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Potentials and cultivation of bubble bush (*Jatropha curcas Linn.*) in human welfare: A review

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Abstract
The present review glance the potentials of *Jatropha curcas L* and its present uses and applications in human welfare. Recently, interest in this species is has been growing day by day due to its ability to flourish on degraded land and in soils with low natural fertility, its rapid growth and easy propagation and the identification of several secondary metabolites which are industrially as well as medicinally important. For instance, now a days Jatropha is used as ananti-cancer agent as well it is also applicable in the production of cosmetic products and also in the production of biofuels. This review also provide a brief idea on the production of biofuel through Jatropha which now a days works as a boon for the industries and also a good financial asset. India, Brazil, and China together are responsible for 55% knowledge about this species, obtained through scientific research and production. Also, exploitation of its seed oilfor use in cosmetics in some countries were also critically reviewed. Most details centered on the profitable uses of Jatropha and its usage in the biofuel production is described in the following review.

Keywords: Jatropha, cosmetics, seed oil, fuel properties, vegetable oils, etc

Introduction

Jatropha curcas Linn. also known as physic nut, barbodas nut, poison nut, bubble bush or purging nut is a drought resistance large shrub or small tree, reaching height up to 6 m (20 ft) or more, belongs to the kingdom plantae and family Euphorbiaceae, producing oil containing seeds. [1]. Jatropha curcas L is one of the most common species found in Nigeria, but many ant other species exists in other different parts of the world. In 1996 a researcher named Hellen reported about 165-175 species known from the genus Jatropha and 14 wild and cultivated species in India.

The J curcas L plant was originated from Mexico and was spread to Asia and Africa by Portuguese leaders as a hedge plant. The genus called Jatropha derived from the Greek word called “Jatros” which means doctor and “trophe” which means food, that is it implies medicinal uses. Hence it is traditionally a medicinal plant. Jatropha curcas L has been propagated as unique and potential tropical plant for augmenting renewable energy resources due to its several merits for which it deserves to be considered as sole candidate in the tangible and intangible benefits for ecology and environment.

It possess phorbol esters, which are considered toxic in nature. Moreover, edible (nontoxic) provenances native to Mexico also exists. It also carries compounds such as trypsin inhibitors, phytate saponins and a type of lectin known as curcin [2]. The seed contains 27-40% oil [3] that can be used to produce high quality biofuel, useable in a standard diesel engine. Whereas edible (nontoxic) provenances can be used for animal feed and food [4, 5].

Classification of Jatropha curcas Linn.

Table 1

Scientific name	*Jatropha carcus Linn.*
Domain	Eukaryota
Kingdom	Plantae
Subkingdom	Angiosperms
Infrakingdom	Streptophyta
Division	Tracheophyta
Phylum	Spermatophyta
Class	Dicotyledonae
Order	Euphorbiales
Family	Euphorbiaceae
Genus	Jatropha
Species	Curcas Linn.

Morphological and botanical features of *Jatropha curcas*

The morphology (vegetative and floral) of *Jatropha* species is described below:

