TAMARINDUS INDICA L. OR "ASAM JAWA" : The sour but Sweet and useful

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(July – September 2007)

ABSTRACT

Indonesia as a tropical country has grown up various kinds of plants. Most of them could cure many kind of illnesses and to make human's body still healthy. Traditional medicines made from a certain ingredient of these plants are called "JAMU".

One of the healing plants or herbal traditional medicines is Tamarindus indica L. (scientific name) with common name Tamarind or Asam Jawa in Indonesia. Indonesia people call asam according to its sour taste and jawa because there's a lot in Centre Java (asam in Javanese language is sour and Jawa is Java).It comes originally from Africa (Savana Africa) but has grown in Indonesia for century.

Asam Jawa (fruit) is known to have ability of curing many kinds of diseases such as rheumatism, cough ,fever, allergy and oral ulceration. Besides it's also used as antidotes in several cases. There are many other uses of this plant, like to keep body healthy and fresh, to eliminate body fat, to enhance body's vitality, to provide vitamins B and C, and to cure many diseases. This article reviews the characteristics, common usages, traditional medicines usages, chemical contents, pharmacological, toxicological and clinical studies of "Asam Jawa" (Tamarindus indica L.).

INTRODUCTION

Indonesia is an archipelago country that lies between two continents, Asia and Australia hand two oceans, the Indian and Pacific. The geographical position of Indonesia is 6 ^{o} NL (North Latitude) – 11 ^{o} SL (South Latitude) and 95 ^{o} - 141 ^{o} EL (East Longitude). Conferring this fact, Indonesia is passed by the equator. This equator makes Indonesia has a tropical climate with two kinds of seasons, dry and wet season (1, 2).

This climate makes Indonesia get sun light for the whole year. No wonder

many kinds of plant grow there. Those plants have various uses especially in medicine: for keeping the body healthy and curing the illnesses. These uses have been known for a very long time by our ancestor when even the chemicals are discovered. The natural ingredients that have been mixed up are called *jamu.* (4, 5).One of plants that has many uses is *Tamarindus indica* L. or *Asam Jawa* in Indonesia. The name tamarind is taken from the Arabian language: Tamar – Hindi that mean date. In Indonesia it is known by the name asam jawa (asam = sour and jawa = Java land) because of its sourness and a lot in Java. This plant is well known among the Indonesian people with many kinds of different names. And because its taste and uses, fruit and seed of tamarind is made many beverages and candies.

The tamarind became known in Europe during the middle ages, doubtless through the Arabians. Until correctly describe by Garcia d'Orta (1563), it was suppose by Europeans to be produce by Indian palm (3). Strangely, *Asam Jawa* or Tamarind is sour but sweet and has many uses.

ASAM JAWA or TAMARIND

The name of Tamarind in Indonesia is Asam Jawa , asam mean sour and Jawa mean Java , the name of island in Indonesia.

There is not in every province in Indonesia as tamarind producer. The provinces that producer tamarind are West Java, Central Java, East Java including Madura, North Sumatra, West Kalimantan, Bali and South Sulawesi. This plant usually gowns on the lower land as a street side plant.

Local Names of Tamarind (1, 4, 6, 7)

The Asam Jawa is Indonesia common name of Tamarind, there are many differences name in Indonesia.

Besides Indonesia, tamarind is also well known at other asian countries with different kinds of names. For example, in Malaysia they call it also asam jawa ; in Philipines sampalok (Tagalog language) , kalomagi (Bisaya language) , salomagi (Ilokano language) ; in Burma magyee, magye-pen ; in Cambodia ampul, ampil khoua me ; in Laos khaam, makkham ; in Thailand makham, bakham, sokham ; in Vietnam me, trai me.

The larger producing country in Asia is India and it's called tamarind or Indian date. This plant is called Suan Jiau in China and tamarindo de la India in Spanish (6). In Japan this tree called also Tamarindo.

