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ETHNOMEDICINAL PLANTS FOR PREVENTION OF CARDIOVASCULAR DISEASES IN BANGLADESH

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Abstract

Cardiovascular diseases (CVD) are the major causes of death globally. The treatment of CVD by using modern medicines is very expensive. The present article mainly focuses the ethnomedicinal plants used by the local people for the prevention of cardiovascular diseases in Bangladesh. Information on the ethnomedicinal uses of plants was collected using semi-structured interviews with key informants during the year of 2017 and 2018. Group discussion with local people was also conducted for the promotion of data collection. A total of 41 medicinal plant species was recorded for the prevention of cardiovascular diseases. These species belong to 30 families. The most frequently used medicinal plant species for the prevention of cardiovascular diseases were *Terminalia arjuna* (Roxb. *ex* DC.) Wight & Arn., *Terminalia bellirica* (Gaertn.) Roxb., *Terminalia chebula* Retz., *Allium sativum* L., *Tamarindus indica* L. and *Alternanthera sessilis* (L.) R. Br. *ex* Roem. Informant consensus factor (Fic) has been calculated to determine the agreement of local people in the use of medicinal plants for the CVD. Among the ailments categories high Fic value was found in case of antioxidant followed by heartache, high blood pressure and blood purifier. Comparing with previous research *Hylocereus undatus* (Haw.) Briton and Rose, *Alternanthera paronychioides* Klotzsch *ex* Koch and *Lactuca sativa* L. were seem to be newly reported medicinal plants for the prevention of cardiovascular diseases in Bangladesh. The plant species with high citation, Fic and Fl values can be subjected to phytochemical investigation to find new class of active compounds for the treatment of cardiovascular diseases. The findings of the present study are very preliminary. Further long term studies are needed to validate the ethnomedicinal plants used by the local people for the prevention of cardiovascular diseases in Bangladesh.

Introduction

Cardiovascular diseases (CVD) refer to any disorders of the heart and blood vessels. The most common ones are disorder of the heart muscle, strokes, heart failure and those caused by high blood pressure (Olorunnisola *et al*., 2011). Worldwide, CVD is assuming an increasing role as a major cause of morbidity and mortality (Krisela, 2007). It is estimated at approximately 1.6 million deaths per annum worldwide (WHO, 2003). Between 1990 and 2020, the proportion of deaths from CVD is projected to increase from 28.9 to 36.3% (Gowri *et al*., 2011). Moreover, in terms of number of years of life lost, CVD is expected to jump in ranking from the fourth to first, while as a cause of premature death and disability, it will rise from fifth to first (Hennekens, 2000). The predisposing factors to CVD include cigarette smoking, elevated cholesterol, hypertension, obesity, physical inactivity and diabetes (Olorunnisola *et al*., 2011). According to the INTERHEART study, Bangladeshis had the highest prevalence of CVD risk factor among five South Asian countries with the prevalence of self-reported history of hypertension (14.3%),