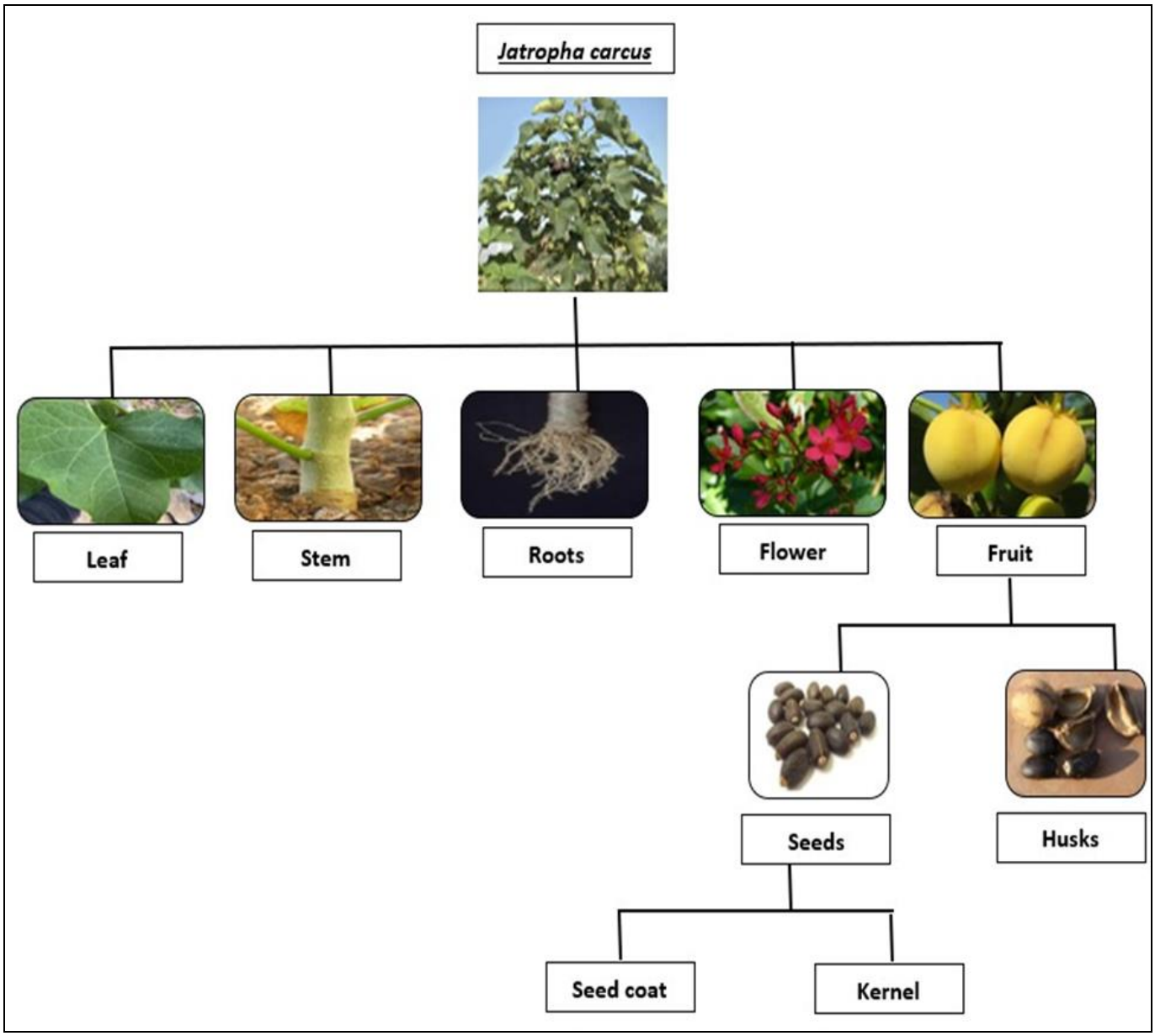

Fig 1: Morphological and Botanical tea urn of Jatropha curves

Morphology characters involves leaves, trunk, flowers, fruits and seeds characters. Trink characters include height of brances and branches arrangement, diameter of canopy, number of nodes, etc. Similarly the other morphological characters includes the physiological characters such as size, height, breadth, petiole length etc. A breif description of all the characters is given in the table below:

Table 2: showing the general characteristics of a plant (***Jatropha carcus***)

Habitat	**Monoecious, succulent, shrubs, or small tree**
Duration	Deciduous
Root	A tap root with lateral roots
Stem	Erect and unarmed
Description	Scars, cylindrical, and stour green at apex and pale Brown at the base.

Botanical features

The leaves are morphologically variable. In general, the leaves are green to pale green, alternate to subopposite and 3-5 lobed with a spiral phyllotaxis [6].

Table 3: showing the botanical characteristics of a plant (*Jatropha carcus*)

Leaf morphology	
Leaf type	Foliage often green
Leaf organization	Simple
Leaf outline	Broadly ovate
Leaf lamina	Symmetrical

Leaf base	Deeply cordate
Leaf apex	Acute and acuminate
Leaf texture	Chartaceous
Leaf surface	Glabrous
Forms of margin	Entire and undulating
Types of lobes	Palmately lobed
Shapes of leaves	Wide ovate
Venation	Reticulate, palmate And divergent.
Length	13.6-18.1 cm
Breadth	9.57-20.98
Petiole length	15.3-27.5
Flower morphology	
Inflorescence type	Biparous and dichasial
Shape	Rosaceous
Type	Unisexual, hemaphrodite
Bract type	Leafy, foliaceous
Sepal and corolla	Petaloid, polypetaloid
Fruit morphology	
Shape	Ellipsoid to tear drop
Type	Simple
Texture	Glabrous
Dehiscence	Septrifugal
Seed morphology	
Shape	Ellipsoid and triangular convex
Length	1.6-1.8
Width	0.7-1.0
No. of seeds	03

Whereas the flowers both male and produced on the same inflorescence that is occasionally flowers are hermaphrodite [6, 7]. The fruits are generally produced in winters where some plants have 2-3 harvests and some produced continuously the whole season. The seeds become mature when their capsule changes from green to yellow, seed yields about 25-40%oil by weight.

