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Jatropha curcas

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This paper revie s the current status of studies on *Jatropha curcas* in China. *Jatropha curcas* has been gro n in China for more than 300 ears. It is mainl distributed in the south est from the Yunnan-Gui hou Plateau to the hot and dr Three-River Valle ith hot monsoon climate and the southeast in the provinces of Fujian, Guangdong, Guang i, Hainan and Tai an along the coast. The regions here it occurs have annual rainfall >500 mm and average annual temperature greater than 19 C. It occurs on a ide range of soil regimes in these regions. In China the jatropha usuall blossoms and bears fruits onl once a ear, but there are also instances of t o or more o erings per ear. In some small but high ielding pilot areas, dr fruit output is reported to be 9,000 12,000 kg per ha, hereas in large plantings the output averages onl about 1,800 kg per ha. In order to contribute to sustainable production of jatropha, further studies focused on different ecot pes, improvement of seed qualit , plantation techniques, o ering and fruiting characteristics, and harvest and post-harvest handling of seeds are required. More research on biomedicinal potential of various parts of the plant and more information on the actual and potential markets is needed to reali e the full potential of jatropha.

Bene ts · Biodiesel · Botan · China · Distribution · *Jatropha curcas*

M. Ye
College of Forestr and Horticulture, Sichuan Agricultural Universit , 625014 Ya'an, People's Republic of China

C. Li
College of Animal Sciences, Ministr of Education Ke Laborator of Molecular Animal Nutrition, Zhejiang Universit , 310029 Hang hou, People's Republic of China

G. Francis · H. P. S. Makkar (✉)
Institute for Animal Production in the Tropics and Subtropics (480b), Universit of Hohenheim, 70593 Stuttgart, German
e-mail: makkar@uni-hohenheim.de

The e ploitation of bioenerg has recentl attracted much scienti c and commercial attention as a means of addressing the looming energ crisis. China is alread the second largest bu er of crude oil orld- ide, and the demand for oil is increasing due to its fast gro ing econom . In the conte t of the search for indigenous sources of rene able liquid fuels, *J. curcas* (Ph sic nut) has received increasing interest since the beginning of the 21st centur (Dong 2004; Fei et al. 2005; Lin 2004; Min et al. 2005; Su et al. 2006; Tian et al. 2005; Xin 2005).

Jatropha curcas is a multipurpose shrub or small tree belonging to the famil of Euphorbiaceae ith man attributes and multiple uses. In man countries, it has been used to prevent or control erosion, reclaim land, and for live fencing. Recentl , it is also being planted as a commercial crop, but it gro s mainl in the ild. The plant has graduall attracted increased interest for biodiesel, and increasing farmer income. In China, there ma be a basis for emerging commerciali ation of jatropha. A more comprehensive evaluation of its multifaceted potential is needed to bring the e pected economic, social and environmental bene ts for the countr as a hole.

This paper revie s jatropha resources, distribution, biolog , and ecolog . It is hoped that the state-of-the-art information provided here ill stimulate research and development leading to more intensive, ef cient, and sustainable utili ation of jatropha.

Provenances and distribution

Jatropha curcas (Ph sic nut) is a shrub or small tree belonging to the famil of *Euphorbiaceae*. There are 175 species of jatropha plants in the orld (Anon mous 1996), of hich ve are present in China (Anon mous 1996). These are *J. curcas* L., *J. podagrica* Hook, *J mutifida* L., *J. gossypiifolia* L. and *J. integerrima* Jacq. In China *J. curcas* L. has man alternate names, for e ample Xiaotong i (Pan hihua), Shuhuasheng (Hainan), Huang hongshu (Guangdong) and Jiahuasheng (Guang i). This plant has mainl been developed as a bioenerg plant, hereas *J. podagrica Hook* and *J. integerrima* Jacq are mainl promoted as ornamental plants (Anon mous 1996; Shui 2005).

