

بسم الله الرحمن الرحيم



**Sudan University of science and technology**  
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**Extraction of tamarindal and furan derivative from *tamarindusindica***

**A Thesis submitted In Partial Fulfillment of The Requirements For  
The B.Sc. Degree In Chemistry**

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# الآية

قال تعالى:

بسم الله الرحمن الرحيم

اللَّهُ نُورُ السَّمَاوَاتِ وَالْأَرْضِ ۗ مَثَلُ نُورِهِ كَمِشْكَاةٍ فِيهَا

مِصْبَاحٌ ۗ الْمِصْبَاحُ فِي زُجَاجَةٍ ۗ الزُّجَاجَةُ كَأَنَّهَا كَوْكَبٌ  
دُرِّيٌّ يُوقَدُ مِنْ شَجَرَةٍ مُبَارَكَةٍ زَيْتُونَةٍ لَّا شَرْقِيَّةٍ وَلَا  
غَرْبِيَّةٍ يَكَادُ زَيْتُهَا يُضِيءُ وَلَوْ لَمْ تَمْسَسْهُ نَارٌ ۗ نُورٌ  
عَلَىٰ نُورٍ ۗ يَهْدِي اللَّهُ لِنُورِهِ مَن يَشَاءُ ۗ وَيَضْرِبُ اللَّهُ

الْأَمْثَالَ لِلنَّاسِ وَاللَّهُ عَلِيمٌ

صدق الله العظيم

سورة النور، الآية (35)

## **Dedication**

We would like to dedicate this thesis to our parents for their endless love, support and encouragement

## Acknowledgment

First of all, thankallah for always being with me during this project and indeed , throughout my life

قال تعالي (قل بنعمة الله وبرحمته فبذلك فليفرحوا هو خير مما يجمعون )

We would like to sincerely thank our supervisor ,Prof .Ahmed elsadig for his guidance and support throughout this study and especially in his confidence in us

To all our friend thank you for your understanding and encourgment

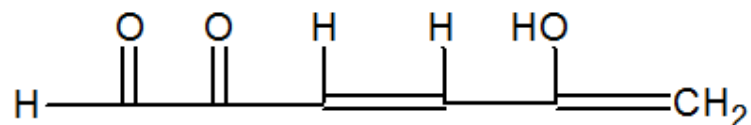
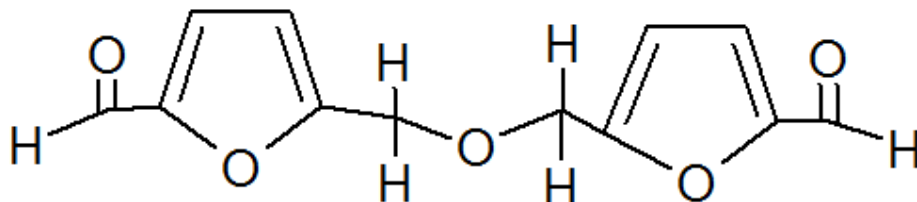
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## ABSTRACT

In this research two compounds(A and B) were isolated from tamarind fruit pulp through a multi step extraction process with different solvents benzene and petroleum ether ,water and chloroform

The IR spectrum gave the expected functional group of the compound (A) and compound (B)

The structure of the compound are :



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## **Tamarindusindica(aradaib):**

### **1-Introduction:**

Of all the fruit trees of the tropics, none is more widely distributed nor more appreciated as an ornamental than the tamarind, *Tamarindusindica* L. (syns. *T. occidentalis* Gaertn.; *T. officinalis* Hook.), of the family Leguminosae. Most of its colloquial names are variations on the common English term. In Spanish and Portuguese, it is tamarindo; in French, tamarin, tamarinier, tamarinier des Indes, or tamarindier; in Dutch and German, tamarinde; in Italian, tamarandizio; in Papiamentu of the Lesser Antilles, tamarijn. In the Virgin Islands, it is sometimes called taman; in the Philippines, sampalok or various other dialectal names; in Malaya, asamjawa; in India, it is tamarind or ambli, imli, chinch, etc.; in Cambodia, it is ampil or khoua me; in Laos, makkham; in Thailand, makharm; in Vietnam, me. The name "tamarind" with a qualifying adjective is often applied to other members of the family Leguminosae having somewhat similar foliage.



**Plate XIV: TAMARIND,**

**1-1-Description:***Tamarindusindica*

The tamarind, a slow-growing, long-lived, massive tree reaches, under favorable conditions, a height of 80 or even 100 ft (24-30 m), and may attain a spread of 40 ft (12 m) and a trunk circumference of 25 ft (7.5 m). It is highly wind-resistant, with strong, supple branches, gracefully drooping at the ends, and has dark-gray, rough, fissured bark. The mass of bright-green, fine, feathery foliage is composed of pinnate leaves, 3 to 6 in (7.5-15 cm) in length, each having 10 to 20 pairs of oblong leaflets 1/2 to 1 in (1.25-2.5 cm) long and 1/5 to 1/4 in (5-6 mm) wide, which fold at night. The leaves are normally evergreen but may be shed briefly in very dry areas during the hot season. Inconspicuous, inch-wide flowers, borne in small racemes, are 5-petalled (2 reduced to bristles), yellow with orange or red streaks. The flowerbuds are distinctly pink due to the outer color of the 4 sepals which are shed when the flower opens.

The fruits, flattish, beanlike, irregularly curved and bulged pods, are borne in great abundance along the new branches and usually vary from 2 to 7 in long and from 3/4 to 1 1/4 in (2-3.2 cm) in diameter. Exceptionally large tamarinds have been found on individual trees. The pods may be cinnamon-brown or grayish-brown externally and, at first, are tender-skinned with green, highly acid flesh and soft, whitish, under-developed seeds. As they mature, the pods fill out somewhat and the juicy, acidulous pulp turns brown or reddish-brown. Thereafter, the skin becomes a brittle, easily-cracked shell and the pulp dehydrates naturally to a sticky paste enclosed by a few coarse strands of fiber extending lengthwise from the stalk. The 1 to 12 fully formed seeds are hard, glossy-brown, squarish in form, 1/8 to 1/2 in (1.1-1.25 cm) in diameter, and each is enclosed in a parchment like membrane.

## **1-2 Origin and Distribution:**

Native to tropical Africa, the tree grows wild throughout the Sudan and was so long ago introduced into and adopted in India that it has often been reported as indigenous there also, and it was apparently from this Asiatic country that it reached the Persians and the Arabs who called it "*tamarhindi*" (Indian date, from the date-like appearance of the dried pulp), giving rise to both its common and generic names. Unfortunately, the specific name, "*indica*", also perpetuates the illusion of Indian origin. The fruit was well known to the ancient Egyptians and to the Greeks in the 4th Century B.C.

The tree has long been naturalized in the East Indies and the islands of the Pacific. One of the first tamarind trees in Hawaii was planted in 1797. The tamarind was certainly introduced into tropical America, Bermuda, the Bahamas, and the West Indies much earlier. In all tropical and near-tropical areas, including South Florida, it is grown as a shade and fruit tree, along roadsides and in dooryards and parks. Mexico has over 10,000 acres (4,440 ha) of tamarinds, mostly in the states of Chiapas, Colima, Guerrero, Jalisco, Oaxaca and Veracruz. In the lower Motagua Valley of Guatemala, there are so many large tamarind trees in one area that it is called "El Tamarindal". There are commercial plantings in Belize and other Central American countries and in northern Brazil. In India there are extensive tamarind orchards producing 275,500 tons (250,000 MT) annually. The pulp is marketed in northern Malaya and to some extent wherever the tree is found even if there are no plantations.