Nutritional composition of Jatropha curcas

Data shows that whole seeds contains 5.68% moisture, 32.88% protein, 27.36% oil, 5.68% ash, 3.81% fiber and 30.11% total carbohydrates (reducing and non-reducing sugars).if managed properly, Jatropha yields 4-5 kg of seeds per tree production from the fifth year onwards and seed yield can be obtained up to 40-50 years from the day of planting [16]. The seed weight range from 0.53-0.86 g and the kernel contains 22-27% protein and 57-63% oil [14, 15]. these limits indicating that Jatropha is a good nutrition source. The latex of Jatropha contains an alkaloid known as "jatrophine" which is believed to have medicinal properties. These kernels are also known to produce a quantity oil which can be used as a fuel directly or as a substitute to diesel in the trans esterified form. The oil is also useful for making candles, soaps, lubricants, and varnishes and is used for illumination. The seed can be used as a good protein source for humans as well as for livestock's [11, 12].

Waste biomass from J curcas L. plantation and its oil production has nutrient and mineral content as present in the table:

Table 4: showing the nutritional characteristics of a plant (*Jatropha carcus*)

Nutrients	Leaf	Wood	Hull	Seed husk	Kernel	Seed cake
N %	6.40	3.34	2.15	0.19	4.39	4.90
P %	0.34	0.09	0.05	0.01	1.10	0.90
K %	2.45	2.87	0.73	0.31	0.94	1.75
Ca %	1.40	0.30	0.44	0.28	0.34	0.31
Mg %	0.53	0.26	0.30	0.06	0.53	0.68
S %	0.19	0.12	0.10	0.01	0.21	0.24
Zn (ppm)	28	55	22	1	47	55
Fe (ppm)	168	99	40	8	73	772
Cu (ppm)	6	2	11	3	18	22
Mn (ppm)	117	605	25	13	28	85
B (ppm)	71	10	4	2	5	20
Na (ppm)	808	134	28	20	17	-------

Cultivation

Cultivation is uncomplicated, Jatropha curcas grows in tropical and subtropical areas (agriculture information.com). The plant can grow in waste and barren lands and grows on almost any terrain, even on gravelly, sandy and saline soils. Complete germination is achieved within 9 days. Addition of manure during the process of germination sometimes possess negative impacts during that phase but it is very fruitful when it applies after germination. It can be propagated by cuttings, which yields faster results than multiplication by seeds. Jatropha curcas starts yielding from

9-12 months duration, the best yields are obtained only after 2-3 years of time. The seed production is around 3 tons per hectare. If planted in hedges, the reported productivity of Jatropha is from 0.8-1.0 kg per meter of live fence.

Jatropha curcas cultivation in India

In India Jatropha curcas is an important source for the biodiesel production. The Ex- president of India Dr. APJ Abdul kalam, was one of the strongest advocates of Jatropha cultivation for biodiesel production [17]. Once this plant is cultivated the plant has a useful lifespan of several decades. During its life Jatropha requires very little water compared to other cash crops. Recently the state bank of India provided a boost to the cultivation of Jatropha in Indian by a signing a memorandum of understanding with D1 Mohan to provide loans to the tune of 1.3 billion rupees to local farmer in India. Many states in India such as Andra Pradesh, Chattisgarh, Karnataka, Tamilnandu, Rajasthan, etc. are supporting biodiesel production from Jatropha.

The country have 168-million-hectare arable lands out of its 328.73-million-hectare geographical area. There is about 63 million ha. Wastelands in the country. Out of which about 40 million ha area can be used for jatropha plantation. The state wise availability of waste lands and their exploitations under jatropha plantation is as under:

Table 5: showing the state wise availability of wastelands and their exploitable potential under jatropha plantations

