under experimental investigation and proved effective in controlling severe bleeding [1].

So far, a lot of historical recorded charred herbs are still widely used in clinic. A collection of clinical comparative

Table 2. Clinical Comparative Study.

Disease	herbs charred in the prescription	effective cases	effective rate
Purpura	<i>loniceræ japonicæ flos</i> , <i>rubiae radix et rhizoma</i> , <i>sanguisorbæ radix</i> , <i>rhei radix et rhizoma</i> , <i>cirsii herba</i> , <i>rehmanniæ radix</i> , <i>typhæ pollen</i> , <i>crinis carbonisatus</i> , <i>scutellariæ radix</i> , <i>moutan cortex</i>	57	95 [4]
	<i>rehmanniæ radix</i> , <i>cirsii japonici herba</i> , <i>cirsii herba</i> , <i>scutellariæ radix</i> , <i>rubiae radix et rhizoma</i>	39	97.5 [5]
	<i>platycladi cacumen</i> , <i>schizonepetæ herba</i> , <i>nelumbinis rhizomatis nodus</i> , <i>sanguisorbæ radix</i>	40	100 [6]
	<i>schizonepetæ herba</i> , <i>nelumbinis rhizomatis nodus</i> , <i>loniceræ japonicæ flos</i>	43	86 [7]
	<i>schizonepetæ herba</i> , <i>nelumbinis rhizomatis nodus</i> , <i>loniceræ japonicæ flos</i>	32	86 [8]
	<i>schizonepetæ herba</i> , <i>rehmanniæ radix</i> , <i>gardeniæ fructus</i>	35	97.2 [9]
	<i>schizonepetæ herba</i> , <i>typhæ pollen</i>	22	95.7 [10]
	<i>rehmanniæ radix</i>	128	93.4 [11]
	<i>rehmanniæ radix</i> , <i>gardeniæ fructus</i> , <i>moutan cortex</i> , <i>phellodendri chinensis cortex</i> , <i>sanguisorbæ radix</i> , <i>ramie root</i> , <i>cimicifugæ rhizoma</i> , <i>typhæ pollen</i> , <i>carthami flos</i> , <i>dryopteridis crassirhizomatis rhizoma</i>	54	96.4 [12]
Metrorrhagia			

Disease	herbs charred in the prescription	effective cases	effective rate
Upper gastrointestinal bleeding	rehmanniae radix praeparata, rubiae radix et rhizoma, trachycarpi petiolus, sanguisorbae radix, crinis carbonisatus, mume fructus, nelumbinis rhizomatis nodus	98	98 [13]
	eucommiae cortex, sanguisorbae radix, nelumbinis rhizomatis nodus, cyperi rhizoma, crassirhizomatis rhizoma	52	92.9 [14]
	bletillae rhizoma, schizonepetae herba, trachycarpi petiolus, typhae pollen, sanguisorbae radix	125	100 [15]
	sanguisorbae radix, sophorae flos, crinis carbonisatus, typhae pollen, artemisiae argyi folium	57	95.0 [16]
	rubiae radix et rhizoma, sanguisorbae radix	53	94.6 [17]
	gardeniae fructus, sanguisorbae radix	50	100 [18]
	schizonepetae herba, typhae pollen	50	92.3 [19]
	typhae pollen	36	90 [20]
	gardeniae fructus, moutan cortex, platycladi cacumen, cirsii japonici herba, cirsii herba, imperatae rhizoma, notoginseng radix et rhizoma, rhei radix et rhizoma, bletillae rhizoma	40	97.6 [21]
	Ten ashes powder	99	99 [22]
	Ten ashes powder	29	96.7 [23]
	rhei radix et rhizoma	56	96.6 [24]
	rhei radix et rhizoma	50	96.2 [25]
	rhei radix et rhizoma	39	94.13 [26]
	rhei radix et rhizoma	43	96 [27]
	rhei radix et rhizoma	51	80.9 [28]
	Ten ashes powder	56	93.3 [29]
	Ten ashes powder	99	99 [30]
	Ten ashes powder	147	98.0 [31]
	Ten ashes powder	100	90.9 [32]
Hemorrhoids bleeding	rubiae radix et rhizoma, sanguisorbae radix, sophorae fructus, platycladi cacumen	153	91.1 [33]
nasal bleeding	Ten ashes powder	160	100 [34]
	gardeniae fructus	34	94.4 [35]
fundus bleeding	rhei radix et rhizoma	34	94.4 [36]
	platycladi cacumen	25	92.5 [37]
Bleeding after tooth extraction	gardeniae fructus	100	92.6 [38]
	crinis carbonisatus	75	98.7 [39]

In addition, a notable prescription named *Ten Ashes Powder* was first found in *Miraculous Book of Ten Prescriptions* in Yuan dynasty, which consists of ten herbs all charred to ashes (Table 1). It has become the most commonly used prescription in clinic from 2000 to 2021 (Table 2). Compared to the routine control treatment, it plays a more effective role in the treatment of upper gastrointestinal bleeding, postoperative hemorrhage of mixed hemorrhoids, and hemorrhoids bleeding.