## **1-3 Varieties:**

In some regions the type with reddish flesh is distinguished from the ordinary brown-fleshed type and regarded as superior in quality. There

are types of tamarinds that are sweeter than most. One in Thailand is known as '**Makhamwaan**'. One distributed by the United States Department of Agriculture's Subtropical Horticulture Research Unit, Miami, is known as '**Manila Sweet**'.

#### **1-4 Climate:**

Very young trees should be protected from cold but older trees are surprisingly hardy. Wilson Popenoe wrote that a large tree was killed on the west coast of Florida (about 7.5° lat. N) by a freeze in 1884. However, no cold damage was noted in South Florida following the low temperatures of the winter of 1957-1958 which had severe effects on many mango, avocado, lychee and lime trees. Dr. Henry Nehrling reported that a tamarind tree in his garden at Gotha, Florida, though damaged by freezes, always sprouted out again from the roots. In northwestern India, the tree grows well but the fruits do not ripen. Dry weather is important during the period of fruit development. In South Malaya, where there are frequent rains at this time, the tamarind does not bear.

#### **1-5 Soil:**

The tree tolerates a great diversity of soil types, from deep alluvial soil to rocky land and porous, oolitic limestone. It withstands salt spray and can be planted fairly close to the seashore.

#### **1-6 Propagation:**

Tamarind seeds remain viable for months; will germinate in a week after planting. In the past, propagation has been customarily by seed sown in position, with thorny branches protecting the young seedlings. However, today, young trees are usually grown in nurseries. And there is intensified interest in vegetative propagation of selected varieties because of the commercial potential of tamarind products. The tree can be grown easily from cuttings, or by shield-budding, side-veneer grafting, or air-layering.

### **1-7 Culture:**

Nursery-grown trees are usually transplanted during the early rainy season. If kept until the second rainy season, the plants must be cut back and the taproot trimmed. Spacing may be 33 to 65 ft (10-20 m) between trees each way, depending on the fertility of the soil. With sufficient water and regular weeding, the seedlings will reach 2 ft (60 cm) the first year and 4 ft (120 cm) by the second year.

In Madagascar, seedlings have begun to bear in the 4th year; in Mexico, usually in the 5th year; but in India, there may be a delay of 10 to 14 years before fruiting. The tree bears abundantly up to an age of 50-60 years or sometimes longer, then productivity declines, though it may live another 150 years.

### **1-8 Season:**

Mexican studies reveal that the fruits begin to dehydrate 203 days after fruit-set, losing approximately 1/2 moisture up to the stage of full ripeness, about 245 days from fruit-set. In Florida, Central America, and the West Indies, the flowers appear in summer, the green fruits are found in December and January and ripening takes place from April through June. In Hawaii the fruits ripen in late summer and fall.

**1-9Harvesting:**

Tamarinds may be left on the tree for as long as 6 months after maturity so that the moisture content will be reduced to 20% or lower. Fruits for immediate processing are often harvested by pulling the pod away from the stalk which is left with the long, longitudinal fibers attached. In India, harvesters may merely shake the branches to cause mature fruits to fall and they leave the remainder to fall naturally when ripe. Pickers are not allowed to knock the fruits off with poles as this would damage developing leaves and flowers. To keep the fruit intact for marketing fresh, the stalks must be clipped from the branches so as not to damage the shell.

**1-10Yield:**

A mature tree may annually produce 330 to 500 lbs (150-225 kg) of fruits, of which the pulp may constitute 30 to 55%, the shells and fiber, 11 to 30 %, and the seeds, 33 to 40%.

**1-11 keeping quality:**

To preserve tamarinds for future use, they may be merely shelled, layered with sugar in boxes or pressed into tight balls and covered with cloth and kept in a cool, dry place. For shipment to processors, tamarinds may be shelled, layered with sugar in barrels and covered with boiling sirup. East Indians shell the fruits and sprinkle them lightly with salt as a preservative. In Java, the salted pulp is rolled into balls, steamed and sun-dried, then exposed to dew for a week before being packed in stone jars. In India, the pulp, with or without seeds and fibers may be mixed with salt (10%), pounded into blocks, wrapped in palmleaf matting, and packed in burlap sacks for marketing. To store for long periods, the blocks of pulp may be first steamed or sun-dried for several days.

## 1-12 Pests and Diseases:

One of the major pests of the tamarind tree in India is the Oriental yellow scale, *Aonidiellaorientalis*. Tamarind scale, *A.tamarindi*, and black, or olive, scale, *Saissetiaoleae*, are also partial to tamarind but of less importance. Butani (1970) lists 8 other scale species that may be found on the tree, the young and adults sucking the sap of buds and flowers and accordingly reducing the crop.

The mealybug, *Planococcuslilacinus*, is a leading pest of tamarind in India, causing leaf-fall and sometimes shedding of young fruits. Another mealybug, *Nipaecoccusviridis*, is less of a menace except in South India where it is common on many fruit trees and ornamental plants. *Chionaspisacuminata-atricolor* and *Aspidiotus* spp., suck the sap of twigs and branches and the latter also feeds on young fruits. White grubs of *Holotrichiainsularis* may feed on the roots of young seedlings. The nematodes, *Xiphinematitri* and *Longidoruselongatus* may affect the roots of older trees. Other predators attacking the leaves or flowers include the caterpillars, *Thosaaaperiens*.

*Thalarsodesquadraria*, *Stauropusalternus*, and *Laspeyresiapalamedes*; the black citrus aphid, *Toxopteraaurantii*, the whitefly, *Acaudaleyrodesrachispora*; thrips, *Ramaswami ahiellsubnudula*, *Scirtothripsdorsalis*, and *Haplothripsceylonicus*; and cow bugs, *Oxyrhachistarandus*, *Otinotusonerotus*, and *Laptoentrusobliquis*.

Fruit borers include larvae of the cigarette beetle, *Lasiodermaserricorne*, also of *Viracholaisocrates*, *Dichocrocispunctiferalis*, *Triboliumcastaneum*, *Phycitaorthoclina*, *Cryptophlebia (Argyroploca) illepide*, *Oecadarchis* sp., *Holocerapulverea*, *Assaraalbicostalis*, *Araecerussuturalis*, *Aephitobiuslaevigatus*, and *Aphomiagularis*. The



latter infests ripening pods on the tree and persists in the stored fruits, as do the tamarind beetle, *Pachymerus (Coryoborus) gonogra*, and tamarind seed borer, *Calandra (Sitophilus) linearis*. The rice weevil, *Sitophilusoryzae*, the rice moth, *Corcyra cephalonica*, and the fig moth, *Ephestiacautella*, infest the fruits in storage. The lesser grain borer, *Rhyzoperthadominicabores* into stored seeds.

In India, a bacterial leaf-spot may occur. Sooty mold is caused by *Meliolatamarindi*. Rots attacking the tree include saprot, *Xylariaeuglossa*, brownish saprot, *Polyporuscalcuttensis*, and white rot, *Trametesfloccosa*. The separated pulp has good keeping quality but is subject to various molds in refrigerated storage.