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abdominal obesity (43.3%), current and former smoking (59.9%), and the lowest prevalence for regular physical activity (1.3%) and daily intake of fruits and vegetables (8.6%) (Joshi *et al.*, 2007). In Bangladesh, 99.6% male and 97.9% females are exposed to at least one of the established risks of CVD and at risk of CVD at a younger age (below 40 years in men) (El-Saharty *et al.*, 2013). The expected high incidence of the diseases, couple with high cost of modern pharmaceuticals and healthcare remedies, makes it all important to search for safe, effective and cheaper remedies from natural world. Before the discovery of modern medicines, many plants have been used by human in the management, treatment and the related complications of CVD. In Bangladesh a number of plants are reputed to possess cardio protective properties, resulting in their use by traditional healer for treatment of chest complaints, high cholesterol, high and low blood pressure and general heart problems. Plants may serve as the alternative sources for the development of new anticoagulant agents due to their biological activities. There is compelling scientific evidences demonstrating that the consumption of dietary anticoagulants or phytochemicals with anticoagulant properties can ultimately reduce or eliminate the risks of thromboembolic diseases (Kumar *et al.*, 2011; Lee *et al*., 2012; Manicam *et al.*, 2010). Currently, ethnomedicinal knowledge of plants has been eroding at alarming rate from the nature before proper documentation and evaluation. In order to protect such knowledge, documentation of ethnomedicinal plants is already started in Bangladesh. A number of articles published in this field included Mia and Haque (1988); Hassan and Khan (1986, 1996); Alam (1992); Alam *et al*. (1996); Uddin *et al*. (2001, 2006, 2012, 2017), Khan *et al*. (2002), Ghani (2003), Uddin *et al*. (2004), Yusuf and Uddin (2006); Yosuf (2006); Yusuf *et al*. (2009), Uddin and Roy (2007); Roy *et al*. (2008); Emily *et al*. (2010); Uddin (2013), Haque *et al*. (2014); Uddin *et al*. (2015a,b) and Haque *et al*. (2017). These articles listed a good number of medicinal plants of particular community or particular diseases or particular areas of Bangladesh. But there is no record of ethnomedicinal plant species useful for CVD management in Bangladesh. In order to document and validate ethnomedicinal plant species for CVD management in Bangladesh, an attempt was undertaken to achieve the following objectives: (a) to record, integrate and document all scattered traditional healthcare knowledge on ethnomedicinal plants for CVD management in Bangladesh, (b) to determine ethno-medically potential and culturally important and most cited plant species using statistical models, (c) to validate the folk knowledge of ethnomedicinal plants with thrombolytic agents.

Materials and Methods

Bangladesh is located in between 20°34' to 26°38' N and 88°01' to 92°41' E and total area is 147,570 sq. km. The country is bounded by India to the West, North, East, by Myanmar to the South-East corner and By the Bay of Bangle to the South. Bangladesh ornamented by different forest types including hill forest, plain land sal forest, mangrove forest, fresh water swamp forest and homestead vegetations. Among the forest types native flora is very diverse due to geo-morphological variations. Once Professor MS Khan estimated that the country may have 5000 angiosperm plant species. Very recently, the plant taxonomist compiled 3611 species from existing literature. Among them, more than 1000 plant species have been used by the local people as medicines. Bangladesh is the also dwelling place for a good number of ethnic communities. These communities have their own cultural tradition and heritage in their social life. For the primary health care they have been used native plant species.

Seven sampling sites have been selected for the data collection in Bangladesh. These are Thakurgaon, Dinajpur, Sirajgonj, Dhaka, Brahmanbaria, Feni and Bhola. The sampling sites have been visited during the year of 2017 and 2018. Visit duration for each site was lasted for 4-5 days. The data on medicinal uses of plants were recorded through semi-structured interviews, key

informant discussions and also with the help of herbal practitioners (Alexiades, 1996). Field interview, plant interview and group discussion with local people were also conducted for the promotion of data collection. During the field survey, information on uses of plants to treat human, parts used, modes of preparation and administration was collected. The vernacular names have been collected with the help of local people whenever available. A total of 166 local informants including 66% males and 34% females were interviewed during the ethnobotanical survey. The local informants were housewives, herbalist, farmers, craftsmen, shopkeepers, teachers and also students. The informants were ranged within 21–70 years old. Voucher specimens for each medicinal plant species were collected and processed using standard herbarium techniques (Hyland, 1972). Identification of plant species have been done by the experts in both field and laboratory. In case of confusion in identity, standard literature was consulted and the relevant voucher specimens available at Dhaka University Salar Khan Herbarium (DUSH) were also compared. All voucher specimens were deposited at DUSH.

Factor of informant consensus (Fic), Fidelity level (Fl) and Citation frequency was calculated using bio statistical formulas. Factor of informant consensus (Fic) was calculated applying the following equation: Fic = $N_{ur} - N_{taxa}/N_{ur}$-1, Where N_{ur} is the number of use reports in each category, N_{taxa} is the number of species in each category (Trotter and Logan, 1986; Heinrich *et al*., 1998). Citation frequency was calculated using the following formula: frequency of citation for a particular species= (Number of citations for that particular species/ Number of all citations for all species) x 100 (Uddin *et al*., 2017). The Fidelity level, was calculated for the most frequently reported medicinal plant species as: Fl (%) = (Np / N) × 100; Where, Np = number of informants that claim a use of a plant species to treat a particular disease; N = number of informants that use the plants as a medicine to treat any given disease (Friedman *et al*., 1986).