TABLE I. THE DIFFERENCES LOCAL NAMES OF TAMARIND IN INDONESIA

Island	Part of island	Local name	Island	Part of island	Local name
1. Sumatra	- Aceh - Gayo - Minang	bak mee acamlagih asam jawa, cumalagi	4.Kalimantan	-Dayak - Gorontalo - Buol - Baree - Makassar - Bugis	asang jawa asang jawi tamalagi sambalagi camba cempa
2. Java	- West Java - Central and East Java - Madura	asem,tangkal asem asem, wit - asam acem	6. Maluku	-Tanimbar - Kai - East Seram - South Seram - Ulias - Buru - Ternate	sablaki asam jawa tobelake asang jawa asan jawa asan jawaka asam jawa
3.Nusa Tenggara	- Bima - East Sumbawa - WestSumbawa - Sawu - Flores - Solor,Alor - Rote	Mange kamaru kaza helagi make,mage, naange tobi ninilunau	7. Bali	-	Celagi, clagi

Scientific name of Tamarind

The origin of Tamarind is unknown. Tamarind is indigenous to dryer savannas of tropical Africa but it certainly naturalized along ago in tropical Asia. Now, it is cultivated in most all tropical countries, included Indonesia (4).

Tamarind has monospecific genus. In the past a distinction was made between tamarind from West and East Indies. (2),

- West Indies: *Tamarindus occidentalis*, pod up to 3 times longer than wide, containing 1 – 4 seeds.
- East Indies: *Tamarindus indica,* pod up to 6 times or more longer than wide, containing 6 – 12 seeds.

In the beginning both types were equaled with one name. In 1791, Gaerth named it *Tamarindus occidentalis* and Hook named *Tamarindus officinalis*.(2).

Now, tamarind is classified as closed-seeding plant that has double germ.

The scientific classification of Tamarind is (Integrated Taxonomic Information System – Plant Data base):

Kingdom: Plantae

Sub Kingdom: Tracheobionta

Division: Spermatophyta

Sub Division: Magniliophyta

Class: Magnoliopsida

Sub Class: Risidae

Ordo: Fabales

Family: Fabaceae

Genus: Tamarindus L.

Species: *Tamarindus indica* L.

Descriptions of Tamarind (3, 12)

- Tree :

Tamarind tree is slow growing tree that resistant to strong winds and perennial.

This plant is a large evergreen tree which 25 – 30 meters tall, more or less deciduous, and diameter up to 2 meters. The crown is densely foliaged, widely spreading, rounded. The barks are rough, scaly, fissured, and grayish-brown. It has many branches and twigs. The old tree often twisted, grooved and fluted but not buttressed.

The wood of tamarind is durable, solid, hard, heavy and whitish-pale.

In Indonesia, its wood is used to make “dakon” (Javanese) or “congklak” (Sundanese) and “gangsing” , there are toys from the wood of tamarind. Leaves of tamarind are pinnately compound with 10 – 20 pairs of oblig leafless.

Figure 1 : Tamarind Tree (Pohon “Asam Jawa”)

- Leaves :

Leaves 7,5 -15 Cm long, ,alternate, stipulate, petiolate, paripinnantely compound, petiole up to 1,5 Cm long , leaving a prominent scar after falling , blade sub-oblong in outline, up to 13 Cm X 15 Cm with 8 -16 pairs of leaflets narrowly oblong, 1 -3,5 Cm X 0,5 – 1 Cm, entire oblique, rounded at base, and asymmetric, rounded to slightly emarginated at apex. The apex minutely notched, thinly leathery, almost sessile, and glabrous, inflorescence lax lateral and terminal racemes, up to 13 Cm long. The young leaves are pale green.

The small glabrous and leathery leaflets of the tamarind are characteristic at dusk they fold together.

Figure 2: Tamarind Leaves

- Flowers :

Flowers of tamarind are smalls , petals yellowish with orange to red streaks.

Flower is 3 Cm long, fragrant ; sepal 4 uniquely, up to 1,5 Cm long; petal five the posterior and lateral ones largest and showy, creamed colored with brown-red vines, the two interior ones much reduce linear white, pale yellowish but rose red in bud from bracts : racemes 5 – 10 Cm long, often on leafless twigs : two bracts, rose red covering the young buds but falling off before the flower opens : the petal pink veined, two spreading laterally and one as a keel in the center. There are three stamens green, pestle 1 up to 18 ovules

- Fruits and Seeds :

Fruit of tamarind is a sub-cylindrical straight or curve in the indehiscent pod with rounded ends up to 14 Cm X 4 Cm, up to 10 seeded, often irregularly constricted between the seeds; exocarp crustaceous, grayish or more usually scurvy brown with some strong fibrous threads inside when unripe, becoming pulpy, mesocarp thick-syrupy, blackish-brown; endocarp thin, leathery. The pulp of the ripe pods is edible, though sour and after preparation by being squeezed from the pods and with the addition of salt. It is sold in native shops as a blackish brown, an inviting mass suggesting inspissated dates.