Fig 32: Acid-sweet pulp of the tamarind (*Tamarindusindica*) is blended with sugar as a confection, or preserved as jam or nectar. It enhances chutney and some well-known sauces.

### 1-13 Food Uses:

The food uses of the tamarind are many. The tender, immature, very sour pods are cooked as seasoning with rice, fish and meats in India. The fully-grown, but still unripe fruits, called "swells" in the Bahamas, are roasted in coals until they burst and the skin is then peeled back and the sizzling pulp dipped in wood ashes and eaten. The fully ripe, fresh fruit is relished out-



Fig. 33: Bahamian children hold mature but still green tamarinds in hot ashes until they sizzle, then dip the tip in the ashes and eat them. The high calcium content contributes to good teeth.

of-hand by children and adults, alike. The dehydrated fruits are easily recognized when picking by their comparatively light weight, hollow sound when tapped and the cracking of the shell under gentle pressure. The shell lifts readily from the pulp and the lengthwise fibers are removed by holding the stem with one hand and slipping the pulp downward with the other. The pulp is made into a variety of products. It is an important ingredient in chutneys, curries and sauces, including some brands of Worcestershire and barbecue sauce, and in a special Indian seafood pickle called "tamarind fish". Sugared tamarind pulp is often prepared as a confection. For this purpose, it is desirable to separate the pulp from the seeds without using water. If ripe, fresh, undehydrated tamarinds are available, this may be done by pressing the shelled and defibered fruits through a colander while adding powdered sugar to the point where the pulp no longer sticks to the fingers. The seeded pulp is then shaped into balls and coated with powdered sugar. If the tamarinds

are dehydrated, it is less laborious to layer the shelled fruits with granulated sugar in a stone crock and bake in a moderately warm oven for about 4 hours until the sugar is melted, then the mass is rubbed through a sieve, mixed with sugar to a stiff paste, and formed into patties. This sweetmeat is commonly found on the market in Jamaica, Cuba and the Dominican Republic. In Panama, the pulp may be sold in corn husks, palmleaf fiber baskets, or in plastic bags.

Tamarind ade has long been a popular drink in the Tropics and it is now bottled in carbonated form in Guatemala, Mexico, Puerto Rico and elsewhere. Formulas for the commercial production of spiced tamarind beverages have been developed by technologists in India. The simplest home method of preparing the ade is to shell the fruits, place 3 or 4 in a bottle of water, let stand for a short time, add a tablespoonful of sugar and shake vigorously. For a richer beverage, a quantity of shelled tamarinds may be covered with a hot sugar sirup and allowed to stand several days (with or without the addition of seasonings such as cloves, cinnamon, allspice, ginger, pepper or lime slices) and finally diluted as desired with ice water and strained.

In Brazil, a quantity of shelled fruits may be covered with cold water and allowed to stand 10 to 12 hours, the seeds are strained out, and a cup of sugar is added for every 2 cups of pulp; the mixture is boiled for 15 to 20 minutes and then put up in glass jars topped with paraffin. In another method, shelled tamarinds with an equal quantity of sugar may be covered with water and boiled for a few minutes until stirring shows that the pulp has loosened from the seeds, then pressed through a sieve. The strained pulp, much like apple butter in appearance, can be stored under refrigeration for use in cold drinks or as a sauce for meats and poultry, plain cakes or puddings. A foamy "tamarind shake" is made by stirring

this sauce into an equal amount of dark-brown sugar and then adding a tablespoonful of the mixture to 8 ounces of a plain carbonated beverage and whipping it in an electric blender.

If twice as much water as tamarinds is used in cooking, the strained product will be a sirup rather than a sauce. Sometimes a little soda is added. Tamarind sirup is bottled for domestic use and export in Puerto Rico. In Mayaguez, street vendors sell cones of shaved ice saturated with tamarind sirup. Tamarind pulp can be made into a tart jelly, and tamarind jam is canned commercially in Costa Rica. Tamarind sherbet and ice cream are popular and refreshing. In making fruit preserves, tamarind is sometimes combined with guava, papaya or banana. Sometimes the fruit is made into wine.

Inasmuch as shelling by hand is laborious and requires 8 man-hours to produce 100 lbs (45 kg) of shelled fruits, food technologists at the University of Puerto Rico have developed a method of pulp extraction for industrial use. They found that shelling by mechanical means alone is impossible because of the high pectin and low moisture content of the pulp. Therefore, inspected and washed pods are passed through a shell-breaking grater, then fed into stainless steel tanks equipped with agitators. Water is added at the ratio of 1:1 1/2 or 1:2 pulp/water, and the fruits are agitated for 5 to 7 minutes. The resulting mash is then passed through a screen while nylon brushes separate the shells and seeds. Next the pulp is paddled through a finer screen, pasteurized, and canned.

Young leaves and very young seedlings and flowers are cooked and eaten as greens and in curries in India. In Zimbabwe, the leaves are added to soup and the flowers are an ingredient in salads.

Tamarind seeds have been used in a limited way as emergency food. They are roasted, soaked to remove the seedcoat, then boiled or fried, or ground to a flour or starch. Roasted seeds are ground and used as a substitute for, or adulterant of, coffee. In Thailand they are sold for this purpose. In the past, the great bulk of seeds available as a by-product of processing tamarinds, has gone to waste. In 1942, two Indian scientists, T. P. Ghose and S. Krishna, announced that the decorticated kernels contained 46 to 48% of a gel-forming substance. Dr. G. R. Savur of the Pectin Manufacturing Company, Bombay, patented a process for the production of a purified product, called "Jellose", "polyose", or "pectin", which has been found superior to fruit pectin in the manufacture of jellies, jams, and marmalades. It can be used in fruit preserving with or without acids and gelatinizes with sugar concentrates even in cold water or milk. It is recommended as a stabilizer in ice cream, mayonnaise and cheese and as an ingredient or agent in a number of pharmaceutical products.

**1-14 Food Value per 100 g of Edible Portion:**

	<i>Pulp (ripe) *</i>	<i>Leaves (young)</i>	<i>Flowers</i>
<i>Calories</i>	115		

<b>Moisture</b>	28.2-52 g	70.5 g	80 g
<b>Protein</b>	3.10 g	5.8 g	0.45 g
<b>Fat</b>	0.1 g	2.1 g	1.54 g
<b>Fiber</b>	5.6 g	1.9 g	1.5 g
<b>Carbohydrates</b>	67.4 g	18.2 g	
<b>Invert Sugars</b>	30-41 g		
<b>(70% glucose; 30% fructose)</b>			
<b>Ash</b>	2.9 g	1.5 g	0.72 g
<b>Calcium</b>	35-170 mg	101 mg	35.5 mg
<b>Magnesium</b>		71 mg	
<b>Phosphorus</b>	54-110 mg	140 mg	45.6 mg
<b>Iron</b>	1.3-10.9 mg	5.2 mg	1.5 mg
<b>Copper</b>		2.09 mg	
<b>Chlorine</b>		94 mg	
<b>Sulfur</b>		63 mg	
<b>Sodium</b>	24 mg		
<b>Potassium</b>	375 mg		
<b>Vitamin A</b>	15 I.U.	250 mcg	0.31 mg
<b>Thiamine</b>	0.16 mg	0.24 mg	0.072 mg
<b>Riboflavin</b>	0.07 mg	0.17 mg	0.148 mg
<b>Niacin</b>	0.6-0.7 mg	4.1 mg	1.14 mg
<b>Ascorbic Acid</b>	0.7-3.0 mg	3.0 mg	13.8 mg
<b>Oxalic Acid</b>		196 mg	
<b>Tartaric Acid</b>	8-23.8 mg		
<b>Oxalic Acid</b>	trace only		

Tamarind also contain vitamin K – 2.8 mg, vitamin E – 0.1 mg, Pyridoxine 0.066mg, Pantothenic Acid – 0.143 mg

The pulp is considered a promising source of tartaric acid, alcohol (12% yield) and pectin (2 1/2% yield). The red pulp of some types contains the pigment, chrysanthemine.