Results and Discussion

The present ethnobotanical survey recorded a total of 41 medicinal plants belonging to 30 families that were acquired by conducting 166 interviews for the treatment of cardiovascular diseases with 70 formularies from different district of Bangladesh (Table 1).

According to the habit diversity of recorded medicinal plant, 56% was tree, 34% was herb, 5% was shrub and 5% was climber (Fig.1). Leaves are the most commonly used part for medicinal plants or for the preparation of traditional medicine (Fig. 2). Similar trend of using leaves for medicinal use has also been reported from other studies from Bangladesh (Uddin *et al*., 2012; Biswas *et al.*, 2010). According the citation frequency of all medicinal plants, the most frequently used plants were *Terminalia arjuna* (Roxb. *ex* DC.) Wight & Arn., *Terminalia bellirica* (Gaertn.) Roxb., *Terminalia chebula* Retz., *Allium sativum* L., *Tamarindus indica* L. and *Alternanthera sessilis* (L.) R. Br. *ex* Roem.

In the present study 41 medicinal plant species have been found for the treatment of cardiac diseases. Medicinal plant from the families were found high number of species belong to Combretaceae, Ceasalpiniaceae and Apocyanaceae. The most cited species used to treat such ailments are *Terminalia aurjuna*, *Terminalia bellirica*, *Alternanthera sessilis*, *Rauvolfia serpentina* ,*Tamarindus indica*, *Allium sativum*, *Zingiber officinale* and *Achyranthes aspera*. To calculate the Factor of informant consensus (Fic) values total ailments were categorized into four groups *viz:* heartache, antioxidant, blood purifier and high blood pressure. The average Fic value for all ailment categories obtained was 0.78. Such value indicated that maximum people in the study area were well informed about the medicinal knowledge of plants. Among the four categories antioxidant group attained the highest Fic values (0.82) followed by heartache, high blood pressure (0.79) and blood purifier (0.74, Table 2).

Table 1. Ethnomedicinal uses of recorded medicinal plants for the prevention of CVD with Citation Frequency (CF)

Scientific name	Local name	Habit	Family	Parts used	Ailment	Treatment mode	CF (%)
Abroma augusta L., TH-34	Ulotkombol	Shurb	Sterculiaceae	Leaf	Chest pain	Leaf juice is taken	1.205
Achyranthes aspera L., TH-87	Ufuthlenga	Herb	Amaranthaceae	Seed	Chest pain	One spoonful powder is taken	3.012
Allium sativum L., TH-117	Rosun	Herb	Liliaceae	Bulb	Heart disease	Juice is taken	2.41
						Half bulb is taken	6.024
					Blood pressure	Bulb is taken	3.614
Alternanthera paronychioides Klotzsch *ex* Koch, ABR-117	Putishak	Herb	Amaranthaceae	Leaf	Heart disease	Cooked leaf is taken	0.602
				Stem	Antioxidant	Cooked stem is taken	3.012
Alternanthera sessilis (L.) R. Br. *ex* Roem. & Schult., TH-121	Golhaisa	Herb	Amaranthaceae	Root	Burning Chest pain	Juice is taken	3.012
				Leaf	Antioxidant	Cooked leaf is taken	6.627
Amaranthus tricolor L. TH-102	Lal shakh	Herb	Amaranthaceae	Leaf	Blood purify	Fried and eaten	2.41
Anacardium occidentale L., TH-73	Kaju badam	Tree	Anacardiaceae	Fruit	Heart disease	Fruit is eaten directly	0.602
Andrographis paniculata (Burm. f.) Wall.*ex* Nees, TH-45	Chirata	Herb	Acanthaceae	Leaf	Blood purifier	Paste is taken	0.602
Arachis hypogaea L., ABR- 117	Badam	Herb	Fabaceae	Fruit	Heart disease	Juice is taken	2.41
Areca catechu L., TH-15	Supari	Tree	Arecaceae	Fruit	Heart disease	Raw young fruit is taken	0.602
Artocarpus heterophyllus Lamk., TH-306	Kathal	Tree	Moraceae	Fruit	Antioxidant	Fruit is eaten	0.602

Table 1 (contd.)

