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Review

A Promising View of Kudzu Plant, *Pueraria montana* var. *lobata* (Willd.) Sanjappa & Pradeep: Flavonoid Phytochemical Compounds, Taxonomic Data, Traditional Uses and Potential Biological Activities for Future Cosmetic Application

Duangjai Tungmunnithum [1,*], Aekkhaluck Intharuksa [2] and Yohei Sasaki [3]

1 Department of Pharmaceutical Botany, Faculty of Pharmacy, Mahidol University, Bangkok 10400, Thailand
2 Department of Pharmaceutical Sciences, Faculty of Pharmacy, Chiang Mai University, Chiang Mai 50200, Thailand; identity.int@gmail.com
3 Division of Pharmaceutical Sciences, Graduate School of Medical Plant Sciences, Kanazawa University, Ishikawa 920-1192, Japan; sasaki@p.kanazawa-u.ac.jp
* Correspondence: duangjai.tun@mahidol.ac.th; Tel.: +66-264-486-96

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Abstract: *Pueraria montana* var. *lobata* is widely known as kudzu especially in Japan, China, Korea, and other Asian countries. This plant is an ingredient for traditional food and an herbal ingredient for traditional medicines, particular in Japan and China. There are a few reports on its cosmetic uses. Interestingly, many phytochemical compounds from this plant have been continuously reported, particularly flavonoid compounds, which are well-known as potential bioactive ingredients for cosmetics. This work aims to illustrate promising views of kudzu plant, focusing on the diversity of flavonoid phytochemical compounds, taxonomic data, traditional uses, and potential biological activities for future cosmetic applications, i.e., antioxidant, antiglycation, skin regeneration, and melanogenesis inhibitory activities.

Keywords: kudzu; *Pueraria montana* var. *lobata*; flavonoids; traditional use; cosmetic; biological activity

1. Introduction

Pueraria montana var. *lobata* (Willd.) Sanjappa & Pradeep is also known as *kudzu* for Asian people. This plant species belongs to the family Fabaceae. Since ancient times, the kudzu plant has been used by Asian people for various purposes, including as foods and herbal medicines and for its health and beauty benefits. A large number of its flavonoid phytochemical compounds have been reported [1–4]. In this era of modern research and innovation, the cosmetic sector is seeking for alternative choices of plant extracts and/or natural products containing potential bioactive compounds for cosmetic product development [5,6]. Flavonoids are the popular choice of those potential bioactive phytochems for cosmetic applications. Conversely, there are no reports to illustrate these local Asian plants with a view of their cosmetic potentials. Thus, we conducted this work to present a promising view of kudzu plant in terms of its taxonomic data, traditional uses, flavonoid phytochemical compounds and potential biological activities for cosmetic applications. Next, challenging perspectives and cosmetic research directions are also summed up in this work.

2. The Taxonomic Description of *P. montana* var. *lobata* (Willd.) Sanjappa & Pradeep

Kudzu is a perennial climbing plant with yellow hairs in almost all parts. It has a tuberous root and a stem up to 800 cm. Stipules are dorsi fixed, oblong to obovate. It has a petiolate leaf, which is green, and three-lobed leaflets, pubescent, are broadly ovate, 5–7 × 12−18 cm; its base is obovate to obliquely ovate, with abaxially dense hair; its apex is acuminate. It has racemose inflorescence, 14.5-39.7 cm, and bracts are linear or linear-lanceolate, light or dark purple. Its bracteoles are ovate. Its flower is papilionaceous, dark pink to dark purple, standard obovate, and 9.5-12.5 mm. Its wings are subequal to keel. Its stamen is diadelphous. Its ovary is superior, linear, and hairy. Its fruit is legumes, which are long elliptic, 8–11.5 mm × 4.5−10 cm, flattened, with brown hirsute (Figure 1 and Table 1).

Table 1. The important characters of *P. montana* var. *lobata* that can be used for identification.