Seeds irregularly shaped flattened rhomboid, up to 1.8 Cm long, very hard, brown, small, mostly angled.

The simplicia of tamarind fructus called tamarindori pulpa crude or “asam kawak” in Indonesia (6).

Figure 3. Fruit and Seeds of Tamarind

Pests and Diseases of Tamarind (7, 10)

The trees of tamarind are hosts to such pests as shot hole borers, toy beetles, and leaf-feeding caterpillars, bagworms, mealy bugs and scale insects. There are two kinds of insects that attack tamarind, *Caryoborus gonagra* , a large gray-brown chrysomelid beetle found in tamarind seeds and *Charaxes fabius* , a large black yellow spotted butterfly whose larva feed

on the leaves. In some seasons, fruit borer may inflict serious damage to maturing fruits causing a great reduction in marketable yield.

Growth and Development of Tamarind

The tamarind is found in places with sands (near sea) to clay at low to medium altitude (1.000– 1.500 m). Its extensive root system contributes to its resistance to drought and strong winds. If rainfall is > 4.000 mm, the tree does not flower and wet condition during the final stages of fruit development is detrimental.

It is deciduous after the dry weather : The leaf-fall takes place gradually over the greater part of the crown at once and the new leaves develop the crown is quite bare, but if dry weather is pronounced all the old leaves may fall before the new buds have opened. The fresh green, trailing foliage is very beautiful. The flower is born on the new shoots but they are inconspicuous.

The seeds remain viable for many months and germinate within two weeks after sowing. Growth is generally slow, seeding height increasing by about 60 Cm annually. The juvenile phase last 4 – 5 years ar longer. At higher altitude shoots grow mainly an spring, flower throughout the summer and pods ripen in the spring, the period from flowering to harvest being quiet long (about 8 months until maturity). Very little is known about the growth rhythm in the tropics. In the monsoon climate of East Java, the tree changes its leaves towards the end of the dry season (some tree in September others in October – November) Some tree may be nearly leafless for a while, but normally remain foliated. Approximately incidental shoot growth continues through the rainy season(November – April) into dry season, but in July – August the trees are virtually quiescent. Flowers emerge on the new shoots that mark the leaf change, but some trees flower later, even as late as February when the shoots have long matured. They ripen mainly in June until September. The tamarind trees bear fruits in all of years. (4).

Propagation of Tamarind (2, 3, 4)

Tamarind may be propagated by seeds and by marcotting, grafting and budding. Seedlings are big enough to be planted out in the field in a year or less, but they do not come true to type. The most common methods use to propagate the tamarind tree is by means of seeds. Seeds can be transported without difficulty, as they retain their viability for a considerable length of time if keep dry. They are best germinated by planting them 1.27 Cm deep in sandy loam. The

young plants are rather delicate and must be handled carefully to prevent dumping off.

Out standing mother tree are propagated asexually. Shield and patch budding and cleft grafting are fast and reliable methods, and at present used in large-scale propagation in many countries. The best time for it are the cool and dry months of April to October. Budded or grafted trees are planted in the field at the onset of rainy seasons (October–Avril) at spacing of 8 – 10 m.

In Indies and Sri-Langka was reported that the fruits produced is 170 kg/year per one big tree of tamarind or the averages 80 – 90 kg(11).

Simplicias of *Tamarindus indica* L. are Tamarindus Fructus made from fruits and Tamarindori Pulpa Cruda made from pulps (in Indonesia called “asam kawak”) (6).

INGREDIENTS OF *TAMARINDUS INDICA* L. (4, 6)

The bark of the tamarind contains phlobatannine for 35% while the seed containing cellulose and albuminoid.

The fruit contains grape acid, apple acid, citric acid, succinct acid, tartaric acid and pectin. It’s also containing invert sugar.

The acidity taste is caused by tartaric acid, which on ripening does not disappear but is matched approximately by increasing sugar levels. Hence tamarind is said to be simultaneously the most acid and the sweetest fruits.