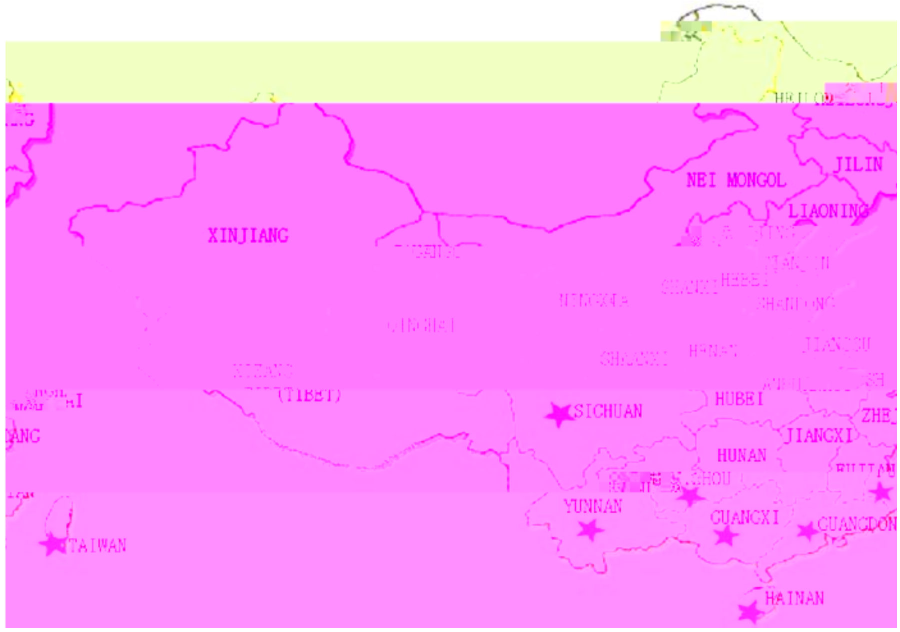
The origin of jatropha in China is unkno n. It is reported that this plant has been gro n in China for more than 300 ears and it has become naturalised. *J. curcas* is idel gro n in Central and South America, Southern Asia, and Central Southern Peninsular Asia including countries such as M anmar, Thailand, Laos, Cambodia, Mala sia and India (Anon mous 1965, 1996; Shui 2005). In China, this plant is distributed from 98 6′ to 121 31′E to 18 14′ to 27 55′N. There are distinctive concentrations of occurrence of jatropha in the south est and the southeast of the countr . Jatropha occurs from the Yunnan-Gui hou Plateau to the dr hot valle of Three-Rivers (Nu River, Jinshajiang River, Lancang River). This area includes the est of Pan hihua prefecture in Sichuan, most of Yunnan province and the south est of Gui hou province. In Sichuan province, jatropha is found in Pan hihua, Yanbian, Mi i, Ningnan, Dechang, Xichang, Huili, and Jin ang Yan uan counties (Li et al. 2006b). In Yunnan province, jatropha is idel gro n in Chu iong Yi Autonomous Cit , Dali, and Honghe, hich are located around the Three-River Valle in the est and south est of Yunnan (Zhang et al. 2001a). Jatropha is also present in the south est Gui hou province, in the dr hot valle of Nanpan River, Beipan River and Hongshui River (Fig. 1). The vertical distribution range of jatropha consists of piedmont, ravines, slopes and alluvial plains, at an altitude of 600 1,800 m (Zheng 1998) Jatropha is mainl present in areas belo an altitude of 1,600 m, ith the highest altitude being 2,000 m (Zheng 1998).

In the Southeast region, jatropha gro s in Fujian, Guangdong, Guang i, Hainan and Tai an along the southeast coast (Anon mous 1998). These areas have tropical and subtropical maritime climate. The vertical distribution of jatropha is 50 1,500 m altitude. Jatropha is common in Hainan Island.

In December 2005, the Sichuan Provincial Approval Board for Forest Breeding identi ed t o improved clones of jatropha: Chen Fang in Sichuan (CSC) High-to icit 1 and CSC High-oil 63 (Huang and Han 2006; Wu et al. 2008). The plants of the former clone gro to a height of 5 m, have smooth bark, and a large number of t igs. The average to ic protein content of seeds is 4.2%, hich as 30.4% higher than the parent plant. It is relativel tolerant to drought and pests- and diseases and can be gro n on poor and degraded soil. This provenance normall gro s belo elevations of 1,800 m in the basins of Yalong River and Jishajiang River, and belo 1,600 m in branch-valle areas in Huili count of Liangshan state and Yanbian count of Pan hihua Prefecture. It could be introduced into Yunnan, Guang i and Gui hou, here the climate is similar to the above areas.