Plant Structures	Organs	Important Character
Vegetative Structures	Root	Tuberous
	Stem	Erect
	Stipule	Dorsifixed
	Leaf shape	Broadly ovate
Reproductive Structures	Inflorescence	Raceme with inflorescence bracts
	Flower Form	Papilionaceou form
	Stamen	Diadelphous
	Ovary	Superior
	Fruit	Legumes

Flowering season: Between July and October

Distribution: Eastern to southeast Asia to Australia, America and some parts of the European Union e.g., Italy, Switzerland.

Synonyms: *Pueraria lobata* (Willd.) Ohwi, *Pueraria thunbergiana* (Siebold & Zucc.) Benth, *Pueraria triloba* (Houtt.) Makino, *Pueraria volkensii* Hosok, *Pueraria pseudo-hirsuta* T.Tang & Wang, *Pueraria novo-guineensis* Warb, *Pueraria neo-caledonica* Harms, *Pueraria koten* H.Lev. & Vaniot, *Pueraria hirsuta* (Thunb.) Matsum., *Pueraria harmsii* Rech., *Pueraria caerulea* H.Lev. & Vaniot, *Pueraria bodinieri* H.Lev. & Vaniot, *Pueraria argyi* H.Lev. & Vaniot.

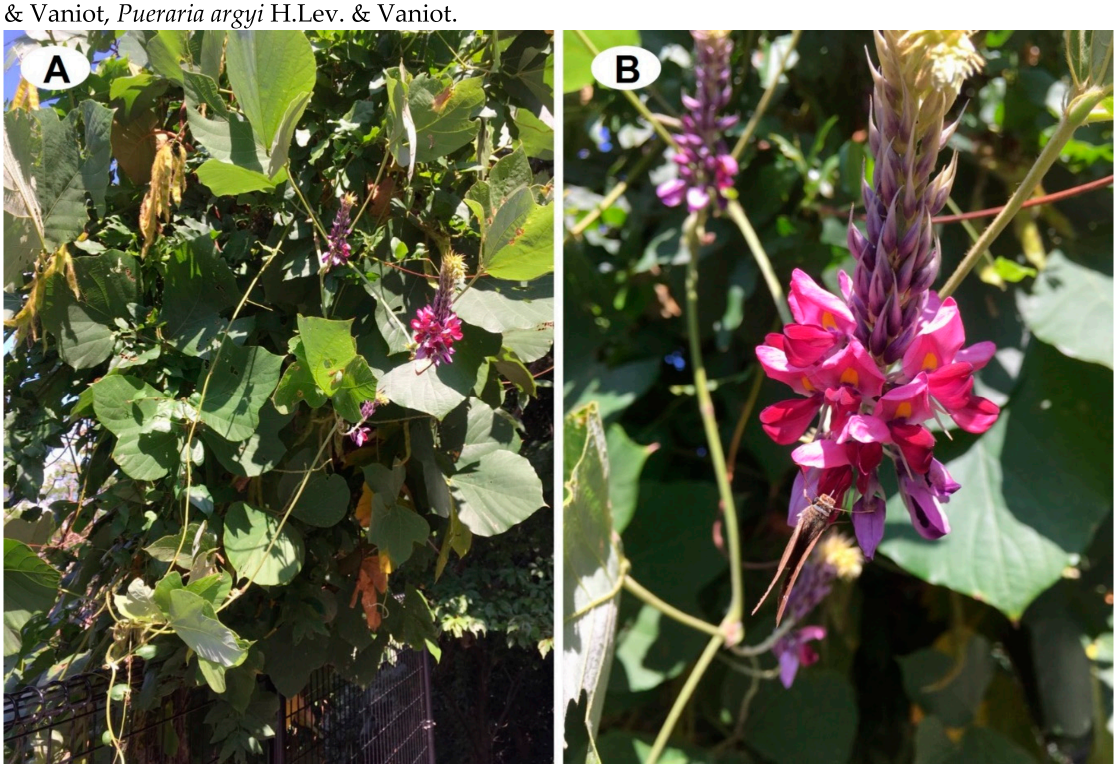

Figure 1. *Pueraria montana* var. *lobata* (Willd.) Sanjappa & Pradeep: (**A**) habitat; (**B**) inflorescence and flower. The photo in Figure 1 was taken by D.T. in September 2016 in Japan.

