CHAPTER I

INTRODUCTION

1. Cashew tree

The cashew tree, *Anacardium Occidentale* Linn., is a native plant of Brazil which was introduced to America, Africa and Asia by the Portuguese in the 1600's. The governor of Trang first introduced it into Thailand in 1901. It can be grown in all parts of Thailand even in areas with a high degree of alkalinity, acidity or salinity. The tree is an evergreen, naturally growing up to 20 to 40 ft. high and has a spread at 15 to 25 ft. The size of the tree is 1 to 3 ft. The yellow – green leaves, revealing distinct veins, are elliptic in shape and approximately 4 to 8 inch in length and 2 to 3 inch in width (Figure 1.1). Leaves feel leathery to the touch [1,2].

Cashew begins to produce fruits when it is three years old. The productivity reaches the highest level when it is 10 to 15 years old. Cashew flowers between December and March, depending on localities, weather conditions and strains (Figure 1.2). Though cashew can be grown in all regions, the plantation area in the Southern part of the country is considerably larger than the rest of the country especially in Songkhla, Phuket, Nakhon Sithammarat, Phung – nga, Krabi and Surat Thani [3,4].

Figure 1.1 Cashew tree

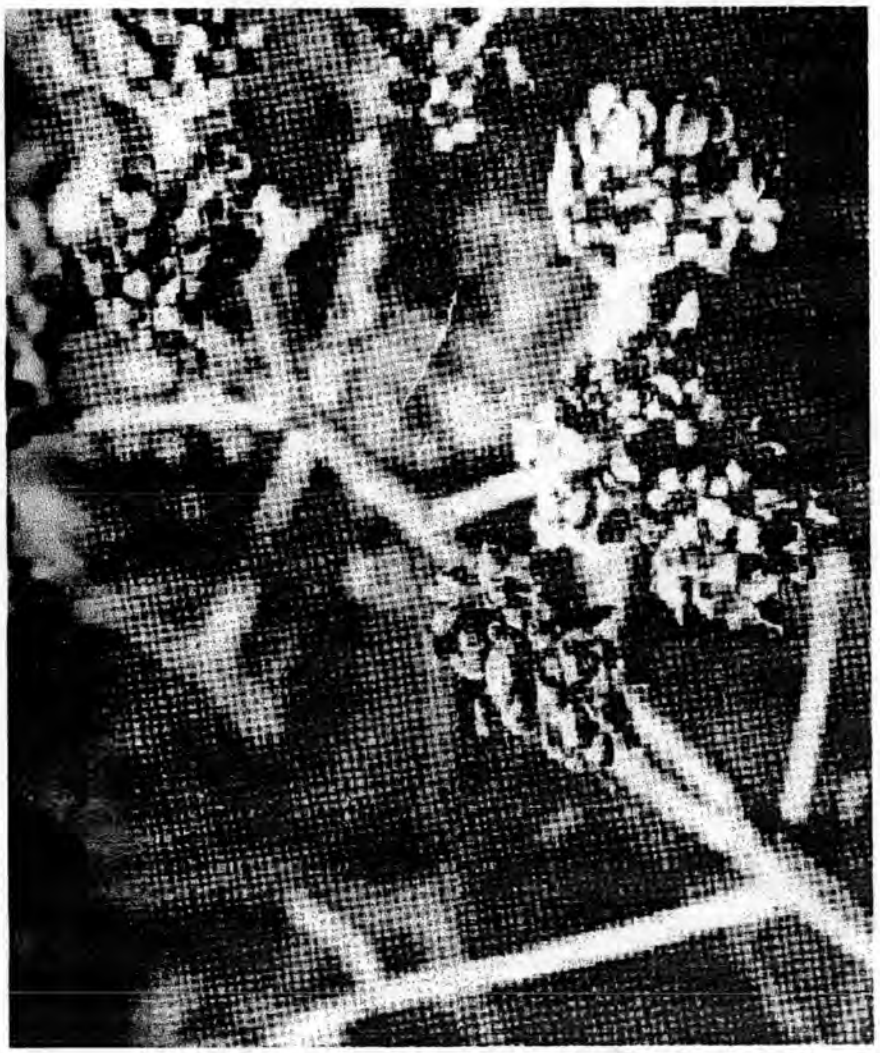


Figure 1.2 Cashew flowers

The cashew nut (Figure 1.3) is attached to the bottom of the apple (Figure 1.4), which varies in size from 2 to 4 inch length and 1.5 to 2 inch in width.