States	Available wastelands (million hectare)	Exploitable potential of jatropha plantation (million hectare)
Andhra Pradesh	5.175	4.396
Arunachal Pradesh	1.832	0.997
Assam	2.001	1.456
Bihar/ Jharkhand	2.099	1.860
Goa	0.061	0.04
Gujrat	4.302	2.871
Haryana	0.373	0.262
Himachal Pradesh	3.165	0
Jammu and Kashmir	6.544	0
Karnataka	2.084	1.789
Kerala	0.145	0.10
Madhya Pradesh	6.971	6.620
Maharashtra	5.349	4.855
Manipur	1.295	1.262
Meghalaya	0.99	0.937
Mizoram	0.407	0.407
Nagaland	0.840	0.840
Orissa	2.134	1.888
Punjab	0.223	0.106
Rajasthan	10.564	5.688
Sikkim	0.356	0.213
Tamil nadu	2.301	1.795
Tripura	0.127	0.128
Uttar Pradesh	3.877	1.214
West Bengal	0.571	0.258
Union territories	0.057	0.055
Grand total	63,843	40,037

Cultivation of *Jatropha curcas* through micropropagation

Invitro propagation is also referred to as, micro or clonal propagation. it is a process of sexual reproduction by multiplication of genetically identical copies of individual plant. The latex of J curcas contains an alkaloid known as "jatrophine " which is believed to have medicinal properties. The sap of the plant is used for treatment of piles, snakebite, skin diseases, paralysis, dropsy, malarial fever, arthritis, gout, jaundice, and resistance to various stresses [18]. because of this variety of jatropha products it is cultivated by peasant farmers but due to its rapid demand in industries it is grown in laboratories also by the meansof micropropagation. Conventional agriculture uses seeds and cuttings for its propagation, J curcas in self-compatible but sometimes it tends to cross pollinate.

Protocol for the *in vitro* production of *Jatropha curcas*

Micropropagation is a very easy technique but requires an experience and skills to do, in practice due to the chances of contamination. The process for micropropagation of Jatropha curcas is as under:

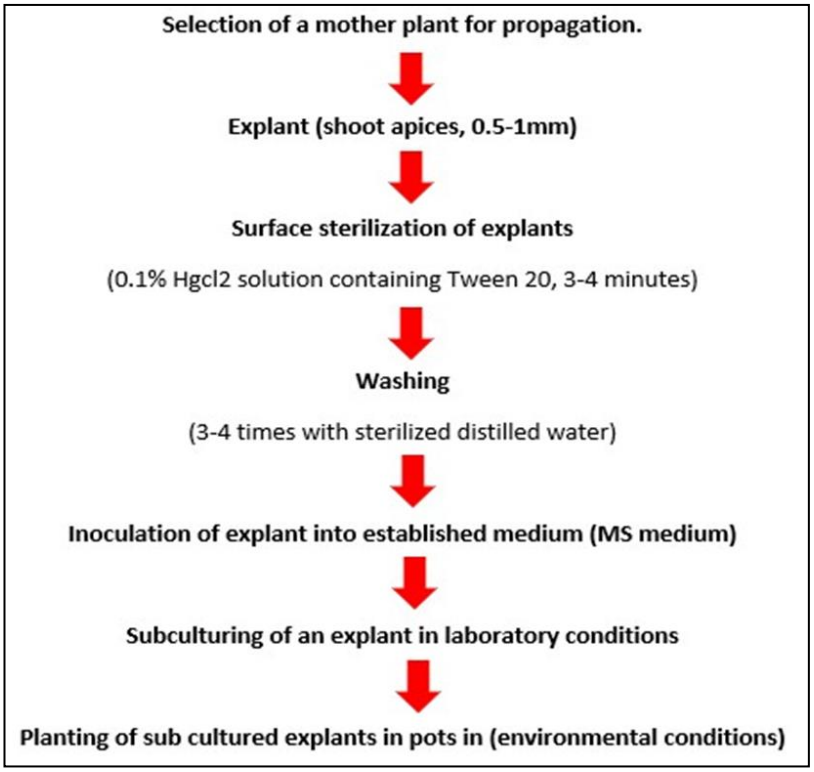

Fig 2: Protocol for the *in vitro* production of Jatropha curcas

1. Selection of a mother plant

The mother plant used for micropropagation must be 4-7 years old, preferable 6 years. Where in the mother plants yields at least 4 kg of seeds per plant per year and yields at least 40% oil per seeds. The mother plant used must be healthy and free from microbes. Treating the mother plant comprises act if spraying the mother plant with a mixture of antimicrobicide and insecticide for about 5 days to 8 days after collection. The explant can be node, stem, root, leaf, but mostly preferred nodes.