3. Flavonoid Phytochemicals

The tuberous root of kudzu is used as a traditional medicine in Eastern Asian countries, e.g., China, Korea, and Japan. The root was reported as a rich source of bioactive constituent. More than 70 phytochemicals were reported [7]. Polyphenols, in particular isoflavonoids, and triterpenoids with their glycosides were found as major groups of phytochemical compounds in the kudzu root [8–10]. Moreover, aromatic glycosides and minor compounds such as choline chloride, acetylcholine chloride, allantoin, and D-(+)-pinitol were also reported [1,11]. Focusing on flavonoid and some other phenolic compounds found in kudzu (Table 2), the first isolation of chemical constituents in *Pueraria* roots was done in 1959. That study indicated that the methanolic extract of the roots contained isoflavone derivatives, namely daidzein (4′,7-dihroxyisoflavone), daidzin (daidzein 7-glucoside), daidzein diacetate, daidzein dimethyl ether, genistein triacetate, and apigenin triacetate [12]. Then, Murakami isolated puerarin (8-D-glucopyranosyl-4′,7-dihydroxyisoflavone or 8-D-glucopyranosyldaidzein) from of the roots of this plant that were used as a crude drug in Japan and China [13]. Several isoflavonoid compounds were detected from the root of *P. lobata* i.e., formononetin, pueraria glycoside 1-6 (PG 1-6), and puerarol, including the known compounds [14]. Besides these, the isoflavonoids and their glycosides were isolated from the *P. lobata* root purchased from Shanghai, China, i.e., puerarin-4′-*O*-D-glucoside, 3′-hydroxypuerarin, 3′-hydroxypuerarin-4′-*O*-deoxyhexoside, 3′-methoxypuerrin, 6″-*O*-D-xylosylpuerarin, 3′-methoxy-6″-*O*-D-xylosylpuerarin, 3′-methoxydaidzin, 3′-methoxydaidzein, daidzein-7-*O*-methyl ether, 3′-methoxydaidzein-7-*O*-methyl ether or 3′-methoxyformononetin, and biochanin A [15,16]. Two new isoflavone diglucosides—formononetin 8-*C*-(*β*-D-apiofuranosyl-(1→6)-*β*-D-glucopyranoside) and formononetin 8-*C*-(*β*-D-xylopyranosyl-(1→6)-*β*-D-glucopyranoside)—as well as the known compounds, were separated from the dried roots of *P. lobata* from China [17]. Twelve phenolic constituents from the crude drug of root were determined by a microwave-assisted extraction (MAE) and ultra-high-performance liquid chromatography, together with diode array detection and time-of-flight mass spectrometry. Those 12 compounds were puerarin, puerarin-3′-methoxy-4′-*O*-glucoside, puerarin-4′-*O*-glucoside, 3′-methoxypuerarin, daidzein, daidzein-4′,7-*O*-glucoside, daidzin, genistein, genistin, mirificin, sophoraside A, and ononin [18]. In addition, a study indicated that daidzein, mirificin, puerarin, 6″-*O*-xylosylpuerarin, 3′-hydroxypuerarin, genistin, and 8-*C*-glycoside-xyloside can be used as chemical markers for discrimination between *P. lobata* and *P. thomsonii* [19]. Furthermore, Zhang and his team reported seven isoflavones from roots of this plant using high-performance liquid chromatography (HPLC) analysis coupled with electrospray ionization (ESI)-ion trap mass spectrometry analysis. The researcher found that two of them were the new isoflavonoids: neopuerarin A (8-*C*-∝-glucofuranosyl-7,4′-dihydroxyisoflavone) and neopuerarin B (8-*C*-*β*-glucofuranosyl-7,4′-dihydroxyisoflavone) [20].