Asclepias carassavica L. , ABR-119	Bankapas	Herb	Asclepiadaceae	Whole plant	Chest pain	Extract is taken internally with one table spoon full water	0.602
Asparagus racemosus Willd., TH-43	Chattayn bio	Climber	Liliaceae	Root	High blood Pressure	Juice is taken	1.205
Averrhoa carambola L., TH-95	Kamranga	Tree	Oxallidaceae	Fruit	Blood pressure	Juice is taken	1.807
Bryophyllum pinnatum (Lamk.) Oken, ABR- 118	Pathor kuci	Herb	Crassulaceae	Leaf	Blood pressure	1/2 cup juice is taken in the morning everyday	1.807
Centella asiatica (L.), Urban, TH-02	Thankuni	Herb	Apiaceae	Leaf	Heart disease	1 cup juice is taken with turmeric in empty stomach	0.602
					Blood purifier	Juice is taken in empty stomach early in the morning	4.819
Curcuma longa L., TH-167	Holud	Herb	Zingiberaceae	Rhizome	Blood purifier	Powder is taken with jira	1.205
Datura metel L., TH-20	Dutura	Herb	Solanaceae	Seed	Blood pressure	Juice is taken	0.602
				Root	Heart disease	Juice is taken	0.602
Diplazium esculentum (Retz.) Sw, TH-300	Dheki shak	Herb	Athyniaceae	Leaf	High blood Pressure	Cooked & taken	2.41
Enhydra fluctuans Lour., ABR- 14	Helencha	Herb	Asteraceae	Leaf	Heart disease	Cooked leaf is taken	0.602
				Stem	Heart disease	Cooked stem is taken	0.602
				Leaf	Blood purify	Cooked & taken	1.205
Glinus oppositifolius (L.) A. DC., TH-298	Gema shak	Herb	Molluginaceae	Leaf	Blood pressure	Dried leaf is taken	0.602
Hylocereus undatus (Haworth) Britton & Rose	Dragon fruit	Climber	Cactaceae	Fruit	Heart disease	Raw fruit is taken	0.602

Table 1 (contd.)

Ipomoea fistulosa Mart. *ex* Choisy, TH-297	Dulkolmi	Herb	Convolvulaceae	Stem	Heart disease	Stem is eaten	0.602
Lactuca sativa L., TH-56	Lettuce pata	Herb	Asteraceae	Leaf	Heartache	Taken as salad	1.205
Litsea glutinosa (Lour.) Robinson, TH- 08	Menda	Tree	Louraceae	Bark	Chest pain	Paste is applied to affected area	1.205
Lycopersicon lycopersicum (L.), Farwell, TH-128	Tomato	Herb	Solanaceae	Fruit	Heart disease	Juice is taken	0.602
Mangifera indica (L.), TH-133	Aam	Tree	Anacardiaceae	Leaf	Heart disease	Leaf steeped in water and the extract is taken	1.205
						Raw leaf is taken on empty stomach	3.012
Mimosa pudica L., TH-35	Lajjabati	Herb	Mimosaceae	Leaf	Heart disease	Leaf steeped in water and the extract is taken	0.602
				Stem	Chest pain	Paste applied	0.602
Moringa oleifera Lamk., TH-26	Sajna	Tree	Moringaceae	Leaf	High blood pressure	Juice is taken	0.602
Musa sapientum L., TH-67	Kola	Herb	Musaceae	Fruit	Heart disease	Cooked fruit is taken	0.602
					Blood pressure	1/2 cup of juice is taken every morning for 15 days	1.205
Nigella sativa L., TH-80	Kalojira	Herb	Ranunculaceae	Seed	Heart disease	Taken with honey for one month	0.602
					Blood pressure	Crushed seed is taken with honey	1.807
Phyllanthus emblica L., TH-05	Amloki	Tree	Euphorbiaceae	Fruit	Blood pressure	Fruit is taken	1.807
Punica granatum L., TH-28	Dalim	Shrub	Lythraceae	Fruit	Heart disease	Juice is taken	0.602

Table 1 (contd.)