The ripe fruit has 40 – 50% edible pulp that can be eaten and contains per 100 g : 17.8 – 35.8 g. water ; 2 - 3 g. protein ; 0.6 g. fat ; : 41.1 – 61.1 g. carbohydrate ; 2.9 g fiber ; : 2.6 – 3.9 g ash ; 34 – 94 mg. calcium ; 34 -78 mg. phosphorus ; 0.2 – 0.9 mg. iron ; 0.33 mg’ thiamine ; 0.1 mg. riboflavin ; 1 mg. niacin ; 44 mg. vitamin C .

Fresh seeds contains 13 % water, 20 % protein, 5.5 % fat, 59 % carbohydrate, 2.4 % ash and the remain are amyloids, phytohemaglutinins and flavonoids.

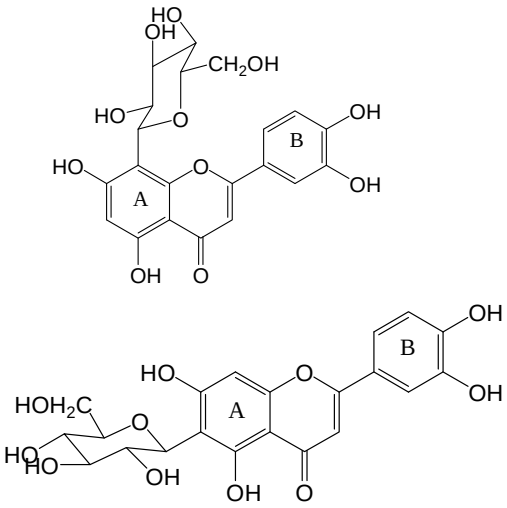
Pulps, leaves and stems of *Tamrindus indica* L. contain saponins, flavonoids and tannins (6).

Ingredients the parts of *Tamarindus indica* L. tree : (6)

- Pulps contains invert sugar, pipecolic acid, citric acid, nicotinic acid, 1-malic acid, pipecolic acid, vitexin, isovitexin, orientin, isoorientin, vitamin B_3 ,volatile oils (geranial, geraniol, limonene), cinnamates, serine, beta-alanine, pectin, praline,

phenylalanine, leucine, potassium and lipids.

- Leaves contains sitexin, isovetexin, orientin, isiorientin, 1-malic acid, tannin, glycosides, and peroxidase.
- Barks contains tannins, saponins, glycosides, peroxidase and lipids.



Orientin

Iso-orientin

Figure 4. Chemical Structures of Orientin (8-c-Beta-D-glucopyranosyl-3',4',5,7- tetrahydroxyflavone) and Iso-orientin (6-substituented luteolin analogue) (13)

A new cardenolide was isolated from acetone soluble fraction of the concentrated 90 % ethanolic extracts of the seed of *Tamarindus indica* Linn. (14). Shoboonlue *et al* (15) shown that the potassium level is low in young tamarind leaves and high in ripe tamarind fruit.

The recent research (2003), a comparatives study was carried out to the characteristics of ripened tamarind fruit collected from five different countries (Bangladesh, India, Pakistan, Philippines, and Thailand) in South-East Asia (16). Physiological development of tamarind fruit proximate chemical composition, total sugar content, mineral component, antioxidant activities and phenolics of ripened fruit pulp were analyzed. The moisture content of the ripened fruit was 20 %. The results shown that proximate composition, energy value, sugar content and mineral components were expressed as 100 g dry-weight of the tamarind pulps. The amount of crude proteins crude lipids, crude fiber, ash and total crude carbohydrates were 8.5 to 9.1; 2.7 to 3.1; 2.8 to 3.4 ; 2.9 to 3.3 and 82.1 to 82.6 g , respectively. The energy value range from 1539 to 1581 KJ and the total sugar content varied between 46.5 and 58.7 g. Mineral components the amounts of Mg (25.6 – 30.2 mg0 and Na (23.8 – 28.9 mg) were found to be highest, while the lowest amount were recorded for Ca (0.8 – 1.2 mg) and Zn (0.8 – 0.9 mg). The values antioxidant activity expressed by oxygen radical absorbance capacity (ORAC) and total phenolic content (TPC) in tamarind fruit pulp ranged from 59.1 top 60.3 μmol of Trolox equivalent (TE)

g dry-weight and 626.6 to 664.0 mg of garlic acid equivalent (GAE) 100 g dry-weight. (16).