Kudzu flower is also called *Gehua* or *Flos Puerariae* and has been utilized as traditional medicine for treatments of dysentery, alcohol intoxication, and alcohol abuse [7]. The flower contains a large amount of isoflavones (1.84%–2.86%), including kakkalide, irisolidone, and triterpenoidal saponins (0.43%–2.5%), which comprises kaikasaponin and soyasaponin [1]. Forty-one phytochemicals (25 isoflavones, 13 saponins, and 3 flavones) were detected in *P. lobata* flower by using ultra-high-performance liquid chromatography (UPLC) analysis coupled with quadrupole time-of-flight mass spectrometry [2]. Some isoflavones, such as puerarin, daidzin, daidzein, genistin, genistein, and biochanin A, that were found in the root were also detected in the flower in small quantities [2]. The leaves of kudzu are able to be used as a vegetable. The leaves consist of many chemical components, such as triterpenoidal saponins (kaikasaponin III) and isoflavones, namely daidzin, genistin, rutin, kakkalide, robinin (kaempferol 3-*O*-rhamnosyl (1→6) galactosyl-7-*O*-rhamnoside) and nicotiflorin (kaempferol-3-*O*-rutinoside) [3,4]. The summarizing table illustrating flavonoid phytochemical compounds and some interesting phenolics found in roots, flowers, and leaves of kudzu plant are shown in Table 2 with CAS number, extraction methods, and determination techniques.

Table 2. Flavonoid phytochemical compounds and some interesting phenolics found in roots, flowers, and leaves of kudzu.

Source	Compounds	CAS Number	Extraction	Determination Techniques	Reference
Root	apigenin triacetate	3316-46-9	solvent extraction (methanol)	column chromatography	Shibata et al., 1959 [12]
	daidzein	486-66-8			
	daidzein diacetate	3682-01-7			
	daidzein dimethyl ether	1157-39-7			
	daidzin	552-66-9			
	genistein triacetate	5995-97-1			
	puerarin	3681-99-0	solvent extraction (methanol)	column chromatography	Murakami et al., 1960 [13]
	daidzein	486-66-8	solvent extraction (acetone, methanol, buthanol)	HPLC–UV	Ohshima et al., 1988 [14]
	daidzin	552-66-9			
	formononetin	485-72-3			
	pueraria glycoside 1-6 (PG 1-6)	117060-54-5			
	puerarin	3681-99-0			
	puerarol	N/A			

Table 2. *Cont.*

Source	Compounds	CAS Number	Extraction	Determination Techniques	Reference
	3′-hydroxypuerarin	117060-54-5	solvent extraction	HPLC–APCI–CAD/MS	Rong et al., 1998 [16]
	3′-hydroxypuerarin-4′-*O*-deoxyhexo side	N/A	(petroleum ether, hexane, methanol-water 3:1, v/v)		
	3′-methoxy-6″-*O*-D-xylosylpuerarin	N/A			
	3′-methoxydaidzein	21913-98-4			
	3′-methoxydaidzin	200127-80-6			
	3′-methoxyformononetin	N/A			
	3′-methoxypuerarin	117047-07-1			
	6″-*O*-D-xylosylpuerarin	N/A			
	biochanin A	491-80-5			
	daidzein-7-*O*-methyl ether	N/A			
	puerarin-4′-*O*-D-glucoside	N/A			
	daidzein	486-66-8	solvent extraction (methanol-water 3:1, v/v)	HPLC/MS	Rong et al., 1998 [15]
	formononetin	485-72-3			
	genistein	446-72-0			
	4′-methoxypuerarin	92117-94-7			
	daidzein	486-66-8	solvent extraction (water, methanol)	HPLC/MS	Sun et al., 2008 [17]
	daidzin	552-66-9			
	formononetin 8-*C*-[β-D-apiofuranosyl-(1→6)]-β-D-glucopyranoside	N/A			
	formononetin 8-*C*-[β-D-xylopyranosyl-(1→6)]-β-D-glucopyranoside	N/A			
	genistin	529-59-9			