				Leaf	Heart disease	Juice is taken	0.602
Rauvolfia serpentina (L.) Benth. *ex* Kurz., TH-103	Sarpagandha	Herb	Apocynaceae	Root	Blood purifier	Paste is taken	0.602
					Blood pressure	Powder is taken twice a day after meal	1.205
					Heart disease	Powder is taken twice a day after meal	1.807
					High blood pressure	Powder is mixed with water & taken	7.229
Saraca asoca ((Roxb.) Willd., TH-175	Ashok	Tree	Fabaceae	Bark	Chest pain	Bark steeped in water and the extract is taken in empty stomach	0.602
					Blood purify	Grinded to form powder & mixed with water which taken internally	1.807
Spondias indica (Wight &Arn), TH-07	Amra	Tree	Anacardiaceae	Fruit	Blood pressure	Fruit juice is taken	0.602
					Heart disease	Fruit is taken	3.012
Tamarindus indica L., TH-197	Tetul	Tree	Caesalpiniaceae	Fruit	Blood pressure	Fruit juice is taken	3.012
					Heart disease	Ripe fruit is eaten	4.217
				Leaf	Heart disease	one cup boiled leaf juice is taken	6.024
				Leaf	High blood pressure	Juice is taken internally as necessary	9.639
Terminalia bellirica (Gaertn.) Roxb., TH-31	Bohera	Tree	Combretaceae	Fruit	Blood purifier	Fruit powder is taken twice a day with arjun	0.602

Table 1 (contd.)

				Bark	Heart disease	Dried bark grinded and mix with water than taken in the morning	10.84
Terminalia arjuna (Roxb. *ex* DC.) Wight & Arn., TH-01	Aurjun	Tree	Combretaceae	Bark	High pressure	Eaten in empty stomach	1.807
					Heart disease	Powdered bark is mixed with Amloki & Bohera fruits and taken one spoonful twice daily	2.41
						Powdered bark is taken in empty stomach early in the morning	9.036
						Bark soaked in water then taken in empty stomach	10.84
				Fruit	Heartache	Juice taken internally	3.012
Terminalia chebula Retz., TH-13	Haritoki	Tree	Combretaceae	Fruit	Blood purify	Soaked into water and taken internally	9.036
				Bark	Heart disease	Soaked into one glass of water and taken internally	9.036
				Rhizome	Gastric problem	Juice is taken	1.807
Zingiber officinale Rosc., TH-105	Ada	Herb	Zingiberaceae	Rhizome	Blood pressure	Rhizome is taken with tea	3.012

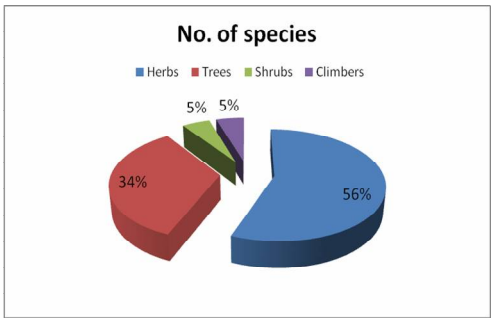

Fig.1. Habit diversity.

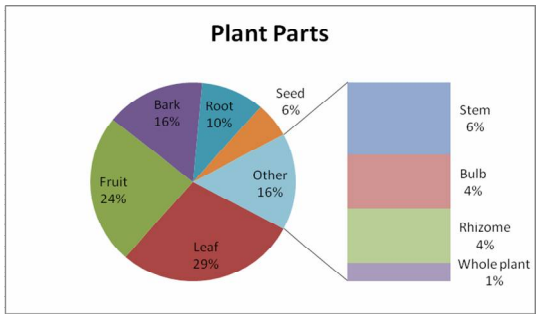

Fig. 2. Proportion of parts used of medicinal plant species.

Table 2. Factor of informant consensus (Fic) for each use category related to cardiovascular diseases.

Category	No. of species (Ntaxa)	No. of use reports (Nur)	Factor of informant consensus (Fic)
Antioxidant	4	18	0.823529
High blood pressure	15	69	0.794118
Heartache	32	152	0.793333
Blood purifier	11	40	0.74359

Table 3. Fidelity level (Fl %) of most cited plant species.