2. Surface sterilization of explants

The explant is agitated with 70% alcohol and then blotted properly afterwards explant is treated with a disinfectant. As disinfectant contains chemical in higher amount it is necessary to sterilize it. After treating with a disinfectant, the explant must be washed properly with sterile water in order to remove unwanted particles. To prevent it from fungus and contamination soak the washed explant in solution of fungicides and antibiotics, example Bavistin and PVP and again rinse it with sterile water and it leave it to blot.

3. Washing

Rinse the surface sterilized explant in detergent such as Tween 20 afterwards treat the rinsed explant with mercury chloride solution in precaution because Hgcl2 is toxic in nature. Again, rinse it with sterile water as Hgcl2 is very toxic in nature. Again, rinse it with sterile water 2-3 times in order to remove all the undesired particles.

4. Inoculation of explant into established medium

After sterilization and washing, the explant is now established in a medium which support its growth and development. It is performed under sterilized conditions to avoid contamination (under laminar airflow).

a. **Preparation of MS media:** MS media (Murashige and Skoog medium) is a plant growth medium used in the laboratories for cultivation of plant tissue culture. It was developed by plant scientists Toshio Murashige and Folke K.Skoog in 1962 during their research.

Table 6

Major salts (macronutrients)	Per litre
Ammonium nitrate (NH_4NO_3)	1650 mg/l
Calcium chloride($CaCL_2.2H_2O$)	440 mg/l
Magnesium sulfate($MgSO_4.7H_2O$)	370 mg/l
Monopotassium phosphate(KH_2PO_4)	170 mg/l
Potassium nitrate (KNO_3)	1900 mg/l
Minor salts (micronutrients)	Per litre
Boric acid (H_3BO_3)	6.2 mg/l
Cobalt chloride ($CoCl_2.6H_2O$)	0.025 mg/l
Ferrous sulfate ($FeSO_4.7H_2O$)	27.8 mg/l
Manganese(II) sulfate($MnSO_4.4H_2O$)	22.3 mg/l
Potassium iodide (KI)	0.83 mg/l
Sodium molybdate ($Na_2MoO_4.H_2O$)	0.25 mg/l
Zinc sulfate ($ZnSO_4.7H_2O$)	8.6 mg/l

Ethylenediaminetetraacetic acid ferric sodium (NaFe-EDTA)	5 ml/l
Copper sulfate ($CuSO_4.5H_2O$)	0.025 mg/l
Vitamins and organic compounds	Per litre
Myo-inositol	100 mg/l
Nicotinic acid	0.5 mg/l
Pyridoxine	0.5 mg/l
Thiamine	1.0 mg/l
Glycine	2 mg/l
Tryptone (optional)	1 g/l
Indole acetic acid (optional)	1-30 mg/l
Kinetin (optional)	0.04-10 mg/l
Polymerizing agent	Agar
Additional requirements	Per litre
Benzyl amino purine	1.25 mg/l
Biotin	0.05 mg/l
Folic acid	0.5 mg/l
Sodium phosphate	170 mg/l
Cupric sulphate	0.25 mg/l
Vitamin B6	0.5 mg/l
Sucrose	5000 mg/l
Coconut water	10 mg/l
Nickel sulphate	0.045 mg/l
phloroglucinol	100 mg/l

b. Inoculation of explant on MS media: in laminar air flow under sterile condition with the help of sterilized forceps inoculate the explant on MS media.

4. Induction of callus: a variety of tissue can be used for the induction of callus. Both the application of auxin as well as high cytokinin concentration were effective [20]. The addition of 2% v/v coconut milk to this medium was shown similar effect like coconut [19, 21]. J. curcas is highly sensitive to auxin with respect to the stimulation of cell division rather than induction of roots [22]. Replacing NAA by IBA in combination with BA induce callus [23-25]. However, IBA on its own is sufficient to induce callus.

5. Shoot regeneration: after callus induction by the treatment of 1.5 mg/l kinetin with the combination of 1 mg/l of BA induces shoot regeneration following the photoperiod of 16 h 25+-2c, for 2 weeks.

6. Root regeneration: the induction of rooting by auxins is commonly applied to regenerate viable plant from shoots and cutting [29]. IBA has been shown to be very effective in the rooting of J. curcas [27]. 40% rooting was achieved with 0.1 mg per litre of IBA for 5 weeks [28] and in 85.71% rooting induced from shoots on MS basal media with 1 mg of IBA [26].

7. Hardening: after the regeneration in laboratory condition it is necessary to prepare plant for environmental stress. Hence it requires hardening in external (environmental) conditions. Hardening is usually done in 10 cm diameter pots, filled with farm yard manure, soil, sand; 1:1:1 by volume.