Seeds contain approximately 63% starch, 14-18% albuminoids, and 4.5-6.5% of semi-drying oil.

The flavonoids in the leaves of *tamarindusindica* can be separated by paper chromatography and identified as vitexin, isovitexin, orientin and isoorientin.

Tamarind fruit contains certain health benefiting essential volatile chemical compounds, minerals, vitamins and dietary fiber.

Its sticky pulp is rich source of **non-starch polysaccharides** (NSP) or dietary-fiber such as *gums, hemicelluloses, mucilage, pectin* and *tannins*. 100 g of fruit pulp provides 5.1 or over 13% of dietary fiber. NSP or dietary fiber in the food increases its bulk and augments bowel movements thereby help prevent constipation. The fiber also binds to toxins in the food thereby help protect the colon mucus membrane from cancer-causing chemicals.

In addition, dietary fibers in the pulp bind to bile salts (produced from cholesterol) and decrease their re-absorption in the colon; thereby help excretion of “bad” or LDL cholesterol levels from the body.

While lemon composes of *citric acid*, tamarind is rich in **tartaric acid**. Tartaric acid gives a sour taste to food but is also a very powerful antioxidant. (Anti-oxidant E-number is E334). It helps the body protect from harmful free radicals.

Tamarind fruit contains many volatile phytochemicals such as *limonene, geraniol, safrole, cinnamic acid, methyl salicylate, pyrazine* and *alkyl-thiazoles*. Together these compounds account for the medicinal properties of tamarind.

This prized spice is a good source of minerals like copper, potassium, calcium, **iron**, selenium, zinc and magnesium. Potassium is an important component of cell and body fluids that helps control heart rate and blood

pressure. **Iron** is essential for red blood cell production and as a co-factor for *cytochrome oxidases* enzymes.

In addition, it is also rich in many vital vitamins, including **thiamin** (36% of daily required levels), vitamin A, folic acid, riboflavin, niacin, and vitamin-C. Much of these vitamins plays antioxidant, and co-factor functions for enzyme metabolism inside the body.

### **1-15 Food Value:**

Analyses of the pulp are many and varied. Roughly, they show the pulp to be rich in calcium, phosphorus, iron, thiamine and riboflavin and a good source of niacin. Ascorbic acid content is low except in the peel of young green fruits.

### **1-16 Other Uses:**

**1-16-1 Fruit pulp:** in West Africa, an infusion of the whole pods is added to the dye when coloring goat hides. The fruit pulp may be used as a fixative with turmeric or annatto in dyeing and has served to coagulate rubber latex. The pulp, mixed with sea water, cleans silver, copper and brass. The use of tamarind pulp appears to be an important factor in the process dyeing yellow with certain coloring substances 3

**1-16-2 Leaves:** The leaves are eaten by cattle and goats, and furnish fodder for silkworms—*Anaphe sp.* in India, *Hypsoidesvuilletii* in West Africa. The fine silk is considered superior for embroidery.

Tamarind leaves and flowers are useful as mordants in dyeing. A yellow dye derived from the leaves colors wool red and turns indigo-dyed silk to green. Tamarind leaves in boiling water are employed to bleach the leaves of the buri palm (*Coryphaelata* Roxb.) to prepare them for hat-making. The foliage is a common mulch for tobacco plantings.



**1-16-3 Flowers:**The flowers are rated as a good source of nectar for honeybees in South India. The honey is golden-yellow and slightly acid in flavor.

**1-16-4 Seeds:**tamarind kernel powder contain 3 distinct types of polysaccharide fraction which differ in their solubilities in *powder* of gelatinization. They have been designated as fraction P1,P2,P3 the yield of P1 is 2-4% ,P2 20-30% P3 30-35 % . the polysaccharide can be separated by partial hydrolysis with dil acid fractional ppt with alcohol and warm water solution fractional ppt with ammonium sulphate or electrostatic ppt .

Tamarind also show antioxidant activity due to the presence of a phenolic compound in its seed

**1-16-5 Tamarind seed oils:** the mixture of fatty acid of purified tamarind seed oils consist of 28 mole% saturated ,26.7mole% linoleic . the glyceride distribution on molar bases 0% GS3 ,22%GS2U ,37%GSU2 and 41% GU3 where G is glycerol ,S is saturated acid and U is unsaturated acid . linolenic acid was not present with significant amounts of unsaturated . glyceride accounted for the poor keeping quantity of tamarind seed kernel powder

The powder made from tamarind kernels has been adopted by the Indian textile industry as 300% more efficient and more economical than cornstarch for sizing and finishing cotton, jute and spun viscose, as well as having other technical advantages. It is commonly used for dressing homemade blankets. Other industrial uses include employment in color printing of textiles, paper sizing, leather treating, the manufacture of a structural plastic, and glue for wood, a stabilizer in bricks, a binder in

sawdust briquettes, and a thickener in some explosives. It is exported to Japan, the United States, Canada and the United Kingdom.

Tamarind seeds yield an amber oil useful as an illuminant and as a varnish especially preferred for painting dolls and idols. The oil is said to be palatable and of culinary quality. The tannin-rich seedcoat (testa) is under investigation as having some utility as an adhesive for plywoods and in dyeing and tanning, though it is of inferior quality and gives a red hue to leather.

**1-16-6 Wood:** The sapwood of the tamarind tree is pale-yellow. The heartwood is rather small, dark purplish-brown, very hard, heavy, strong, durable and insect-resistant. It bends well and takes a good polish and, while hard to work, it is highly prized for furniture, panelling, wheels, axles, gears for mills, ploughs, planking for sides of boats, wells, mallets, knife and tool handles, rice pounders, mortars and pestles. It has at times been sold as "Madeira mahogany". Wide boards are rare, despite the trunk dimensions of old trees, since they tend to become hollow-centered. The wood is valued for fuel, especially for brick kilns, for it gives off an intense heat, and it also yields a charcoal for the manufacture of gunpowder. In Malaysia, even though the trees are seldom felled, they are frequently topped to obtain firewood. The wood ashes are employed in tanning and in de-hairing goatskins. Young stems and also slender roots of the tamarind tree are fashioned into walking-sticks.

**1-16-7 Twigs and barks:** Tamarind twigs are sometimes used as "chewsticks" and the bark of the tree as a masticatory, alone or in place of lime with betelnut. The bark contains up to 7% tannin and is often employed in tanning hides and in dyeing, and is burned to make an ink.