Scientific name	Np	N	Fl%
Achyranthes aspera L.	5	5	100
Terminalia bellirica (Gaertn.) Roxb.	18	19	94.73
Terminalia arjuna (Roxb. *ex* DC.) Wight & Arn.	42	45	93.33
Terminalia chebula Retz.	15	18	83.31
Tamarindus indica L.	33	38	86.84
Rauvolfia serpentina Benth.	14	18	77.78
Alternanthera sessilis (L.) R. Br. *ex* Roem. & Schult.	11	15	73.33
Allium sativum L.	14	20	70

Np = number of informants that claim a use of a plant species to treat a particular disease; N = number of informants that use the plants as a medicine to treat any given disease.

During ethnobotanical survey the data of the other use of these medicinal plants which showed highest frequency further calculated for Fidelity level (Table 3). Among the most cited ethnomedicinal plant species eight species showed above 70% Fidelity level (Table 3). *Achyranthes aspera* showed 100% Fidelity level but with a low citation frequency (3.012) for the treatment of chest pain. In the present study *Alternanthera sessilis* was highly cited medicinal plant species for antioxidant category which scored highest Fic value. This plant is also used for the treatment of pox (Uddin *et al*., 2017), snake bite (Khan *et al*., 2002). In the present study *Allium sativum* (garlic) is used for the treatment of heart disease management. This plant is also used for gastric, cold, fever, chest pain, reduced pressure and ringworm (Uddin *et al*., 2015a,b, Uddin *et al*. 2017). Experimental and clinical studies showed that garlic produced hypertensive effects and also induced significant reduction in systolic and diastolic blood pressure**.**

Terminalia aurjuna is used for the treatment of heartache which is also used for the same purpose reported from different area from Bangladesh (Uddin *et al*., 2012, Uddin and Hassan, 2014). This plant is also used for stomachache, cough, diabetes, menstruation, gastric pain, and dysentery (Uddin *et al*., 2006, 2012, 2017; Islam *et al*., 2014; Uddin *et al*., 2015a,b). *Terminalia arjuna* is a popular Indian medicinal plant with its bark been used for over centuries as cardiotonic. The bark has been found to contain several bioactive compounds including saponins and flavonoids (Navjot *et al*., 2014). The cardio protective effects, particularly of bark of *Terminalia arjuna* are well known. Such effects include reported protective effects of plant bark against doxorubicin induced cardio toxicity reported significant inotropic and hypotensive effect of bark, also increased coronary artery flow and protection of myocardium against ischemic damage (Sing *et al.* 2008, Dwivedi 2007).

Terminallia bellirica is used for the treatment of heart disease and also reported for stomachache, dysentery, appetizer, anemia, fever, bronchitis, constipation, asthma, vomiting, eye & menstrual disorder (Uddin *et al*., 2006, 2012, 2014, 2015 and 2017). *Tamarindus indica* is used for reducing blood pressure which is also reported from others studies from Bangladesh (Uddin *et al*., 2015, 2017). *Rauvolfia serpentina* is used for controlling high blood pressure and also used for hypertension, mental disorder, stomach ache and gastric (Islam *et al*., 2014; Roy *et al*., 2008; Uddin *et al*., 2004). *Tamarindus indica* is reported for controlling high blood pressure. This plant is also reported for the treatment of reducing pressure, diarrhea, dysentery, appetizer, constipation, impotence, abscess and jaundice (Khan *et al*., 2002; Uddin *et al*., 2012, 2015, 2017). Different parts of plant affect the LDL oxidation and macrophage inflammatory response and also nephrotoxic effects and also having antipsychotic potential helpful in preventing delaying clot formation and have immunostimulant activity (Narendra and Khurana, 2018).

Compared with previous research (Ghani, 2003; Uddin *et al*., 2006, 2012, 2014, 2015, 2017; Haque *et al*. 2017; Sajib and Uddin, 2013; Uddin *et al*., 2013) *Hylocereus undatus*, *Alternanthera paronychioides* and *Lactuca sativa* seem to be newly reported medicinal plants for cardiovascular diseases treatment . Among the three plant species *Lactuca sativa* and *Hylocereus undatus* are not native to Bangladesh but local people used these plants for cardiovascular diseases.

The plant species with high citation, Fic and Fl values can be subjected to phytochemical investigation to find new class of active compounds for the treatment of cardiovascular diseases. The findings of the present study are very preliminary. Further long term studies are needed to validate the ethnomedicinal plants used by the local people for the prevention of cardiovascular diseases in Bangladesh.

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