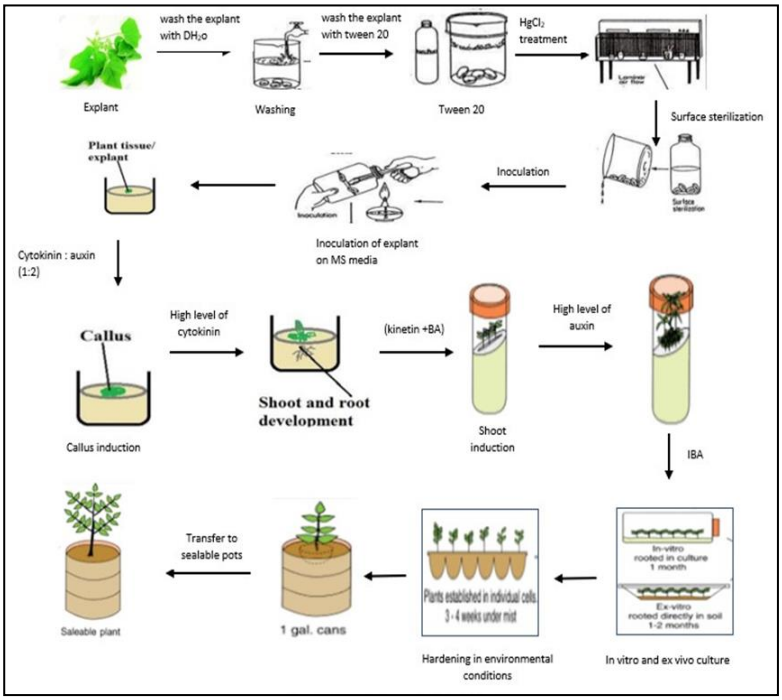

Fig 3

8. Maintainence: although jatropha is atough plant the first month of establishment weed control is essential. This can be done mechanically, by hand or by using herbicides. Jatropha is pretty tolreant when it comes to herbicides. The five main factors to make a jatropha bush productive are:- Selection, Pruning, Light, Water & Nutrition.

***Jatropha* as a product in human welfare**

Traditionally Jatropha is used for treating dydentery and diarrhea but it is also known for its antibacterial activity against Staphylococcus aureus, Escherichia coli and Pseudomonas aeruginosa. The latex of Jatropha conatins an alkaloid called Jatrophine which is believed to have anticancer properties.

It is also used for skin diseases, rheumatism and for sores on domestic livestock [27].

The white latex of Jatropha curcas serves as a disinfection in mouth infections in children [32]. Crude stem bark extracts of J.curcas was reported to inhibit the growth of pathogenic bacteria and fungi [30].

In addition crude of this palnt is found to inhibit HIV induced cytopathic effects with low cytotoxicity.