Bark from young trees yields a low-quality fiber used for twine and string. Galls on the young branches are used in tanning.

**1-16-8Lac:**The tamarind tree is a host for the lac insect, *Kerriallacca*, that deposits a resin on the twigs. The lac may be harvested and sold as stick-lac for the production of lacquers and varnish. If it is not seen as a useful byproduct, tamarind growers trim off the resinous twigs and discard them.

### **18-Medicinal Uses:**

The medicinal value of tamarind is mentioned in traditional Sanskrit literature. The laxative properties of the pulp and the diuretic properties of the leaf sap have been confirmed by modern medical science (Bueso, 1980). Tamarind fruits were well known in Europe for their medicinal properties, having been introduced by Arab traders from India (Rama Rao, 1975). Tamarind products, leaves, fruits and seeds have been extensively used in traditional Indian and African medicine (Jayaweera, 1981; Parrotta, 1990). Several medicinal properties are claimed for preparations containing tamarind pulp, leaves, flowers, bark and roots (Bueso, 1980 .(

A number of recent surveys have listed local folk uses of tamarind as remedies for ailments. These include use as anti-inflammatories in North Africa (Rimbau et al., 1999), use as herbal medicines in Burkina Faso (Kristensen and Lykke, 2003), use against leucorrhoea in Orissa, India (Sen and Behera 2000), use for skin disorders in Gujarat (Punjani and Kumar, 2002), and general use in Nanderbar District of Maharashtra State (Patil and Yadav, 2003) and coastal villages in Tamil Nadu (Rajendran et al., 2003). Some specific examples, many long-standing, are described below .

## Pulp

Tamarind pulp has long been used for many medicinal purposes and continues to be used by many people in Africa, Asia and America. In former times, the fruit pulp was used as a gentle laxative under the name 'Pulpatamarindorum'. It is available commercially in tablet form in Thailand for the reduction of excess weight (Bhumibhamon, 1999, Personal Communication). Tamarind pulp alone or in combination with lime juice, honey, milk, dates, spices or camphor is used as a digestive and a carminative, even for elephants, and as a remedy for biliousness and bile disorders and febrile conditions. It is said to improve loss of appetite .

Tamarind has been used in the treatment of a number of ailments, including the alleviation of sunstroke, Datura poisoning (Gunasena and Hughes, 2000), and the intoxicating effects of alcohol and 'ganja' (*Cannabis sativa* L.). It is used as a gargle for sore throats, dressing of wounds (Benthall, 1933; Dalziel, 1937; Eggeling and Dale, 1951; Chaturvedi, 1985) and is said to aid the restoration of sensation in cases of paralysis. In Brazil, both the fruit pulp and the leaf are regarded as purgative, diaphoretic and emollient .

Tamarind is also said to aid in the cure of malarial fever (Timyan, 1996). In Southeast Asia, the pulp is prescribed to counteract the ill effects of overdoses of chaulmoogra (*Hydnocarpus anthelmintica* Pierre), which is given to treat leprosy, and in Mauritius, the pulp is used as a liniment for rheumatism .

The fruits are reported to have anti-fungal and anti-bacterial properties (Ray and Majumdar, 1976; Guerin and Reveillere, 1984; Bibitha et al., 2002; Metwali, 2003; John et al., 2004). When the bitter principle is

extracted with benzene and subsequently digested with petrol, it yields 0.67% of a brown, odourless liquid named 'tamarindial', identified as 5-hydroxy 2-oxo-hexa- 3,5-dienal (Imbabi et al., 1992 a; 1992 b). It is a potent fungicidal agent to cultures of *Aspergillusniger* and *Candida albicans* and possesses a strong bactericidal activity towards cultures of *Salmonella*, *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*. Extracts from tamarind fruit pulp have also shown molluscicidal activity against *Bulinustrancatus* snails. This activity is believed to be due to the

presence of saponins in the fruit (Imbabi and Abu-Al-Futuh, 1992 a). Tamarind plant extracts have been used to purify drinking water in Burkina Faso and Vietnam (Bleach et al., 1991.(

Fruit extracts have been shown to enhance the bioavailability of ibuprofen in humans (Garba et al., 2003). Frequent research on aqueous extracts of seeds has shown a strong anti-diabetic effect in rats (Maitin et al., 2004 .(

There is current medical interest in the use of purified xyloglucan from tamarind in eye surgery for conjunctival cell adhesion and corneal wound healing (Burgalassi et al., 2000; Ghelardi et al., 2000). Other medical interest relates to the use of tamarind fruit to manage fluoride toxicity (Khandare et al., 2000). In relation to the xyloglucan, Marry et al. (2003) looked at some reaction products and their structural characterisation because of the widespread interest in their use .

## Seed

The seed is usually powdered and is often made into a paste for the treatment of most external ailments. In Cambodia and India, it has been reported that powdered seeds have been used to treat boils and dysentery

(Rama Rao, 1975; Jayaweera, 1981). Seed powder has also been externally applied on eye diseases and ulcers. Boiled, pounded seeds are reported to treat ulcers and bladder stones and powdered seed husks are used to treat diabetes (Rama Rao, 1975). The seed can also be used orally, with or without cumin seed and palm sugar, for treatment of chronic diarrhoea and jaundice. For external appearance, the testa of the seed macerated with vinegar or lime juice is used on the face to prevent the formation of pimples and in Indonesia, oil extracted from the seed is used as a hair dressing .

The antioxidative activity of tamarind seed was investigated by Osawa et al, (1994). They found that an ethanol extract prepared from the seed coat exhibited antioxidative activity as measured by the thiocyanate and thiobarbituric (TBA) method. Ethyl acetate extracts prepared from the seed coat also had strong antioxidant activity. This was confirmed by Luengthanaphol et al. (2004). This suggests that tamarind seed coat, a by-product of the tamarind gum industry, could be used as a safe and low-cost source of antioxidant, although other herbals may be more effective (Ramos et al., 2003 .(

### Leaves

Tamarind leaves are usually ground into powder and used in lotions or infusions. The leaves, mixed with salt and water, are used to treat throat infections, coughs, fever, intestinal worms, urinary troubles and liver ailments. Internally, leaves and pulp act as a cholagogue, laxative and are often used in treating ‘congestion’ of the liver, habitual constipation and haemorrhoids. Leaf extracts also exhibit anti-oxidant activity in the liver. Also taken internally, the leaves are used in cardiac and blood sugar reducing medicines .

Leaves ground into a paste with lime juice and heartwood of *Acacia tundra* Willd. are applied to boils to prevent suppuration and inflammatory swellings. The leaves are also used to treat ulcers, and the juice of the leaves, boiled with oil is applied externally to treat rheumatism and external swellings in the Philippines and West Africa (Jayaweera, 1981; Rama Rao, 1975.)

A sweetened decoction is used in the Philippines, as a cough remedy and filtered juice is used for conjunctivitis. Young leaves are reported to cure other eye infections, sprains and wounds .

Bark, flower and root

The medicinal properties of the bark, flower and root are similar in many respects to the pulp. Treatment for digestive tract ailments and indigestion have been reported from Cambodia, India and the Philippines (Jayaweera, 1981; Rama Rao, 1975). The bark ash is usually the most effective method of administration. The bark has also been used to recover loss of sensation due to paralysis. Gargling the ash with water has been used in the treatment of sore throats, to heal aphthous sores and in urinary discharges and gonorrhoea .