According to Table 2, charred herbs have contributed a lot to the treatment of hemorrhagic diseases. For purpura, the most commonly used charred herbs are schizonepetae herba carbonisata and rehmanniae radix carbonisata. The prescriptions, suggested in the Chinese national *guidelines for TCM diagnosis and treatment of Hensch-Schonlein purpura*, also contain lots of charred herbs, for an example of crinis carbonisatus [2]. For metrorrhagia, both typhae pollen carbonisata and sanguisorbae radix carbonisata are used most frequently. Additionally, trachycarpi petioles carbonisata can be found in the suggested prescriptions in *International clinical practice guidelines of Chinese medicine metrorrhagia and metrostaxis* [3].

It is noteworthy that a new and original application form of charred herbs has occurred in the treatment of upper gastrointestinal bleeding. Different from the conventional oral decoction, the micron-sized rhei radix et rhizome carbonisatus was sprayed on the surface of the lesion through gastroscopy to stop upper gastrointestinal bleeding. It received very

satisfactory results (Table 2).

At last, we suggest that the long-standing clinical applications from ancient times to the present prove the practicability, effectiveness and safety of charred herbs to stop bleeding.

3. Active Components with Haemostatic Effects

Traditional Chinese medicines charred to stop bleeding have contributed a lot to the health care of Chinese people for a long history. However, why the herbs need to be charred at first for haemostatic effects has been lack of adequate scientific explanation for a long time. A question needed to answer in advance is whether the haemostatic difference exists or not between charred herbs and uncharred ones.

According to the references from 2000 to 2021, many researchers revealed that the hemostatic effects increased significantly after the herbs charred, based on their pharmacodynamic animal experiments. Twenty evident examples can be found in Table 3. Therefore, it proved that significant haemostatic difference existed between charred herbs and uncharred ones. It emphasized a need to char the herbs before clinical use for sufficient haemostatic effects. The scientific reason intrigued a number of researchers. They sought for that through focusing on the change of active components.

Table 3. Significant changes of components and hemostatic effects of animal experiments after herbs charred (+: increased; -: decreased).

No.	herbs	Content change	Hemostatic effects of animal experiments
		Tannins	
1	gardeniae fructus [48, 49]	+	+
2	typhae pollen [50]	+	
3	imperatae rhizoma [51]	+	+
4	mali fructus [52]	+	+
5	ten ashes powder [53]	+	+
6	sanguisorbae radix [41, 54, 55]	+	+
7	rhei radix et rhizoma [56]	+	
8	moutan cortex [57, 58]	+	
9	copperleaf herb [59, 60]	-	+
10	platycladi cacumen [61]	-	
11	crataegi fructus [62, 63]	-	+
12	mume fructus [64]	-	+
13	scutellariae radix [65]	-	
calcium ion			
14	crataegi fructus [62, 63]	+	+
15	ten ashes powder [53]	+	
Activated carbon			
16	scutellariae radix [65]	+	
17	gardeniae fructus [66, 49]	+	
18	platycladi cacumen [67]	+	
19	moutan cortex [68]	+	
20	scutellariae radix [69]	+	+
21	sanguisorbae radix [55]	+	
22	imperatae rhizoma [51]	+	+
23	mali fructus [52]	+	+
Flavonoid aglycone			
24	nelumbinis receptaculum [70]	+	
25	sophorae flos [71, 72]	+	+
26	platycladi cacumen [43, 61, 71, 73]	+	+
27	typhae pollen [71]	+	
28	nelumbinis folium [74]	+	+
Anthraquinone aglycone			
29	rhei radix et rhizoma [56, 75]	+	+
30	rubiae radix et rhizoma [76, 77, 45]	+	+
Novel Carbon Dots			
31	phellodendri chinensis cortex [78, 79]	+	
32	cirsii japonici herba [47, 80]	+	
33	cirsii herba [46]	+	
34	moutan cortex [81]	+	
35	nelumbinis folium [82]	+	
36	crinis carbonisatus [83]	+	
37	schizonepetae herba [84, 85]	+	
38	schizonepetae spica [86]	+	
39	dryopteridis crassirhizomatis rhizoma [87]	+	
40	junci medulla [88]	+	
41	pollen typhae [89]	+	
Not detected			
42	lonicerae japonicae flos [90]		+
43	rehmanniae radix [91]		+
44	selaginellae herba [92]		+