The fresh shoots and tender leaves are an excellent source of vitamin B (17).

Pavek *et al.* (18), have found a new hydrophilic antioxidant from a natural complex of branched polysaccharide with polyphenolic component (Polyant-T) in tamarind seeds. It maintains its antioxidant activity in present of transient metal ions.

Ishola *et al*. (19) shown that the edible pulp of *Tamarindus indica* L. fruit is relatively poor in protein and oil, but the seed is a good source of both. The pulp and seed are good sources of calcium, and the seed of phosphorus, magnesium and potassium. Low level of phytic acid and heat labile trypsin inhibitor are present (19).

Sudjaroen *et al* (20) were studied isolation and structure elucidation of phenolic antioxidant from tamarind (*Tamarindus indica* L.) seed and pericarp. They concluded that the profile (%0 of polyphenolic in tamarind pericarp was dominated by proanthcyanidin (73.4) in various forms (+)-catechin (2.0), procyanidin B2 (8.2), (-)-epicatechin (9.4), procyanidin trimer (11.3), procyanidin tetramer (22.2), procyanidin pentamer (11.6), procyanidin hexamer (12.8), along with taxifolin (7.4), apigenin (2.0), eriodictyol (6.9), luteolin (5.0) and naringenin (1.4) of total phenol respectively. The content of tamarind seeds comprised only procyanidin represented (%) mainly by oligomeric procyanidin tetramer (30.2), procyanidin hexamer (23.8), procyanidin trimer (18.1), procyanidin pentamer (17.6), with lower amount of procyanidin B2 (5.5) and (-)-epicatechin (4.8). Extraction of tamarind pericarp and seeds using acetone: methanol : acetic acid gave only procyanidin oligomers, but in much higher yield and variety. The antioxidant capacity of the Soxhlet methanolic extracts were determined, and indicates that tamarind may be an important source of cancer chemo-preventive natural products in tropical regions (20).

The recent research (2007), by Iman *et al* (21), shown that *Tamarndus indica* L., a useful medicinal plant was subject to phytochemical investigation. There are two triterpenes (lupanone and lupeol) have been isolated from this plant. The lupanone and lupeol from this plant are being reported the first time.

It appeared that tamarind fruit contains a biologically important source of mineral elements, shows a high antioxidant capacity and high level phenolics. Tamarind fruits or food-products from

tamarind fruit pulps may act a functional food, the consumption of which is associated with specific beneficial effects on human health.

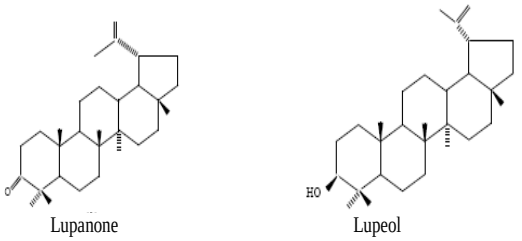


Figure 5. Chemical Structures of Lupanone and Lupeol (21)

There are many biological activity possible in tamarind tree specialized in fruit pulp and seed, because these ingredients.

THE ADVANTAGES OF TAMARIND (4, 6,7, 8 , 17, 22)

Tamarind tree has many characteristics, its wood or bark is hard and solid, and its fruit is sour with sweet taste, many nutrition and biological active ingredients, so there are many advantages of tamarind.

1. **General uses :**

- The wood or bark is used for making boat, house frame, family or kitchen tools and toys (dakon /congklak, gangsing).
- The seed oil that resembles linseed oil is suitable for making paints and varnish.
- The fruit can be used for cleaning silver and copper ware.

Figure 4. Congklak made of Tamarind wood (Indonesian Product)

2. **Foods or food products :**

As mentioned above, the food or food products from tamarind fruit pulps may act as functional foods not only as a food (energy or nutrition sources), with beneficial affection for healthy.

- The green fruit s and flowers may be used for souring soupy dish of fish and meat.
- The ripe fruit of the sweet type is usually eaten fresh,.
- The fruits of sour types are made into juice, jam, syrup and candy.