The bark is astringent and is used as a tonic and in lotions or poultices to relieve sores, ulcers, boils and rashes in the Philippines and Eastern Sudan (Dalziel, 1937). The bark of the tree should be peeled off if needed for medicinal purposes during the time when the tree is not flowering or when the flowering season ends. Ashes of the burnt shells of ripe fruits are used as an alkaline substance with other alkaline ashes in the preparation of medicine 'Abayalavana' in India, for curing enlarged spleen .

A poultice of flowers is used in the treatment of eye diseases and conjunctivitis in the Philippines (Brown, 1954; de Padua et al.,1978). The flowers are also used internally as a remedy for jaundice and bleeding piles .

The 'Irula' tribals of the Anaikkatty hills in the northwest of Coimbatore, Tamil Nadu, India, use tamarind root bark for abortion and for prevention of pregnancies. The root bark is ground into a powder and mixed with hot water and administered three days before abortions and for prevention of pregnancies (Lakshmanan and Narayanan, 1994 .(

#### Veterinary use

Atawodi et al. (2002) reported on the use of tamarind for treating trypanosomiasis in domestic animals in Kaduna, Nigeria. Indigenous knowledge revealed the use of tamarind and *Adamsoniadigitata*, *Terminaliaavicenoides*, *Khayasenegalensis*, *Sterueliasetigera* in various combinations .

Chungsamarnyart and Junsawan (2001) have shown that a crude extract of tamarind fruits in water with 10% ethanol, 1:2 and 1:5 weight/volume used for seven days can be used as a dip against the engorged female cattle tick, *Boophilusmicrophus*. The active substances are the organic acids, especially oxalic and tartaric .

The pulp is also effective in ridding domestic animals of pests in Colombia, through the application of pulp with butter and other ingredients (Morton, 1987)



## **Chapter two**

### **2-1 Matrial:**

#### **2-1-1 Tamarind fruit pulp**

#### **2-1-2 Solvent**

Benzene,

Chloroform,

Petroleum Ether and

Water

## **2-2 Thin layer chromatography (TLC)**

Thin layer chromatography was carried out using silica gel 60 GF254 pre coated plates with mobile phases

## **2-3 Instruments**

### **2-3-1 Infrared spectrophotometer (IR)**

Infrared spectral data analysis were carried out using FT-IR spectrophotometer, FT-IR1300 perkin Elmer USA

### **2-3-2 General instruments**

Electronic balance S.NO.12916463 ,Japan

Heating mantle ,sunbin ,made in india

### **2-3-3 Glass ward**

## **2-4 Method:**

### **2-4-1 Preparation of *tamarind* fruit pulp powder**

Tamarind fruit was purchased from the market, carefully freed from the outer covering shell, then the pulp was separated from the seeds and dried at room temperature, after that the dried pulp was crushed to produce powder of tamarind fruit pulp.

### **2-4-2 Extraction:**

300g of tamarind fruit pulp powder was weighted, and placed in 500 ml round bottle flask, about 200 ml of benzene was added to the flask content, the mixture was heated for 3 hours. This process was repeated for the residue.

The benzene extract was heated in order to evaporate the solvent ,the solid particle remained after evaporation of the benzene was washed in

petroleum ether to produce a component dissolved in petroleum ether and another one did not dissolve in petroleum ether. About 50 ml of water was added to the un dissolved part in pet ether with stirring ,then heated for 30 min and kept in dark, after one day brown precipitate was formed ,the precipitate was filtered and it gave symbol A, the filtrate was extracted using chloroform as a solvent ,the chloroform extract was allowed to stand in order to evaporate the chloroform and an oily green liquid was obtained Components A and B undergoes tests of IR

### 2-5 chemical names of the isolated compounds

**Table (2-1) chemical name**

Compound symbol	Chemical name
A	5,5'-(oxydimethanediyl)difuran-2-carbaldehyde
B	5- hydroxyl-2-oxohexa-3,5-dienal

**Table (2-2) yield percentage ,melting point molecular formula and molecular weight**

Compound symbol	logp	mp. C°	Y%	/α	n/	γ/dyne/cm <sup>3</sup>	d/g.cm <sup>3</sup>	Mf	Mwt
A	-0.85+/-0.48	267	0.2	23.84	1.589	49.9	1.1314	C <sub>12</sub> H <sub>10</sub> O <sub>15</sub>	234.2084

B	- 0.87+/ -0.56	302	0.12	12. 37	1.489	41.3	1.167	C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	126.11004
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All this data except melting point was obtained from ACD labs