The CSC High-oil 63 plant has small, sub-rounded fruits, ith thin capsule sheath and seedcoat. The kernel is moderate and plump, ith oil content of 62 65%, hich as 15.6% more than the parent plant (Huang and Han 2006).

The to icit of *J. curcas* is attributed to the presence of phorbol esters (Makkar et al. 1997). It



. Distribution of *Jatropha curcas* in China (the *stars* indicate provinces here Jatropha occurs)

ould be interesting to compare the phorbol ester content in the kernels of seeds from CSC High-to icit 1 and CSC High-oil 63 clones.

Morpholog

Jatropha curcas is a deciduous shrub or small tree that gro s to a height of about 5 m. It has smooth bark, sturd branches, and thick paper leaves. The leaves are 8 to18 cm ide, shin and glabrous, ith e iguous and pilose stipules. The petiole is 10 16 cm long. The in orescence is monoecious, but the individual o ers are unise ual. The male o er has 5 sepals, 5 petals and 10 androeciums. The petals are lanceolate and t ice the length of sepals. The female o er has no petals. The fruit of *J. curcas* is a capsule, 3 4 cm long and 2.5 3.0 cm ide. The immature capsule is subsphaeroidal and green turning to ello and later to dark bro n hen ripe. The capsule develops cracks hen full dr . The seeds, 1.5 2.0 cm long and 1.0 1.2 cm ide, are rich in oil, elliptical, and black (Anon mous 1996, 1972).

Biological characteristics

Root

Jatropha has ell developed roots. The taproots are long and prominent and the lateral roots are also ell developed. In loose soil, the taproot can be t ice the length of the aerial portion. When jatropha is 18 25 cm tall, the tap root ma be 40 50 cm long ith 6 10 lateral roots that are 30 45 cm long (Meng Ye, unpublished observations). Li et al. (2006a, b) isolated 57 strains of endoph tic fungi from the roots and stem of jatropha, among hich 2 strains are antagonistic to *Colletotrichum gloeosporioides*.

Stem

Under hot-dr conditions as in Pan hihua cit , the annual height increment of the ild gro ing jatropha plants is about 10 cm in the rst and second ear, and 20 and 40 cm in the third and fourth ear, respectivel . After ards the plant begins to gro rapidl . In the case of planned afforestation, the plant can gro 40 50 cm tall in the rst ear and above 100 cm in the second ear. In the middle or the last ten da s of Februar hen the temperature is near 15 C, the plant begins to sprout and gro . In November, the leaves senesce. The branches, trunk, and roots of jatropha are succulent. Diseases and insect pests are seldom observed in the ild trees (Meng Ye, unpublished observations).

Flowering and fruiting

Plant o ering and breeding characteristics ere reported b Chang- ei et al. (2007). Fruit is produced through apomi es but not ind pollination. Jatropha is self compatible, but normall sho s outcrossing and requires pollinators. A tendenc to promote enogam and minimi e geitonogam as also evident. Jatropha begins to bear fruits 3 to 4 ears after being planted in the dr regions here it normall occurs. It ill reach the full fruit period in the fth ear. Usuall the plant bears fruits once a ear. In Pan hihua district of Sichuan, it o ers in April and the fruits ripen in September to October (Kun et al. 2007; Li et al. 2006a, b). In the sunn and hot areas such as Xishuangbanna and De Hong of Yunnan province, the plant can blossom t ice a ear ith a second o ering in October, the fruits of hich mature in Februar ne t ear (Wu and Chen 1988). With suf cient ater-suppl , jatropha blooms throughout the ear (Meng Ye, unpublished observations).

It is estimated that in some small but high ielding areas ith fertile soil and suf cient ater-suppl , dr fruit output is as high as 9,000 12000 kg per ha (ield from small areas up to one hectare), hereas in large ild gro ing areas, the output is onl about 1,800 kg per ha (Zhang et al. 2001a). Ho ever, the former gure appears to be ver high and dif cult to attain under routine plantation conditions (Meng Ye, personal observations).