There are many beverages or juices and candies with tamarind ingredient in Indonesian markets such as “Gula Asam” and “Sari Asam” (beverages), and “Gulas” and “Bon-C” (candies).

Figure 5. Juice or Beverage Products with Tamarind ingredient (Indonesian Products)

- Tamarind seeds are edible as snack after soaking in water and boiling to remove the seed -coat.
- Flour of the seeds may be made into cakes and breads.

Figure 6. Candy Products with Tamarind ingredient (Indonesian Products)

Figure 7. "Sayur Asam" with Tamarind Spice Cooked Dish of Indonesia

- The pulps of tamarind is also made spices for making many cooked dishes of Indonesia such as " sayur asam" or "jangan asam".

TABLE 1. *TAMARIDUS INDICA* L. TRADITIONAL MEDICINAL USED IN SEVERAL INDONESIAN ETHNICS

No.	Indonesian Ethnic	Part used	Traditional Indication
1	Sakai – Mandau Riau	Fruits in mixture	Abortive
2	Mentawai – Siberut Island West Sumatra	Fruits in mixture	Stomach pain, Post – partum
3	Sunda – West Java	Fruits in mixture Fruit pulps in mixture Fruits Young leaves + fruits Young leaves+ fruit pulps	Fever, Urolithiasis, Post – partum, Body pain (“pegal linu”) Fever, Sprained Flatulent Unpleasant body smell Constipation
4	Jawa – Central Java	Fruits in mixture Fruits in mixture Fruits	Shedding skin Menstruation pain Fever, Body fresher
5	Madura – Madura Island	Fruits in mixture Young leaves in mixture Fruits in mixture	Asthmatic, Diabetic Nausea in pregnant Body slimmer
6	Bali – Bali Island	Fruits in mixture Fruits in mixture	Cough with throat pain Flatulent
7	Sumbawa – Sumbawa Island	Young leaves Fruit pulps	Itching Lung disease/disturb.
8	Dawan – Central Nord Timor	Fruits	Fever
9	Atoni – Kupang Island	Young fruits	Diarrhea
10	Kutai – East Kalimantan	Fruits	Partum
11	Ambon – Seram peoples	Fruit pulps	Catch a cold (“masuk angin”)

3. Traditional Medicines:

(4,6,7,8,10,17,22)

Because of its taste is sour and sweet, cool and astringent, and its ingredients, many parts of tamarind have been used as traditional medicines for many cases of the human – health.

- Leaves of tamarind are used to cure cough, pyretic, rheumatism, jaundice, worm infection, sores, ulcer and insomnia. Its leaf is used as a hot juice or decoction.
- Flowers used for pulmonary tuberculosis, cough with blood, pharinkhitis chronic, rheumatism, locally edema and wound.
- Barks used for asthmatic, pyretic, amenorrhea, colic and scorbutic ("sariawan").
- Fruits pulp are used to cure constipate, pyretic, dysentery, loss of appetite, alcohol toxicity, vomit, worm infection, jaundice, nausea and vomit in pregnant, asthmatic, breast inflammation urticaria allergic, morbili, thirsty and for intoxication of Hydrocarpus seeds..
- Seeds used for snake bite, wound/ ulcer, and drop off hair.

Pulps and fruits of *Tamarindus indica* L. is often used with other medicinal plants for any treat of diseases. In The Formulary of Indonesian Traditional Medicines (10), there is Jamu's formula : *Tamarindus indica* L. pulps 10 g, fresh *Curcuma xanthorriza* Roxb. rhizomes 20 g and sugar 30 g, are mixing in water until 250 ml, boiling at 90 ^{o}C for 15 minutes , filtered and add water until 250 ml again. It's as an infusion that is drinking for appetite stimulation.

.In Indonesia, there are many ethnics that have many herbal medicines used traditionally and may be difference between ethnics. Table 1 below shows the uses of tamarind in several ethnics in Indonesia (23).

In the scope of regulations of several countries; French regulated that's fruit pulp tamarind permitted as a laxative, Belgium regulated its pulp permitted as a traditional laxative, and Swedish regulation, it classified as a natural product (24).

PHARMACOLOGICAL ACTIVITIES OF *TAMARINDUS INDICA* L.