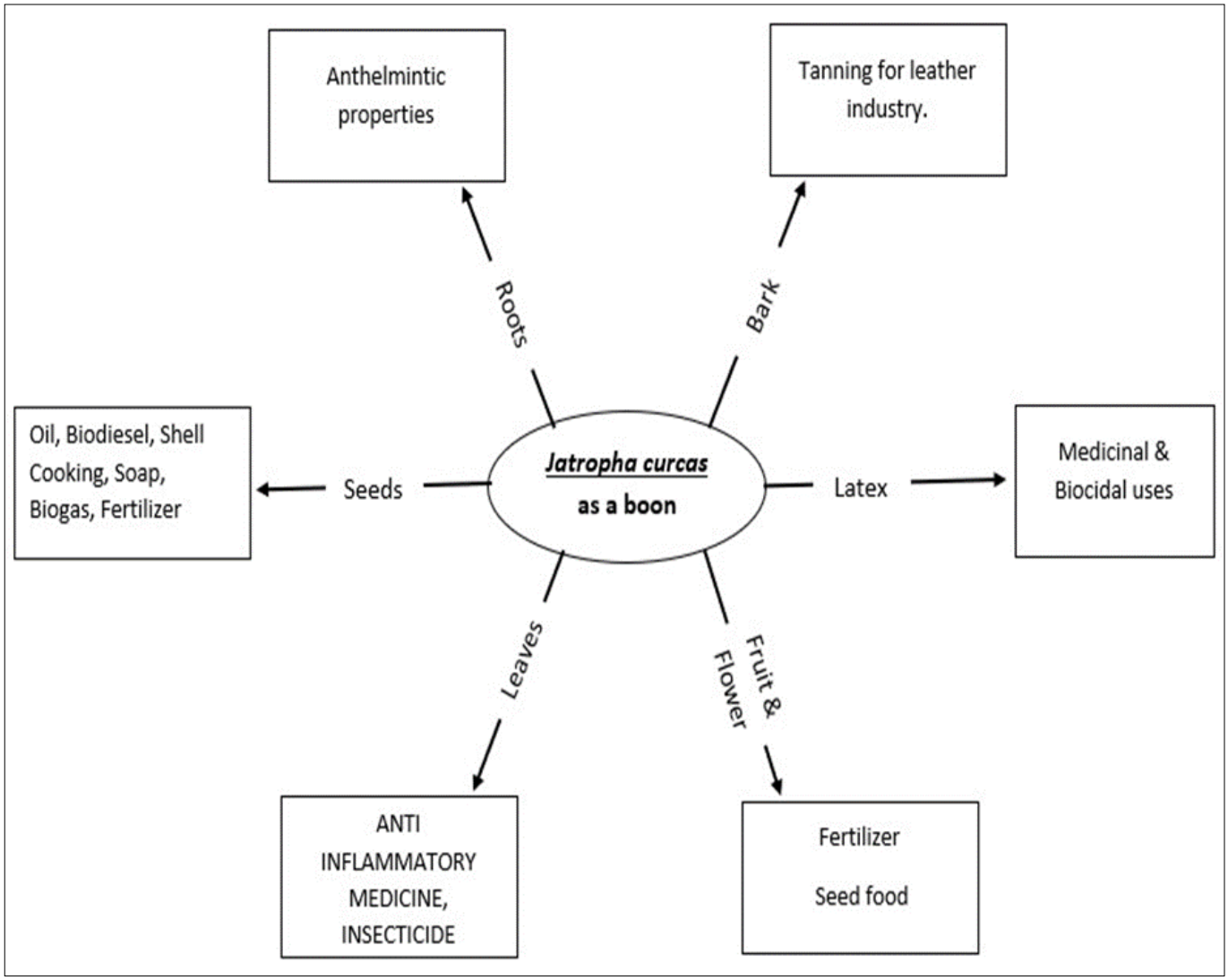

Fig 4: showing the uses of Jatropha curcas in human welfare.

A. *Jatropha* curcas as biodiesel: Now a days jatropha curcas is a very good option for producing biodiesel at a large scale, it is economically very productive. The biodiesel obtained from jatropha is called Jatropha PPO (pure plant oil) it can be used for transport. PPO can be used in multi-functional platforms. In several countries including India, PPO is being used for the production of electricity via multifunctional platforms. The jatropha seed oils content range from 30% to 50% in weight containg about 14% free fatty acid (FFA). This oil content exceeds the limit of 1% FFA level that can be converted to biodiesel by a process called transesterification using an alkaline catalyst [33]. the fuel properties of jatropha biodiesel are comparable to those of biodiesel, and are equivalent to the latest standards of biodiesels [34]. The viscosity of the biodiesel can be arranged according to the need of application. The use of Jatropha curcas as a fuel is has great potential, especially in underdeveloped nations.