Table2. *Cont.*

Source	Compounds	CAS Number	Extraction	Determination Techniques	Reference
	3′-methoxypuerarin	117047-07-1	microwave-assisted extraction	UHPLC–DAD–TOF/MS	Du et al., 2010 [18]
	daidzein	486-66-8			
	daidzein-4′,7-*O*-glucoside	N/A			
	daidzin	552-66-9			
	genistein	446-72-0			
	genistin	529-59-9			
	mirificin	103654-50-8			
	ononin	486-62-4			
	puerarin	3681-99-0			
	puerarin-3′-methoxy-4′-*O*-glucoside	N/A			
	puerarin-4′-*O*-glucoside	N/A			
	sophoraside A	868409-19-2			
	3′-hydroxypuerarin	117076-54-5	solvent extraction (methanol-water 95:5, v/v)	HPLC–ESI/MS	Zhang et al., 2011 [19]
	3′-methoxypuerarin	117047-07-1			
	6″-*O*-apiosylgenistin	N/A			
	6″-*O*-xylosylpuerarin	N/A			
	biochanin A	491-80-5			
	daidzein	486-66-8			
	daidzin	552-66-9			
	formononetin	485-72-3			
	genistein	446-72-0			
	genistein 8-*C*-glucoside-xyloside	N/A			

Table 2. *Cont.*

Source	Compounds	CAS Number	Extraction	Determination Techniques	Reference
flower	genistin	529-59-9	solvent extraction	HPLC/MS	Zhang et al., 2010 [20]
	mirificin	103654-50-8			
	puerarin	3681-99-0			
	puerarin-4′-*O*-glucoside	N/A			
	sophoraside A	868409-19-2			
	neopuerarin A	N/A			
	neopuerarin B	N/A			
	irisolidone	2345-17-7	solvent extraction (60% ethanol)	HPLC–ELSD	Niiho et al., 2010 [1]
	kaikasaponin I	N/A			
	kaikalide	58274-56-9			
	soyasaponin I	51330-27-9			
	6-hydroxybiochanin A-6,7-di-*O*-glucoside	N/A	solvent extraction (methanol-water 60:40, v/v)	UPLC-–QTOF/MS	Lu et al., 2013 [2]
	6-hydroxygenistein-7-*O*-glucoside	N/A			
	6′-hydroxygenistein-6,7-di-*O*-glucoside	N/A			
	abrisapogenol F-*O*-rhamnosyl-pentosyl-glucuronide	N/A			
	astragaloside VIII	119556-00-2			
	azukisaponin I	82793-02-0			
	baptisiasaponin I	N/A			
	biochanin A	491-80-5			
	biochanin A-*O*-hexoside	N/A			
	biochanin A-*O*-pentosyl-hexoside	N/A			

Table 2. *Cont.*

Source	Compounds	CAS Number	Extraction	Determination Techniques	Reference
	daidzein	486-66-8			
	daidzin	552-66-9			
	dihydrokaempferol-*O*-hexoside	N/A			
	gehuain	N/A			
	genistein	446-72-0			
	genistein-*O*-pentosyl-hexoside	N/A			
	genistin	529-59-9			
	glycitein	40957-83-3			
	glycitein-*O*-pentosyl-hexoside	N/A			
	glycitin	40246-10-4			
	irisolidone	2345-17-7			
	irisolidone-*O*-hexoside	N/A			
	kaikasaponin I	117210-04-5			
	kaikasaponin II	117210-05-6			
	kaikasaponin III	115330-90-0			
	kakkalide	58274-56-9			
	kakkasaponin I	N/A			
	kakkasaponin II	N/A			
	kakkasaponin III	N/A			
	luteolin	491-70-3			
	phaseoside IV	163597-20-4			
	puerarin	3681-99-0			
	rutin	153-18-4			