3.1. Tannins

Tannins are polyphenolic compounds naturally found in plants. They are able to contract capillaries of wounds and transform exudative protein into macromolecule precipitation which can attach itself to mucous membrane to stop bleeding [40]. Therefore, Tannins are regarded as active components for the haemostatic effects of Chinese herbs. With this notion, researchers began investigations on the change of tannins between charred herbs and uncharred ones, such as gallic acid

and ellagic acid (Figure 2) [41]. Most of them found that the contents of tannins increased obviously after herbs charred, such as herbs No. 1 to No. 8 in Table 3. It seemed that the increase of tannins should be an explanation for the need to char herbs for haemostatic effects. However, some research provided opposite results that the contents of tannins decreased significantly after herbs charred, such as herbs No. 9 to No. 13. Hence, the tannins are only responsible for the haemostatic effects of a part of charred herbs but not all.

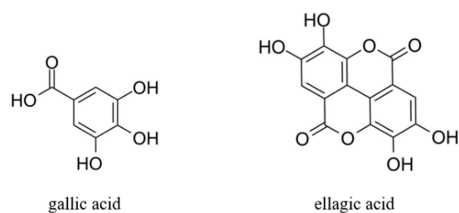


Figure 2. Chemical structures.

3.2. Calcium Ion

Calcium ion is a cofactor of blood coagulation and regarded as a main basis for haemostasis. It can promote protein coagulation in blood, activate numerous factors for polymerization of fibrin and blood coagulation, and reduce permeability of capillaries and cell membranes [40]. Two reports indicated that calcium ion of charred *Crataegi fructus* increased significantly (Table 3). Additionally, the notable prescription named *Ten Ashes Powder* was also subjective to the research of calcium ion (Table 3). Researchers found calcium ion increased a lot and suggested the calcium ion played a part in the haemostatic effects of *Ten Ashes Powder*. On the basis of these, it is likely that the haemostatic effects of charred herbs depend on the increase of calcium ion. However,

according to the report which researched the change of calcium ion on 20 different charred herbs, the likelihood is negative [42]. It turned out that the calcium ion increased only on 12 cases but decreased on 8 cases. In short, similar to tannins, it is difficult for calcium ion to explain the whole situations of charred herbs.

3.3. Flavonoids and Anthraquinones

Some research revealed definite haemostatic effects of some flavonoid aglycones and anthraquinone aglycones isolated from charred herbs, such as quercetin [43], pectolarigenin [44] and 1,3-dihydroxyanthraquinone [45] (Figure 3). A number of studies found that flavone glycosides or anthraquinone glycosides decreased and their corresponding aglycones increased obviously after herbs charred (No. 24-30 in Table 3). Accordingly, they pointed out that the charring process caused this variation above, and the generated aglycones should have an effect on the haemostatic effects of charred herbs. Nevertheless, both the certain flavonoids and anthraquinones do not exist in all charred herbs. Thus, they may not be able to become a widely applicable explanation for the haemostatic effects of charred herbs.

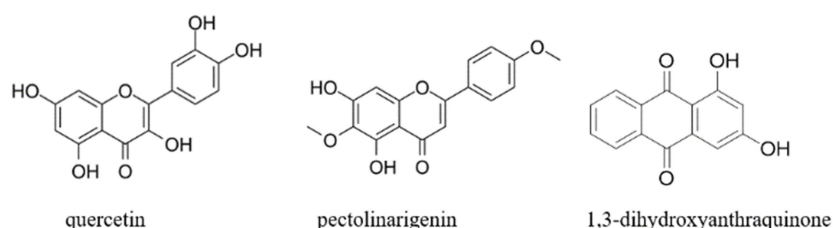


Figure 3. Chemical structures.

3.4. Activated Carbon and Novel Carbon Dots

Activated carbon with lots of loose holes is able to lead to physical adsorption to accelerate haemostasis. Meanwhile, it can activate plasma clotting factors, split blood platelet, and release blood platelet factors to promote coagulation [40]. Obviously, a certain amount of activated carbon will appear under the process of charring herbs by high temperature. It was proved in terms of many accordant experimental results that absorption capacity of carbon increased apparently in charred herbs (No. 16-23 in Table 3). In the light of this, the haemostatic effects of all charred herbs may be partly attributed to the emergence of activated carbon.