Pre-clinical (animals) Pharmacological Data

The antioxidant activity of tamarind has been found by many researchers (16, 18), so the tamarind has

advantages for usage in human health as a herbal medicines for degenerative diseases and usage especially in color cosmetics and sun screen.

A polysaccharide isolated and purified from *Tamarindus indica*, shows immunomodulatory activities such as phagocytic enhancement, leukocyte migration inhibition and inhibition of cell proliferation (25). These properties suggest that this polysaccharide may have some biological applications.

The carcinogenic potential of this tamarind seed polysaccharide was examined in both sexes of B6C3F_1 mice (26). The results demonstrated that its polysaccharide is not carsinogenic in B6C3F_1 mice of ether sex.

Bioassay-guided fractionation of methanolic extract of tamarind seeds led to isolation of L-(-)-di-n-butyl maleate which a pronounced cytotoxic activity against sea urchin embryo cells (27). In order to study structure-activity relationships of its analogues, that L-(-0-di-n-pentyl maleate was the most effective inhibitor to the development of the fertilized sea urchin eggs, and significant inhibitory activity was not in the esters of D-(-)-isomer.

Another research (28), exploited the role of a natural polysaccharide from the tamarind seed (xyloglycan) and the integrin-substrate recognition system (in vitro, with cultured human conjunctival cells) and on repair of corneal wounds in rabbit (in vivo0. The results concluded the ability of the polysaccharide (xyloglycan) to promote corneal wound healing might depend on its influence on the integrin recognition system. This result was support by M. Rolando and C. Valente from the University of Genoa Italy (29),that they used tamarind seed polysaccharide in the eye drops and showed that the eye drops did a significantly better job of relieving several key subjective symptoms of dry eye syndrome-namely, trouble blinking, ocular burning and sensation of having something in one's eye.

Water extract of tamarind seed was found to have potent antidiabetogenic activity that reduces blood sugar level in streptozotocin-induced diabetic male rats (30).

The effects of crude extract from pulp fruit of *Tamarndus indica* L. on lipid serum level and early atherosclerotic lesions in hypercholesterolemic hamsters in vivo, and antioxidant action in vitro, have been studied by Martinello *et al.*(31). Treatment of hypercholesterolemic hamsters with 5% pulp fruit tamarind extract led to decrease in the levels of serum total cholesterol (50%), non-HDL

cholesterol (73%) and triglyceride (60%), and to an increase of high-density lipoprotein (LDL) cholesterol level (61%). In vitro, the extract presented radical scavering ability, as assessed by the 2,2-diphenyl-1-picrylhydrazyl (DPPH) and superoxide radicals assays, and to decreases lipid peroxidation in serum, as assessed by the thiobarbituric acid reactive substances (TBARS). In vivo, the extract also improved the efficiency of the antioxidant defense system, as assessed by superoxide dismutase, catalase and glucathione peroxidase activities (31). Together these results indicate the potential of tamarind (pulp fruits) extracts in diminishing risk of atherosclerosis development in humans.

The recent research (2007), the evaluation of a crude hydroalcoholic extract fro tamarind pup fruit as a source of compound active on the complement system in vitro, and the role of complement system in the phase preceding the inflammatory process of atherosclerosis in hypercholesterolemia hamster, have been done by Librandi and his friends (32). The results shown the activity of 0.8 mg/ml of the extract on the classical/ lectin pathway (CP/LP) increased after 15 min of pre-incubation, while that of the alternative pathway (AP) decreased after 15 min at 1 mg/ml, and the treatment with the extract blocked the increase of complementary activity caused by the cholesterol rich diet, but itself, extract no effect on the complement system in vivo. Activity of the hydroalcoholic extract of tamarind pulp fruit on the complement system may be interest for therapy and research purposed.

Another researcher shown the anti-snake venom of tamarind seed extract (33), that inhibited the PLA_2, protease, hyaluronidase, 1-amino acid oxidase and 5'-nucleotidase enzyme activities of venom (*V. russelli* venom) in a dose-dependent manner. These enzymes are mayor hydrolytic enzymes responsible for early effects of envenomation, such as a local tissue damages, inflammation and hypotension. On animals that received extract 10 minutes after the injection venom were protected from venom induced toxicity. Since it inhibits hydrolytic enzymes and that proved pharmacologically activity, it may be used as an alternative treatment to serum therapy in snake bite case and in addition, as a rich sourche of potential inhibitor of PLA_2 , metalloproteinases, serine proteases, hyaluronidases and 5'-nucleotidases, the enzymes involved in several physiopathological human and animal diseases.