Table 2. *Cont.*

Source	Compounds	CAS number	Extraction	Determination techniques	Reference
leaves	soyasaponin I	51330-27-9	solvent extraction (methanol)	column chromatography	Kinjo et al., 1998 [3]
	soyasaponin IV	108906-97-4			
	tectorigenin	807636-25-5			
	tectorigenin-7-*O*-xylosylglucoside	231288-19-0			
	tectorodin	N/A			
	daidzin	552-66-9			
	genistin	552-66-9			
	kaikasaponin III	115330-90-0			
	kakkalide	58274-56-9			
	nicotiflorin	17650-84-9			
	robinin	301-19-9			
	rutin	153-18-4			
	robinin	301-19-9	solvent extraction (methanol)	HPLC/MS	Lau et al., 2005 [4]

N/A: not available, HPLC-UV: high-performance liquid chromatography-ultraviolet-visible spectrometry, HPLC-APCI-CAD/MS: high-performance liquid chromatography–atmospheric pressure chemical ionization–collision-activated decomposition/mass spectrometry, HPLC-MS: high-performance liquid chromatography/mass spectrometry, UHPLC-DAD-TOF/MS: ultra-high-performance liquid chromatography–diode array detection–time-of-flight/mass spectrometry; HPLC-ESI/MS: high-performance liquid chromatography–ESI-ion trap/mass spectrometry, HPLC-ELSD: high-performance liquid chromatography–evaporative light scattering detector, UPLC-QTOF/MS: ultra-high-performance liquid chromatography–quadrupole time-of-flight/ mass spectrometry.

4. Traditional Uses (Past to Present)

Kudzu is a native plant in eastern Asia and some areas of southeast Asia. Furthermore, this plant was introduced to several parts of the world and has become an invasive species in some nations, especially in the United States [21,22]. The first anecdote of kudzu was described in approximately 1000–500 BC in Shih Ching, Chinese classical poetry [7]. Kudzu is one of the most popular herbal plants in traditional oriental medicine. Two parts of kudzu have been used as herbal medicine: (1) the root, which is called Gegen or Radix *Puerariae lobatae* and (2) the flower, which is named Gehua or *Puerariae flos*. Gegen referred to the roots of *P. lobata* as one of the oldest herbal medicines in Chinese traditional medicine [23]. It was first written in the *Shennong Bencao Jing* (the *Devine Husbandman's Classic of Chinese Material Medica*) during the Western Han Dynasty (between 206 BC and 8 AD) for relieving fever, diarrhea, and emesis [7]. Moreover, in the classic medical book *A Treatise on Fevers* (Shang Han Lun), dated in 200 AD, the usage of Gegen Tang (a decoction containing kudzu root as the major component for curing neck stiffness, lack of perspiration, and aversion to air drafts) was mentioned [24]. It was employed to treat an alcohol-related problem, for example, as an anti-intoxication agent in 600 AD and an anti-dipsotropic agent in 1200 AD, as recommended by Li Shi-Zhen, the notorious physician, herbologist and acupuncturist in Chinese history [19,23]. Almost every part of kudzu has been used for many purposes. For example, leaves, buds, and sprouts have been consumed as a vegetable in Korea [25]. Their tuberous roots have been utilized as a source of starch, which is an essential material for cooking, and also used as food in Japan [26]. To date, the root of this medicinal plant is officially listed in the People's Republic of China and Japanese *Pharmacopoeia* for the treatment of various ailments [7]. Its flower, a showy red-purple petal, is usually mentioned in haiku, poetry, and other Japanese literature [27]. Currently, both roots and flowers of kudzu are used as a dietary supplement and functional food, including for cosmetics, because it is a rich source of phytochemicals and nutrition.