In recent 5 years, a novel substance has been discovered and may become another part of attribution for the haemostatic effects of all charred herbs. This novel substance, named carbon dot, is generated under charring process by high temperature similar to activated carbon. It has been described as a new class of carbon-based nanomaterials with quasispherical nanoparticles usually 1–10 nm in diameter. Compared to traditional semiconductor quantum dots, carbon dots are superior in terms of high aqueous solubility, easy

functionalization, resistance to photo-bleaching, low toxicity, and excellent biocompatibility [46, 47]. This new discovery appealed to some scientists, typified by the research group of Prof. Qu Huihua from Beijing University of Traditional Chinese Medicine. Their latest research explored the haemostatic effect of novel carbon dots derived from various charred herbs and their related haemostatic mechanism. All results confirmed the definite haemostatic effect of carbon dots from different charred medicines (No. 31-41 in Table 3), for an example of charred human hair (Figure 4). Therefore, the novel carbon dots, along with activated carbon, play an important role in the haemostatic effects of charred herbs.

At last, let us go back to the original question why the herbs need to be charred at first for haemostatic effects in clinical use. We assume that the charring process to herbs would give rise to novel carbon dots and activated carbon with significant haemostatic effects, leading charred herbs to better haemostatic effects than uncharred ones. As for the diversity of haemostatic effects of different charred herbs, we believe their characteristic active components make the difference to some extent, such as tannins, flavonoids and anthraquinones.

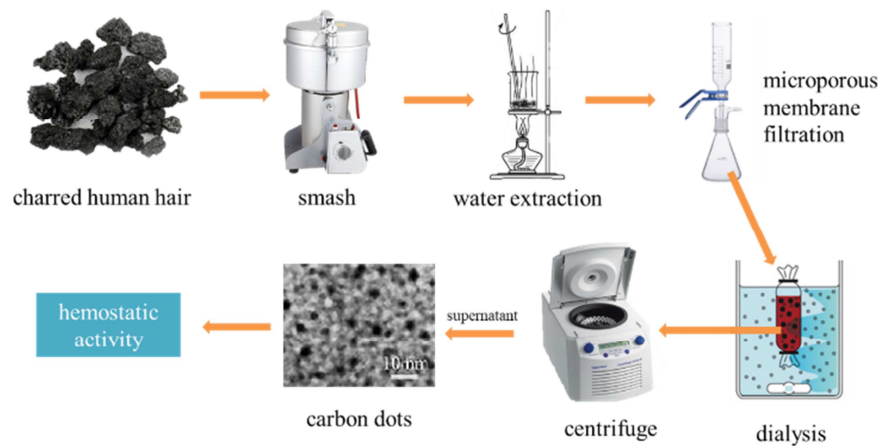


Figure 4. Haemostatic effect of carbon dots from charred human hair.

4. Mechanisms

The haemostatic mechanisms of charred herbs have been subjected to exploration in depth mainly on their impacts on coagulation pathways, platelet systems and fibrinolytic systems. In the section two, we underlined the effective clinical application of charred human hair, ten ashes powder, and micron-sized rhei radix et rhizome carbonisatus. Let us take these as examples to discuss their haemostatic mechanisms (Table 4). According to these examples as following, we believe the charred herbs exert their haemostatic activity probably through activating coagulation pathway, strengthening platelet systems, and/or inhibiting fibrinolysis systems.

The results of mouse tail bleeding and liver hemorrhage experiments showed that novel carbon dots extracted from charred human hair had significant hemostatic activity. They were able to reduce APTT, increase plasma PIB and PLT in the whole blood, reduce plasma 6-keto-PGF1 α concentration, increase TXB2 concentration, and degrade tPA, elevate PAI-1 and D2D level. These results indicated that the novel carbon dots as active components of charred human hair exerted the

hemostatic activity by activating endogenous coagulation pathways and common pathways, increasing platelet counts, increasing their activation factor TXB2, lowering 6-keto-PGF1 α , and inhibiting fibrinolysis systems.

It is reported that the aqueous extracts from *ten ashes powder* significantly decreased the bleeding time and coagulation time of mouse. They were able to decrease PT, TT and PRT, as well as increase platelet aggregation rate. It is suggested that *ten ashes powder* played a hemostatic role through activating endogenous and extrinsic coagulation pathways, and strengthening the function of platelet.