**2-6 schematic explain the extraction process**

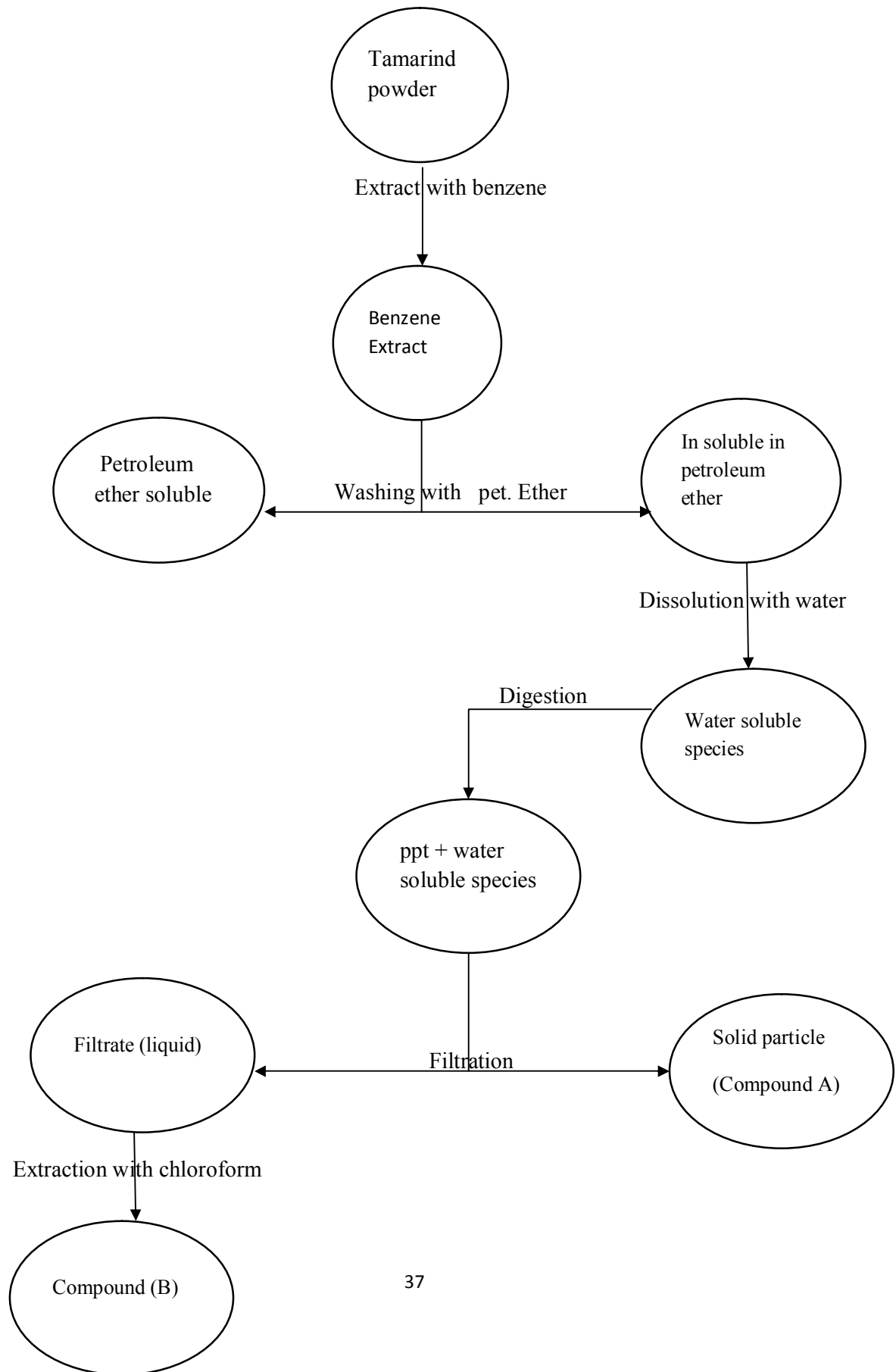


Figure (2-1) IR spectrum of compound (A)

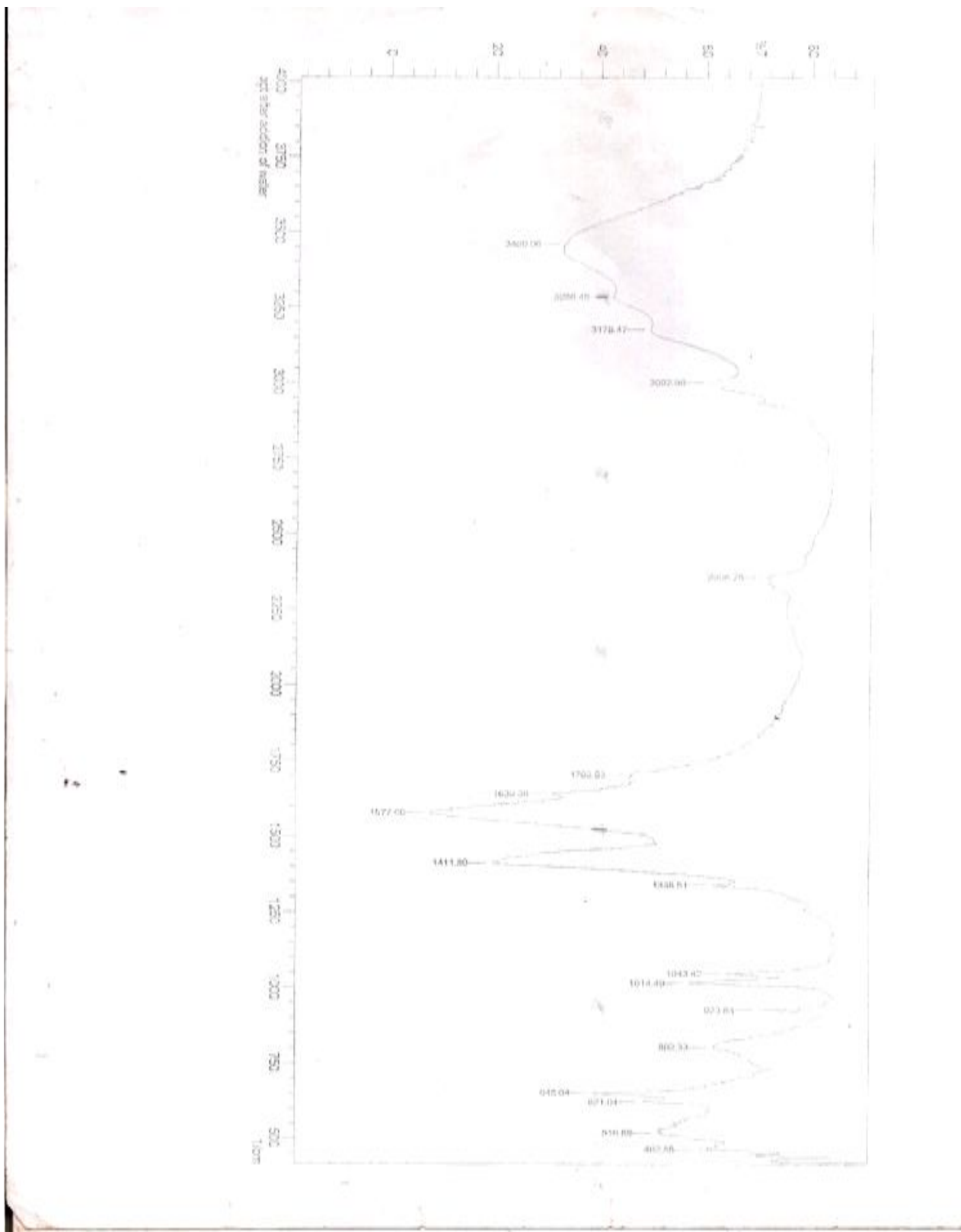
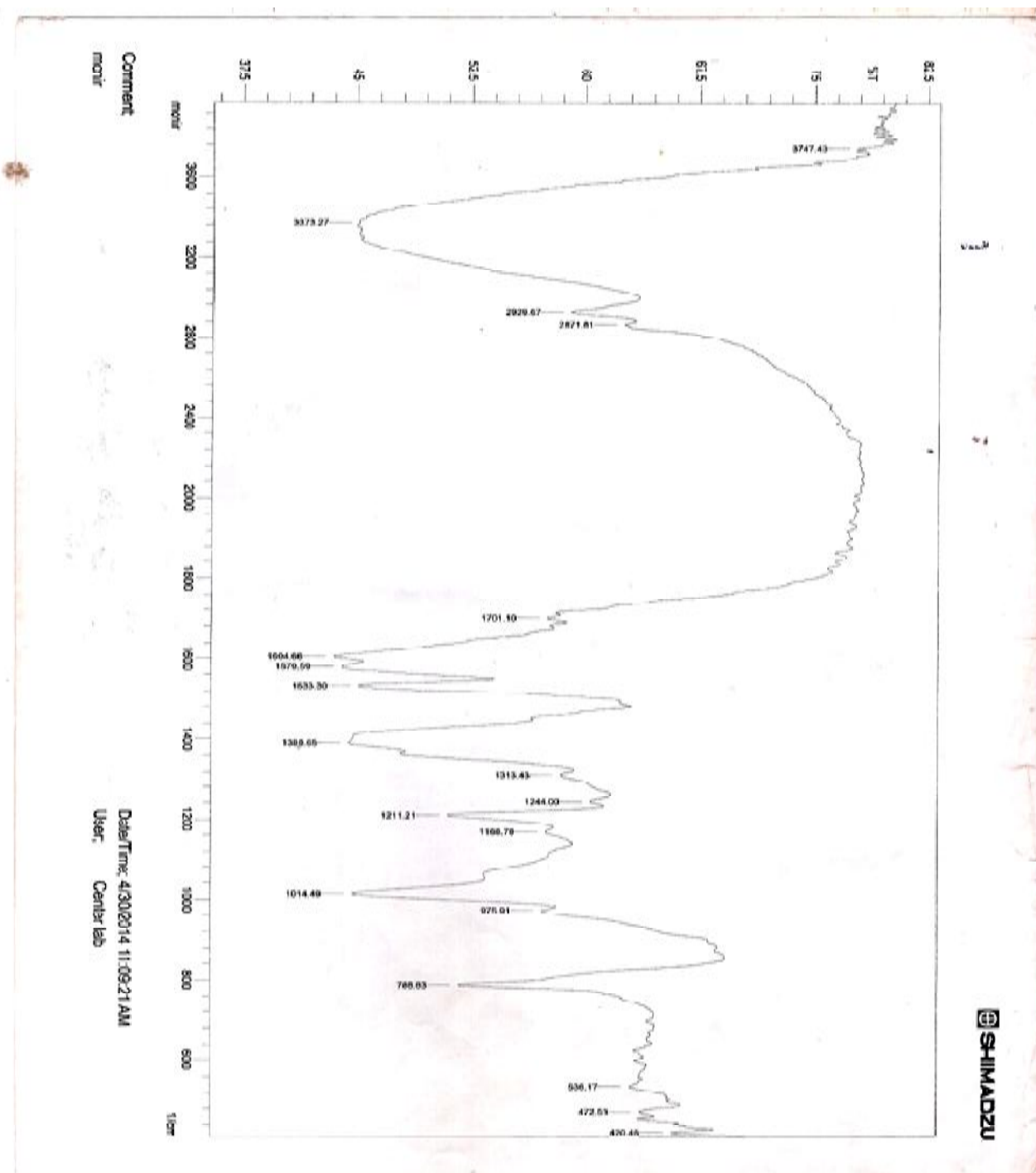