5. Potential Biological Activities of Flavonoids from *P. montana* var. *lobata* for Cosmetic Application

In this section, the biological activities of flavonoid phytochemical compounds from *P. montana* var. *lobata* that have potential for cosmetic applications in this recent decade will be provided. We conducted the literature search using both the present scientific name and various synonyms that represent this kudzu plant. The keyword: flavonoid, biological activity, *Pueraria montana* var. *lobata* or its synonyms have been employed. More than 111 publications were found. Then, we extracted the related publications focusing on cosmetics issues. Interestingly, 1/10 of these hundred publications met our criteria, which means that a huge number of biological activities of kudzu plant in term of the cosmetic perspective are waiting to be discovered. According to this recent work, the four major potential biological activities of flavonoids from *P. montana* var. *lobata* are highlighted as described below.

5.1. Antioxidative Activity

Bebrevska and her team investigated the major phytochemical compounds using the HPLC validation method and investigated antioxidant activity of kudzu plant from 50% ethanolic root extract in in vivo animal model. Their results indicated that the main phytochemicals of this plant is puerarin, which showed the antioxidant potential without toxicity at 10× the treatment dose (50 mg/kg puerarin) for 21 days [28], whereas the minor phytochemical compounds, daidzin, daidzein, genistin, genistein, isoflavonoids 3′-hydroxypuerarin, 6″-xylosylpuerarin, and 3′-methoxypuerarin, were also detected by HPLC analysis. In the same year, Kim and his Korea research team determined antioxidative potential of the isolated compounds and the extracts from nine medicinal plant species; the result proved that puerarin and genistein flavonoids from kudzu root contain at least a 10-fold greater total oxyradical scavenging capacity than that of glutathione [29]. After that, Xiaoming and the Chinese research group also confirmed the in vitro antioxidant potential of this plant using hydroxyl and superoxide radical scavenging assays [30]. Besides this, the antioxidant activity of this plant was also reported in its flowers. The Chinese research team of Han studied the isolated flavonoid phytochemical compound, 4′,5,7-thrihydroxy-6-methoxyisoflavone-7-*O*-β-d-glucopyranoside, or the so-called tectoridin, as well as tectorigenin in the aglycone form, and compared them with the tectorigenin sodium sulfonate. They found that the high water-solubility and antioxidant properties of tectorigenin sodium sulfonate which is the chemical modified flavonoid are better than those of tectorigenin and tectoridin [31]. Currently, Huang, Zhang, and Xue published their work on the increasing of antioxidant activity of the main isoflavones from this plant using mixed fermentation with *Monascus purpureus* [32]; the antioxidant potential was determined by DPPH, OH, FRAP and total antioxidant activity. In 2019, Son and the Korea research team conducted the research comparing major phytochemical compounds and biological activities between leaves, sprouts, stems, aerial parts, and roots; the results proved that kudzu leaves are a better source of isoflavones as well as antioxidant activity [25].

5.2. Antiglycation Activity

Glycation is commonly known as an aging reaction that is naturally occurring on the skin. This process can be increased regularly or rapidly with age depending on the individual. Gasse and the American research group suggested puerarin as one of the effective antiglycation molecules from natural plant sources tested on living human skin explants [33]. In this recent decade, there have been many research teams that showed that the major phytochemical compounds, especially puerarin from kudzu root extract, exhibit the inhibitory activity on the formation of advanced glycation end products (AGEs) related to skin-aging etiology [33–35]. This flavonoid compound from the kudzu medicinal plant is interesting to be investigated as an alternative choice of bioactive compounds for antiaging products.