Seed characteristics

The oil content of seed kernel from 11 counties varied from 51.3 to 61.2% (Li et al. 2006b). Seed (kernel and shell) collected from other regions of China had an oil content of 31.4 37.6% (Wang et al. 2008). These values ere similar to those obtained for seeds from other regions (Table 1). In Yuanmou count of Yunnan, the oil content of jatropha seed kernels as 55.5% (Li et al. 2006b). The total amino acid content of kernel meal (defatted kernels; kernel is the shell-free hite portion of the seed) as relativel high, up to 47.6% of the total eight. Contents of essential amino acids in jatropha are higher than those of man commonl used feed ingredients (Makkar et al. 1998; Zhang et al. 2001a, b; Table 2). The non-protein nitrogen in jatropha meal formed onl 9.0% of the total nitrogen in the jatropha meals suggesting a high level of true protein (Makkar et al. 1998). The high protein ef cienc in rats and the rapid gro th observed in sh fed non-to ic jatropha meal (Makkar and Becker 1999) suggested that the protein qualit of jatropha kernel meal is ver high.

Seed Characters of *Jatropha curcas* from 11 counties in south est China

Parameters	Range
100-seed eight range (g)	48.2 72.3 (49.0 86.0)
Average 100-seed eight (g)	56.9 (0.64)
Percent kernel eight of seed	61.5 68.9 (53.9 64)
Oil content of kernels (%)	51.3 61.2 (43.0 59.0)

Source: (Li et al. 2006b; Zhang et al. 2001a)

Values in the parenthesis are of 18 provenances from different countries (Makkar et al. 1997)

Temperature, moisture, and soil

Luo et al. (2005a) studied the cold injur and cold-resistance properties of jatropha seedlings under different temperatures (25, 12, 8 and 4 C) for time periods of 1, 2, 3 and 4 da s. It as observed that temperatures <8 C resulted in signi cant injur to seedlings. Temperatures >12 C had no signi cant negative effect. Young seedlings died hen e posed to frost. Liang et al. (2007) demonstrated the role of photos nthesis-related proteins and h drogen pero ide scavenging in the cold response mechanism of jatropha seedlings. Zhang et al. (2008) linked a betaine aldeh de deh drogenase gene from jatropha to environmental stress; the e pression of this gene as found to increase in leaves in response to drought, heat and salt concentration.

Jiang et al. (2004) compared drought-tolerance of 10 tree species and sho ed that jatropha had the greatest drought tolerance. Water stress did not change protein content in the vegetative organs and seeds (Chen et al. 2003). Jatropha gro s under a ide range of soil regimes ranging from alluvial soil to red lateritic soil. It gro s ell in deep, fertile and loose soil, such as those in ravines (Meng Ye, unpublished observations). Ho ever, jatropha does not tolerate stick , impermeable, and aterlogged soils.

Sunlight

Jatropha requires suf cient sunshine, and cannot gro ell under shade. Zhang and Fan (2005) investigated the photos nthetic response of jatropha irrigated in such a a as to maintain soil moisture in the pots at

2 Amino acid concentrations of *Jatropha curcas* seeds

Amino acid	Seed meal (%)	Kernel meal (%)	Amino acid	Seed meal (%)	Kernel meal (%)
Threonine	0.87	1.92	Serine	1.14	2.59
Methionine	0.37	0.87	Glutamine	3.83	8.73
Isoleucine	1.04	2.14	Gl cine	1.06	2.29
Leucine	1.66	3.68	Alanine	1.15	2.49
L sine	0.87	1.86	C stine	0.32	0.88
Phen lalanine	1.01	2.28	T rosine	0.33	1.46
Arginine	1.09	6.07	Histidine	0.55	1.24
Valine	1.14	2.41	Proline	0.93	2.03
Aspartic acid	2.23	4.68	Total	20.40	47.62

Source (Zhang et al. 2001b)

Seed meal, solvent e tracted seed cake. The seed cake is produced hen hole jatropha seeds are pressed for oil e traction in an e peller (scre press)

Kernel meal, solvent e tracted jatropha kernel

65% or under dr condition here the soil moisture in the pots as 45%. With irrigation, the light compensation point of photos nthesis and light saturation point ere 163.41 and 1,046.73 µmol m^2 s, respectivel . The diurnal variation in the rate of photos nthesis sho ed a t o-peaked curve. Under the dr condition, the light compensation point and the light saturation point of photos nthesis ere 193.82 and 697.08 µmol m^2 s, respectivel .

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Seedlings

A germination of 80 90% has been obtained for seeds collected during October to December in Pan hihua. The seed had been dried in shade, and stored dr indoors. The seeds retained germinating abilit for >2 ears (Deng et al. 2005). Jatropha planting material is mainl raised through seedlings currentl .