Figure (2-2) IR spectrum of compound B



## CHAPTER THREE

### DISCUSSION

#### 3-1 Discussion of the method

in this research we were extracted two compounds from tamarind fruit pulp using maceration technique, the method was tooked out using benzene and petroleum ether and chloroform solvents, they were extracted the active compounds under the role "like dissolve in like " there are additional uses of petroleum ether which was isolated the undesirable component

#### 3-2 IR spectra discussion

Infrared spectroscopy is one of the most important tool in structure elucidation , it provide an excellent means towards identification of the different functional groups associated with in a molecule .in the present work, I.R analysis was carried out using FT-IR 1300 Perkin Elmer with KBr disk , the results were given in figures (2-1, 2-2) . the IR spectrum of compound (A) showed C-H aliphatic stretching bands appear at  $3002.69\text{cm}^{-1}$  and C-H stretching for aromatic appear at  $3187.47\text{ cm}^{-1}$

Aband appear at  $802.33\text{cm}^{-1}$  may be due to C-H aromatic out of plane bending and the band appear at  $2388.78$  may be result from combination overtones

Conjugation of the carbonyl group with the aromatic furan system was lowered the both carbonyl and the aromatic C=C partial bond to alower frequency and spilted the C=O band to two bands one was appeared at  $1703.03\text{ cm}^{-1}$  and the other near  $1639.38\text{ cm}^{-1}$  , the two band due to C=C aromatic were appeared at  $1577.66\text{cm}^{-1}$  and  $1487.80\text{cm}^{-1}$  respectively



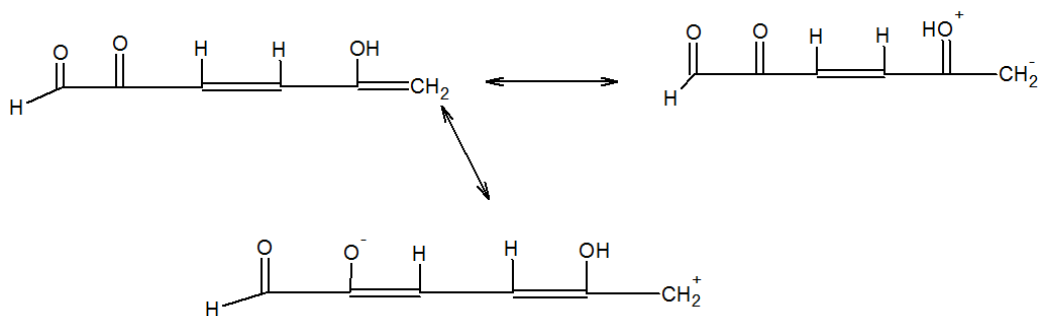
C-O group in the aromatic system was showed two band one near  $1043.042\text{cm}^{-1}$  due to symmetric stretching vibration .the band due to asymmetric vibration was appeared at  $1338.51\text{cm}^{-1}$

C-O adjacent to aliphatic  $-\text{CH}_2$  group asymmetric stretching was appeared at  $1014.49\text{cm}^{-1}$  and symmetric stretching band was appeared at  $923.84\text{cm}^{-1}$

The expected O=C-H may be obscured by intense C-H stretching band

The band which was appeared at  $3460.06$  it appeared because the compound was not perfectly purified

Compound B under high conjugation :



Broad band was appeared at  $3373.27\text{cm}^{-1}$  due hydrogen bonded O-H stretching vibration

C-H aldehyde group appear at at  $2871.81\text{cm}^{-1}$

H-C-H bending bands were appeared at  $1244\text{cm}^{-1}$  and  $1313.43\text{cm}^{-1}$

C-O appear at 1388.65 due to the direct conjugation with the double bond in the carbon no 5

In case of carbonyl and C=C groups there are two possible conformations, the s-cis and s-trans. The s-cis conformation absorbs at a frequency higher than the s-trans conformation

So there are two bands for C=C for due to conjugation between the two double bonds, these bands were appeared at low frequency one was appeared at  $1533.30\text{cm}^{-1}$  and the second was appeared at  $1579.59\text{cm}^{-1}$

C=O also was appeared in two bands one at  $1701.10\text{cm}^{-1}$  and  $1604.66\text{cm}^{-1}$

## **Conclusion and Recommendation**

5,5'-(oxydimethanediyl)difuran-2-carbaldehyde and 5-hydroxyl-2-oxohexa-3,5-dienal were extracted from tamarind fruit pulp

MS analysis and <sup>1</sup>H-NMR spectrum analysis are recommended in order to complete the spectra data for isolated compounds

The further studies on this compound were suggested and the testing of the biological activities for isolated compounds, in addition to study the structure activity relationships are recommended .

## CHAPTER FOURE

### RERFERENCES

Julia F.Mortion (1987) Fruits of Warm Climates. Miami FL: 115-121

K. El-Siddig H.P.M. Gunasena B.A. Prasad D.K.N.G.  
PushpakumaraK.V.R.RamanaP.Vijayanand J.T. Williams (2006) Fruits  
for the Future 1, Tamarind

Chemical abstract:

a. 23 ,1929 ,1508

b. 50 , 1956, 2763

c. 66, 1967, 106143

d. 64, 1966, 13090

e. 89, 1978, 74436f

Ciênc.Tecnol.Aliment., Campinas, 31(2): 497-501, abr.-jun. 2011

web site :

[www.hort.purde.edu](http://www.hort.purde.edu)

10.47PM 9/11/2013

[www.ygoy.com](http://www.ygoy.com)

8.20PM 11/9/2013

[www.nutrition-and-you.com](http://www.nutrition-and-you.com)

8.35PM 11/9/2013