Another recent research (2007), Sauza and Aka (34), have studied the effect of water extract of tamarind on the guinea-pig taenia coli due to its use for treatment of constipation in traditional medicine. They shows the extract at concentrations ranging from 10^{-8} mg/ml to 10^{-2} mg/ml increased the spontaneous contractile activity of guinea-pig taenia coli in a dose dependent manner with $EC_{50} = 4.10^{-6}$ mg/ml. This activity was unaffected by atropine and in the high K^+, Ca^{2+}- free solution, this extract as well as acetylcholine (use as a control induced tonic contraction). These results that the plants extract exert a spasmogenic effect that would not involve cholinergic mechanism of action.

Chronic toxicity of tamarind seed have been done by Iida *et al.* (35),that no toxicity was seen in rats fed diet containing tamarind seed polysaccharide (Glyloid) at 4, 8 and 12% for two years.

Clinical Pharmacological Data

There are not much clinical research about the pharmacological activities of *Tamarindus indica* L. The aim of clinical (and preclinical) research on herbal medicines commonly for giving a scientific evidence of uses herbal medicines, on the base of herbal uses as medicines or/and the effects of herbal ingestion to humans.

Khadare *et al.* (36), evaluated the effect of tamarind on ingestion and whether it provides additional beneficial effects on mobilization of fluoride from the bone after children provided defluoridated water. The main changes in urinary components (volume, pH, fluoride, calcium, copper and magnesium) after tamarind ingestion by the children in the fluoride endemic area, in the control and experimental groups were compared. The results shows that was a significant increase ($P < 0.01$) in fluoride excretion and urinary pH, and a significant decrease in urinary calcium ($P < 0.01$) and copper ($P < 0.05$) excretion, in the experimental group as compared with the control group. There was no change in urinary volume between two groups. (36). Tamarind intake appears to have an additional beneficial effect on the mobilization of deposited fluoride from bone, by enhancing urinary excretion of fluoride.

Fruits of tamarind were evaluated for their effects on lipid profile, systolic and diastolic blood pressure, and body weight in human subjects (37). Dried and pulverized pulp of this fruit at a dose of 15 mg/kg bw. was found to reduce total cholesterol level ($P = 0.031$) and LDL-cholesterol level ($P=0.004$) to significant

extent. Through the fruit exerted to conspicuous effect on the body weight and systolic blood pressure, it significantly reduced the diastolic blood pressure as confirmed by independent sample test at 5 percent significant level.

An innovative new treatment for dry eye use tamarind seed polysaccharide has been studied clinically (38). The tamarind seed polysaccharide 0.5% and 1% were comparable to hyaluronic acid 0.2% with regard to both primary and secondary objective parameters. This polysaccharide showed benefits over hyaluronic acid 0.2% for subjective sensation. This study suggest that this tamarind seed polysaccharide 0.5% and 1% offer at least equivalent relief to hyaluronic acid for eye dry syndrome. All treatments demonstrated optimal tolerability and are suitable for frequent use in therapy of dry eye. The tamarind seed polysacharide 1% produced promising results in benefits of the tamarind seed polysaccharide formulation. This study paves the way for a larger study to further establish the performance and safety of tamarind seed polysaccharide compared with hyaluronic acid and highlight the need to expand this therapeutics agent to a wider dry eye population.

CONCLUSION

- The Root, stem, leaf, fruit and seed of *Tamarindus indica* L. have many purposes for the human life.
- The tamarind has many biological active components that prospective to be effective medicines.
- The scientific evidences of health benefit of tamarind :
    - Pre-clinically pharmacology approved the activities of immunomodulator, on complement system, antioxidant, for eye disease (dry eye), anti-diabetic, cytotoxic, anti-cholesterol, antihypertensive, anti-inflammatory, and laxative (anti-constipation).
    - Clinical trial approved the activities of fluoride renal excretion, anti-cholesterol, anti-hypertensive and for treatment dry eye.
    - Chronic toxicity study, no toxicity was seen for two years in rats.
- This review of *Tamarindus indica* L. is hopeful induce the advance

research about the benefit of this plant for human life.-

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