Cuttings

Cuttings can be generated from one or t o ear old t igs ith 15 20 cm length. The proper time for raising cuttings is from the last ten da s of August to the rst half da s of September in Gui hou. Cuttings ma be covered ith an arched roof made of plastic lm, in hich the temperature should not e ceed 30 C. Rooting begins after 30 45 da s of planting, and the generation rates from cuttings range from 50 to 80% (Li 2005). Roots of the cuttings are not as robust as those of the seedlings.

Tissue culture

The e plants of h pocot l, leaf blade and petiole from jatropha ere cultured on Murashige-Skoog (MS) medium ith indole-3-but ric acid (IBA) and 6-ben ladenine (BA) for induction of callus (Lu et al. 2003; Wei et al. 2004a). The most suitable combination for shoot regeneration from callus as MS medium ith 0.1 mg l^{-1} IBA and ith 0.5 mg l^{-1}BA. Results obtained else here sho ed that ma imum shoot generation as attained in an MS medium ith 1 mg l^{-1} IBA and 3 mg l^{-1}BA (Shrivastava and Banerjee 2008). Regenerated shoots could be rooted on gro th regulator-free MS medium and could be transplanted in soil after simpl hardening for several da s (Lu et al. 2003). Regenerated plants ith ell developed shoots and roots ere successfull transferred to greenhouse, and the survival rate as 81.6% (Lu et al. 2003). Recentl , use of additives such as arginine in addition to IBA and BA into the culture medium as reported to result in 100% survival of tissue-cultured jatropha plants (Shrivastava and Banerjee 2008).

Silviculture

Jatropha can be used for afforestation hen depth of the soil is >30 cm. Jatropha performs ell hen planted for landslide protection along slopes (Chen and Zheng 1987; Yang 2006). The mean annual temperature of the silvicultural locations needs to e ceed 19 C for jatropha to establish. In the dr hot Pan hihua valle , elevations lo er than 1,600 m ere suitable silvicultural regions for jatropha (Yang 2006).

There are several silvicultural methods for jatropha: direct seeding and planting nurser raised seedlings and cuttings. In direct seeding, soil moisture needs to be high. The recommended number of seeds is 4 7 per hole, ith 3 5 cm soil covering. This method is eas and cheap. Ho ever, oung seedlings are easil affected b changes in the environment. The pests, diseases, and drought ma result in lo rate of emergence and uneven seedling gro th. The appropriate season for seedling planting is in June or Jul . Cuttings are planted in Februar or March before sprouting (Sichuan Forestr Department, Chengdu; personal communication). This method appears to be feasible in high moisture soil, and tends to be e pensive on a large scale.

Plantations are often initiall stocked ith 1,500 1,800 trees per hectare at planting. Pits of si e 50 × 50 × 40 cm are prepared for planting the seedlings. Basic fertili ation ith super phosphate and farm ard manure is recommended during planting. Cultivation and plantation methods used in other parts of the orld have been described in Achten et al. (2008).

Jatropha curcas

The research on jatropha has traditionall focussed on its to ic chemical components (Table 3), seed oil (Li et al. 2000; Liao et al. 2003; Liu et al. 2005; She et al. 2005a, She et al. 2005b) and e traction technolog (Liu et al. 2005, b; Zeng et al. 2005).

Wei and Liu (2002) studied the pharmacognos of jatropha as a to ic medicinal plant and described its botanical characters in detail. Song and Chen (2002) anal ed the clinical features in patients ho accidentall consumed jatropha seeds. The poisoned patients had multiple dosage-dependant to icit s mptoms. Treatment ith general antito ins as suggested as the effective therap . Huang et al. (1991) isolated three to ic proteins from jatropha, and found their apparent molecular eight to be about 34, 27, and 9.5 KDa, respectivel . The rst sho ed the strongest to icit , ith LD50 to mouse at 6.39 mg after celiac injection. Jatropherol (JaI), a diterpene separated from jatropha seed oil as sho n to have no contact but strong stomach to icit to silk orm (Li et al. 2005). JaI damaged tissue structure of the midgut in silk orm, ith damage to the insect digestion. It as suggested that damages to insect digestion s stem induced b JaI might be an important to icological mechanism of JaI to silk- orm (Table 3).