5.3. Skin Regeneration Activity

Skin regeneration is well-known for anti-skin-aging and wound healing. Growth of skin epidermal keratinocytes is associated with this process. When skin is injured, epidermal keratinocytes will migrate and proliferate with simultaneous synthesis of collagen when the skin is injured. This promotes skin proinflammatory activity and epithelialization, resulting in skin regeneration and wound healing. Kim and his Korean team conducted their research on isoflavonoids from the flower of kudzu plant, whose skin-regenerating effect was still unknown at that time [36]. They investigated the skin-regenerative potential of isoflavonoids in human epidermal keratinocytes (HaCats) and found that it induced type I and IV collagen synthesis in HaCats, and the treatment with these isoflavonoids increased sprout outgrowth in HaCats [36]. The results suggest that these phytochemical compounds may participate in skin regeneration by promoting migration, proliferation, and collagen synthesis.

5.4. Melanogenesis Inhibitory Activity

Nowadays, white, clean skin is the trend, and a part of the satisfactory appearance of many women, especially in Asia. Melanin plays a major role to determine skin color, there are many research interests focusing on anti-melanogenesis from natural sources. The research study on melanogenesis inhibitory of kudzu plant was reported using the plant name: *P. thunbergiana* [37], which is the synonym of *P. montana* var. *lobate* (http://www.theplantlist.org/tpl1.1/record/ild-29298, Accessed on October 14, 2019) and refers to the same kudzu plant. Han and his research team studied the aerial part of kudzu plant extract and its flavonoids potential on anti-melanogenesis in the B16F10 melanoma cell line [37]. They demonstrated that the extract from the aerial part of this plant consists of anti-melanogenesis activity in in vitro study via two mechanisms by activating Akt/GSK-3b and interrupting maturation of tyrosinase by inhibiting a-glucosidase.

6. Next Challenging Perspectives and Research Directions

The next challenging perspectives and research directions of kudzu plant towards the theme of cosmetic applications are listed as follows: (1) The kudzu medicinal plant is one of the potential raw plant materials for cosmetic product development. However, more research studies of this plant are required, especially about its biological activities. According to our critical review, the flavonoids biological activities of this herbal plant provided interesting results. However, there are not many studies focusing on this kudzu plant. (2) The previous research on the kudzu plant used both the accepted name *Pueraria montana* var. *lobata* (Willd.) Sanjappa & Pradeep as well as the synonyms, for example, *P. thunbergiana,* to publish their works. Therefore, the researchers who are interested in conducting future research on kudzu plant should be concerned to search for its synonyms in their literature review before starting experimental designs to answer their research questions. (3) The types of flavonoid phytochemical compounds in the different parts, such as root, leaf, flower and so forth, of these medicinal plants are different, which may possibly be provided for different biological activities. This should be a point of concern for cosmetics companies to select the part that provides the most potential for expected biological activity for their cosmetic products. (4) The previous study on the toxicity of the kudzu plant mainly focuses on the extract; even both acute toxicity and subchronic toxicity studies of this plant extract indicated its safety in animal models [38]. The toxicity test of the bioactive phytochemical compounds should be confirmed before the development of cosmetic products. (5) The kudzu plant has a wide-range distribution and is easy to grow. Interestingly, there are currently no report on the geographic effect on flavonoid compounds of the kudzu plant. However, some species that are widely distributed, such as flax [6] and other economic plants were studied, and the results indicated that cultivar type, geographic site, and cultivation time influence phytochemical compounds and biological activities.

7. Conclusions

Pueraria montana var. *lobata* (Willd.) Sanjappa & Pradeep, also known by the well-known vernacular name kudzu, has long been used as food, herbal medicine, and cosmetic ingredient in Asia since ancient times. Most of the previous works focus on the potential of this plant as food and traditional medicine, but a small number of modern research studied on the cosmetic potential of this species. Interestingly, the results from these small research numbers exhibited the potential of the kudzu plant for cosmetic applications, such as antioxidative, antiglycation, skin regeneration, and melanogenesis-inhibitory activities. Nevertheless, more research on the biological activities for cosmetic proposes should be done in future work, and the mechanism of action of the targeted biological activities should be intensively investigated to confirm its cosmetic potential.

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