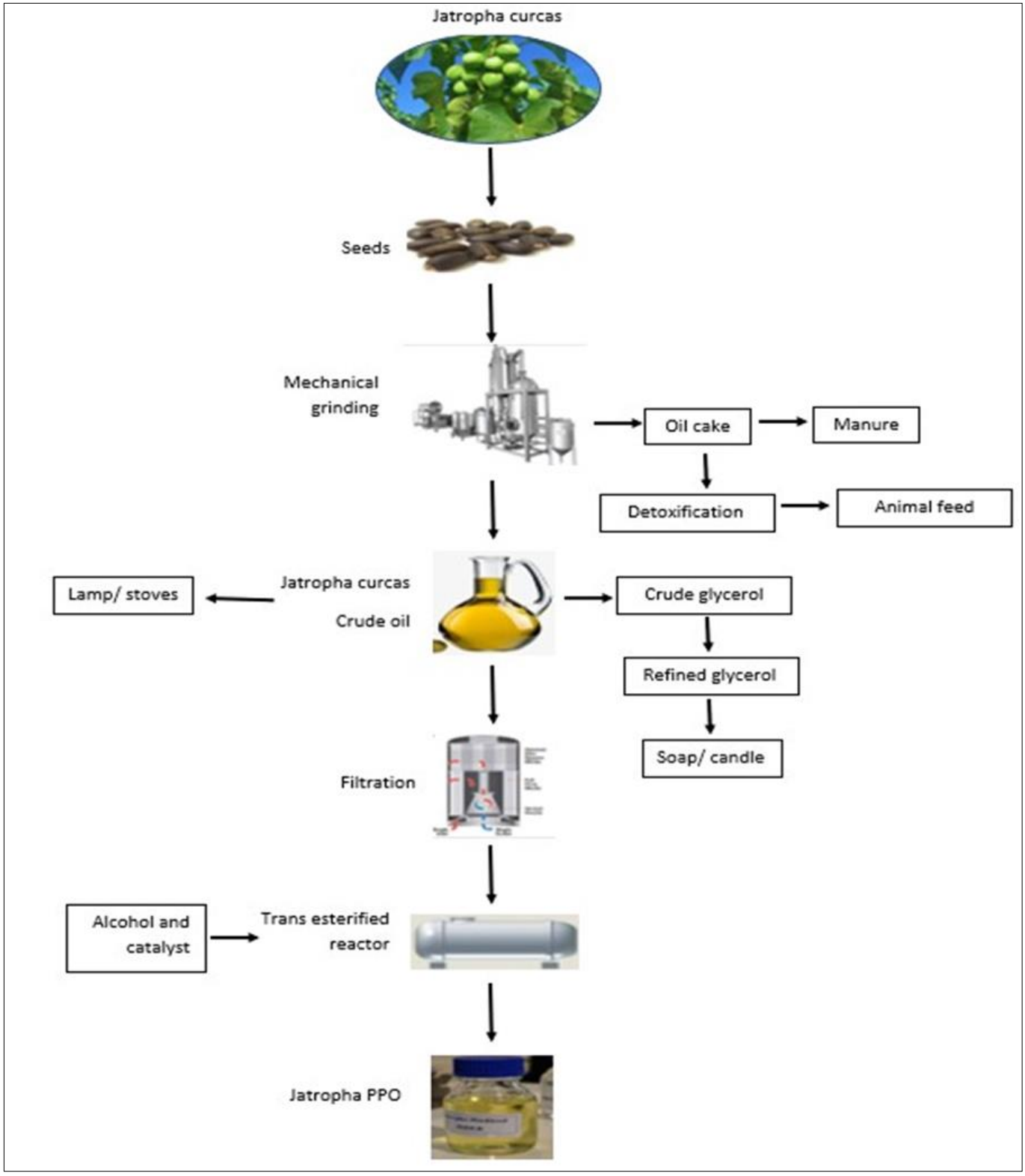

Fig 5: Production of biodiesel from latropha curcas seeds

B. Jatropha curcas as a skin care product: Jatropha curcas is also known for its good medicinal properties, it is used to manufacture soaps in industries which is very good to treat dermal infections. The latex of Jatropha contains a substance called jatrophine which is used in soap making. It is also available in market as a homeopathic drug.

C. Jatropha curcas as an anti-HIV agent: Jatropha curcas leaf extracts shows effective anti-viral and probable entry inhibition activity against potentially drug resistant HIV, which j=has not been reported earlier, hence Jatropha curcas is a good candidate for anti-HIV therapy with further research.

D. Jatropha curcas as a hedge: Jatropha plant was commonly used as a hedge or living fences to protect valuable plants from eaten by animals as it produces latex and is toxic. Besides, they also provide shade for other plants while the dropped leaves will decompose and become fertilizer.

E. Fertilizer and insecticides: the residue from the oil extraction pressed seed cake, is rich in nitrogen, phosphorous, potassium and more fertilizing nutrients. Besides these they also have insecticidal properties which can reduce number of nematodes in soil.

G. Medicinal properties: Tannis and latex extracted from the bark has anti-microbial properties and astringent properties each. Extracts from jatropha has been known for its anti-tumor properties and the leaves as a remedy for malaria and high fever, the seeds are widely used for the treatment of constipation and the sap in accelerating wounding healing procedure.

Conclusion

In this review we learnt about the various properties of jatropha curcas in detail. Jatropha is a very sustainable plant. considering the cosmetic uses of the plant oil, domestication of the plant to extract oil for use in cosmetic preparation should be encouraged. Future works will involve regeneration of jatropha plants from callus, and it is very good research option.

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