Zeng et al. (2004) determined the in vitro antibiotic effect of an alcohol e tract from jatropha leaf on *Escherichia coli* and *Staphlococcus aureus*. The e tract inhibited *E. coli* and *S. aureus*, and the activit against *E. coli* as better than that against *S. aureus*. Li et al. (2004) prepared the poisonous protein, seed oil and its ethanol e tract from jatropha seed and studied the insecticidal activit of e tracts against *Lipaphis erysimi* (Kaltenbach). The poisonous protein sho ed no signi cant effect to *L. erysimi*, hile seed oil possessed strong contact to icit . The contact to icit of the ethanol e tract of seed oil against the aphid as greater than that of the original seed oil. Cheng et al. (2001) compared the molluscicidal ef cac of jatropha seed e tract from Yunnan (China) and Mali (Africa) and found that there as no difference bet een the e tracts. The phorbol

Summar of ndings in biomedical researches on *Jatropha curcas* in China

Items	Findings	References
Toxicity		
To in protein isolation	Three to in proteins ere isolated, their apparent MW ere about 34, 27 and 9.5 kDa, respectivel	Huang et al. (1991)
Clinical features in patients ho accidentall consumed the seeds	The poisoned individuals had multiple to ic s mptoms; treatments ith general antito in and protection to vital organs ere effective therap	Song and Chen (2002)
To icit of Jatropherol to 3rd-instar silk orm	The Jatropherol had no contact to icit but had strong stomach to icit	Li et al. (2005)
Bacteriostasis and insecticidal activity		
Comparison of molluscicidal ef cac	There ere no differences bet een the e tracts from *J. curcas* plants from Yunnan province and Mali	Cheng et al. (2001)
In vitro antibiotic effect on chicken pathogens	The alcohol e tract from *Jatropha* leaf inhibited chicken *Escherichia coli* and *Staphlococcus aureus*	Zeng et al. (2004)
Insecticidal activit of seed e tract against Lipaphis er simi	The poisonous protein sho ed no signi cant effect, hile the contact to icit of ethanol e tract of seed oil as enhanced	Li et al. (2004)
Antifugal activit of curcin	Curcin could inhibit h phal gro th and spore formation	Wei et al. (2004b)
Molecular biological studies		
RAPD anal sis	25 µl reaction s stem (2 mmol l^{-1} Mg^{2+} containing), 150 200 µmol l^{-1} dNTPs, 1 U Taq DNA pol merase, 0.4 µmol l^{-1} primers, 10 20 ng templates and 44 PCR c cles ere the optimal PCR reaction conditions	Sun et al. (2002)
To in protein isolation	Curcin as isolated and puri ed	Lin et al. (2002)
Curcin protein cloning	Curcin protein as cloned and e pressed	Lin et al. (2003)
Antitumor effects of curcin	The obvious antitumor effects of curcin as reported, and activit related to *N*-gl cosidase activit as suggested as the possible mechanism of action	Lin et al. (2003)
Total RNA e traction	A simple, rapid and highl effective method as introduced	Luo et al. (2005b)
Curcin protein in kernels	Curcin as identi ed b Western-blot	Rong and Wang (2005)

To ic and antinutrients in *Jatropha curcas* seeds from China (data from our laborator)

Constituent	Content
Phorbol esters in kernel (mg/g)*	2.2 (0.87 3.32)
Tr psin inhibitor in kernel meal (mg tr psin inhibited/g)	24.5 (18.4 27.5)
Lectin in kernel meal (inverse of the minimum amount of sample in mg/ml of the assa hich produced haem-agglutination)	102 (51.3 204)
Ph tate in kernel meal (% as ph tate equivalent)	8.1 (6.2 10.1)

* As phorbol-12-m ristate 13-acetate equivalent

Kernel meal, defatted kernel (oil <0.5%). Values in parenthesis are for 18 provenances from different parts of orld (Makkar et al. 1997)

2002). This stud revealed the functional mechanism of curcin at molecular level for the rst time. Lin and Chen (2003) cloned and e pressed the protein curcin from the seeds of jatropha. Lin et al. (2003) determined that curcin had an antitumor effect and discussed the mechanisms of action related to *N*-gl cosidase activit . The presence of curcin as demonstrated in calli generated from e plants of jatropha (Rong and Wang 2005).