Some research demonstrated the micron-sized rhei radix et rhizome carbonisatus were able to shorten the bleeding time of rabbit gastric tissue. It is indicated that they decreased PT and APTT, increased platelet aggregation rate, TXB2 and GMP-140, decreased 6-keto-PGF1 α , and PGI2, but had no effect on t-PA and PAI-1. These results proved that the rhei radix et rhizome carbonisatus exerted their hemostatic activity by activating endogenous and extrinsic coagulation pathways, and strengthening the function of platelet, but had nothing to do with fibrinolytic system concerning t-PA and PAI-1.

Table 4. Haemostatic mechanisms of three examples.

Charred medicines	Methods	Results
Charred human hair [83]	(1) Evaluated the impacts on coagulation pathway through measurement of the coagulation parameters (PT, APTT, TT, and FIB) using mouse plasma (2) Evaluated the impacts on the platelet system by measuring platelet count, and the levels of TXB2 and 6-keto-PGF1 α . (3) Evaluated the impacts on the fibrinolytic system by measuring the concentration of tPA, PAI-1, and D2D in plasma	(1) reduced APTT, increased plasma FIB (2) increased PLT concentration, reduced plasma 6-keto-PGF1 α concentration, increased TXB2 concentration (3) degraded tPA, elevated PAI-1 and D2D level.
Ten ashes powder [93]	(1) Evaluated the impacts on coagulation pathway through measurement of PT, TT, PRT (2) Evaluated the impacts on the platelet system by measuring platelet aggregation rate	(1) Decreased PT, TT, PRT (2) Increased platelet aggregation rate
Rhei radix et rhizome carbonisatus [94, 95]	(1) Evaluated the impacts on coagulation pathway through measurement of PT and APTT (2) Evaluated the impacts on the fibrinolytic system by measuring tPA and PAI-1 (3) Evaluated the impacts on the platelet system by measuring platelet aggregation rate, TXB2, 6-keto-PGF1 α , PGI2 and GMP-140	(1) Decreased PT and APTT (2) Had no effect on t-PA and PAI-1 (3) Increased platelet aggregation rate, TXB2 and GMP-140, decreased 6-keto-PGF1 α , and PGI2

Note: prothrombin time (PT), activated partial thromboplastin time (APTT), thrombin time (TT), and fibrinogen level (FIB), platelet counts (PLT), thromboxane B2 (TXB2), 6-keto-prostaglandin F1 α (6-keto-PGF1 α), tissue plasminogen activator (tPA), plasminogen activator inhibitor-1 (PAI-1), D-dimer (D2D), plasma recalcification time (PRT), prostacyclin (PGI2), platelet granule membrane protein-140 (GMP-140).

5. Conclusions and Perspectives

More than 2000 years have witnessed charred herbs as contributors to the health care of Chinese people. Recent decades have also witnessed their novel developments in clinic, as well as witnessed wide scientific research on their active components and mechanisms of haemostatic effects.

Nowadays, they are mostly used to treat purpura, metrorrhagia, upper gastrointestinal bleeding, postoperative hemorrhage of mixed hemorrhoids, and hemorrhoids bleeding. It is noteworthy that a new and original application form of charred herbs has occurred. The micron-sized rhei radix et rhizome carbonisatus were sprayed on the surface of the lesion through gastroscopy to stop upper gastrointestinal bleeding. However, the conventional oral decoction is still a predominate application form, which has lots of disadvantages to use. Thus, there is an urgent need to develop more modern application forms to maximize effects and facilitate usages.

The continuing clinical applications of charred herbs since ancient times have proved the practicability, effectiveness and safety of charred herbs to stop bleeding. However, a consequent question arises why there is a need to char herbs in advance before use in clinic. A number of interested scientists actively sought for answers from the impacts of active components on the haemostatic effects. They found the content of active components increased significantly for a part of charred herbs, such as tannins, calcium ions, flavonoids and anthraquinones. In addition, the charring process to all herbs under high temperature would produce activated carbon and novel carbon dots, which proved to have obvious haemostatic effects. Accordingly, we deem that the emergence or increase of active components may lead charred herbs to significantly better haemostatic effects than uncharred ones, especially the emergence of activated carbon and novel carbon dots. This emphasizes a big need to char herbs at first before their clinical use. It leads to a new issue how to char herbs properly for maximum active components, which is related to the quality control of charred herbs. Hence, the optimum charring methods should be explored in depth for different herbs in the future. A universal, stable, controllable and widely applicable charring method is preferable. In addition, modern research indicates the haemostatic mechanisms of charred herbs are related to their ability to activate coagulation pathways, enhance platelet systems and/or inhibit fibrinolysis systems.

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