A reliable energ suppl and ef cient and clean energ utili ation are essential for sustainable economic development. China's energ consumption has doubled in the past t ent ears (Wu et al. 2006). In 2020, motor vehicles in China ill number 130 150 million and the fossil fuel demand b these motor vehicles onl ill be about 256 million tons: about 85 million tons of gasoline and 171 million tons of diesel (Wang 2006). China's share of orld CO_2 emission is likel to increase from 12% in 2000 to 18% in 2025, rapidl approaching the USA share of 25% (EIA 2004). Jatropha oil could be used to produce high qualit biodiesel (Mandpe et al. 2005). Compared to conventional diesel, biodiesel has the advantage of being a rene able indigenous fuel, the use of hich has positive consequences for the environment and rural socio econom . Jatropha oil can be produced in an environmentall and sociall sustainable manner in tropical countries (Francis et al. 2005).

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Several parts of the jatropha plant have medical and cosmetic uses. The plant is described as "bitter, damp, cool, to ic, antipruritic and st ptic" (Anon - mous 1978). Jatropha is mentioned in the Great Compendium of Chinese Materia Medica (Huang 2001) and the Chinese Dictionar of Medicinal Plants (2003). It is not covered in ancient materia medica and the Chinese Pharmacopoeia (Anon mous 2005). In Yunnan, Pan hihua and Hainan, late of jatropha branches and leaves is used against skin diseases. Jatropha ma be consumed b mistake b children, since its seeds are some hat tast (Song and Chen 2002), but such accidental consumption is not idel reported. The full potential of jatropha as a medicinal plant has neither been thoroughl researched nor full reali ed.

The moisture content of jatropha t igs, trunks, and leaves is relativel high, imparting strong re toler- ance. Jatropha has been planted as a re barrier since 1980s. It is also planted as a re barrier b the natives to prevent the spread of re outbreaks. The moisture content of aerial parts of jatropha during late drought season as: trunk 60.1%, annual t ig 78.3%, tender sprouts 81.4%, and leaves 79.4%. Furthermore, jatropha can be used as a hedge to prevent spread of diseases and insect infestation in afforested areas (Li et al. 2006b).

After oil e traction from seeds, the remaining seed cake is high in protein and other nutrients, and has a ide variet of applications as an organic fertiliser and soil conditioner. Processing and deto i cation can convert the seed cake into high protein animal feed. Under a conservative scenario, 2 million ha of land could be planted ith jatropha in China b 2020. These plantations are e pected to produce 5.85 million tons of oil per ear (Wang 2006) and kernel meal equiv- alent to 5.6 million tons of so bean meal on protein equivalent basis (45% crude protein). Under an optimistic scenario, the production of oil from jatropha could var bet een 70 and 200 million tons per ear (Wang 2006). In such a situation deto i ed jatropha kernel meal could provide bet een 67 and 190 million tons of so bean meal on protein equivalent basis. The consumption of animal derived products in China is likel to increase b 41 million tons b 2020. Additional amounts of feed ingredient obtained as a b -product of biodiesel production from jatropha gro n largel on barren and astelands ill signi - cantl contribute to achieving the consumption target of biologicall high-valued diet.

Jatropha curcas seed cake also has high energ value and can be pressed into briquettes and burned as fuel (Wang 2006). As the seed cake is generated in large quantities after oil e traction, its commercial use is vital for economic viabilit of the jatropha s stem. High qualit protein concentrate could also be produced from seed cake (Makkar et al. 2008) hich after deto i cation could also be used in the diets of farm animals and aquaculture species. Seed cake and parts of jatropha plant could also be used for biogas production (Gunaseelan 2009).

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Jatropha is a versatile oil plant ith man economical and ecological attributes, and has considerable potential in China. The drought resistant plant and can gro on degraded and poor soil, can be used to reclaim eroded land and other poor sites, and has fe pests and diseases. Research focused on different ecot pes, improvement of seed qualit , plantation techniques, o ering and fruiting characteristics, and harvest and post-harvest handling of seeds is required to help jatropha producers reali e its full potential. More research is needed on biomedicinal aspects of active principles contained in its different parts; botan , agronom , and ecolog of *J. curcas*; and more information on the actual and potential markets. In the short term, commercial utili ation of the seed cake as animal feed in addition to the oil ma contribute to increasing the economic viabilit of jatropha production s stem.

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