The cashew nut is from 2.5 to 3.2 cm long, 1.9 to 2.2 cm broad and 1.3 to 1.6 cm thick. The shell of the nut is hard and between the two layers of the nut, called testa, contains a phenolic material known as "Cashew Nut Shell Liquid (CNSL)"(Figure 1.5).

1.1 Cashew nut shell liquid

Cashew nut shell liquid (CNSL) occurs as a reddish – brown viscous liquid in the soft honeycomb structure of the shell of cashew nut. It was reported that the cashew nut shell liquid contained in the fresh shell is approximately 15 to 20 percent by weight for African nuts, 20 to 30 percent by weight for Indian nuts and 32 percent by weight for Thailand. Characteristic of specification for commercial CNSL is shown in Table1.1.

Table 1.1 Specification for commercial cashew nut shell liquid [5]

Characteristic	Requirement
Specific gravity, 30 / 30 °C	0.95 – 0.97
Viscosity at 30 °C, c P (max.)	550
Moisture, % by weight (max.)	1.0
Matter insoluble in toluene, % by weight (max.)	1.0
Loss in weight on heating, % by weight (max.)	2.0
Ash, % by weight (max.)	1.0
Iodine value (max.)	
(a) Wij's method	250
(b) Catalytic method	375
Polymerization	
(a) Time, min (max.)	4
(b) Viscosity at 30 °C, c P (min.)	30
(c) Viscosity after acid washing at 30 °C, c P (min.)	200

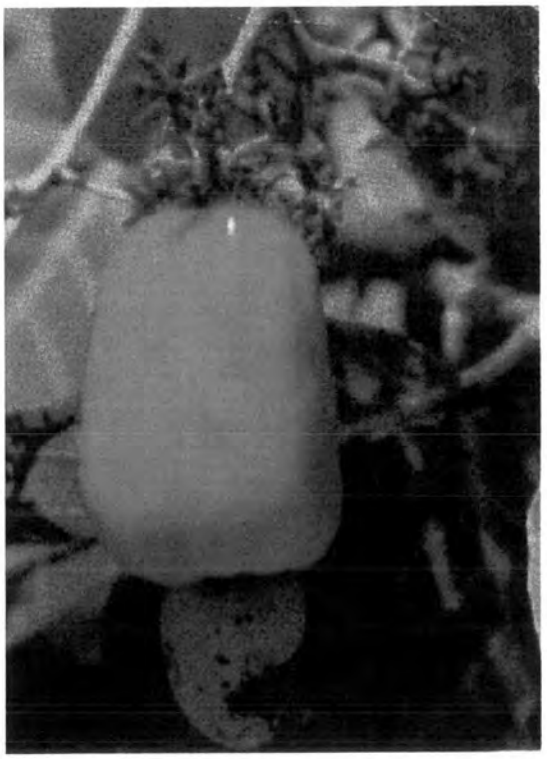


Figure 1.3 Cashew nut

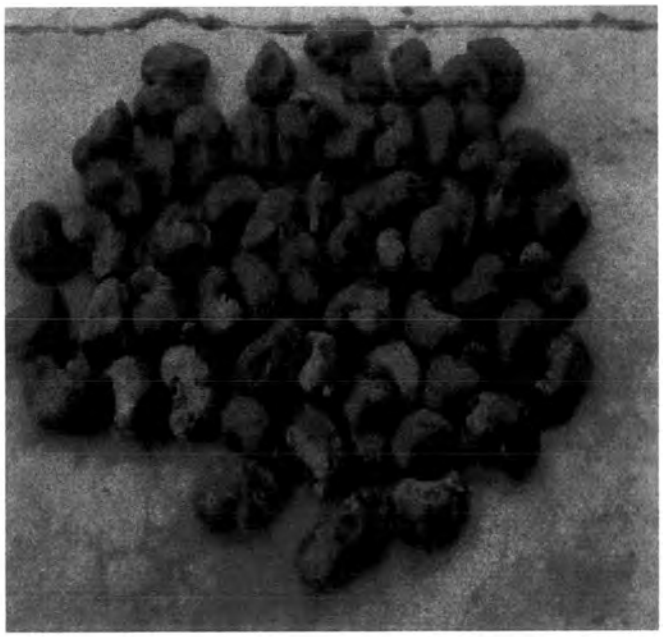
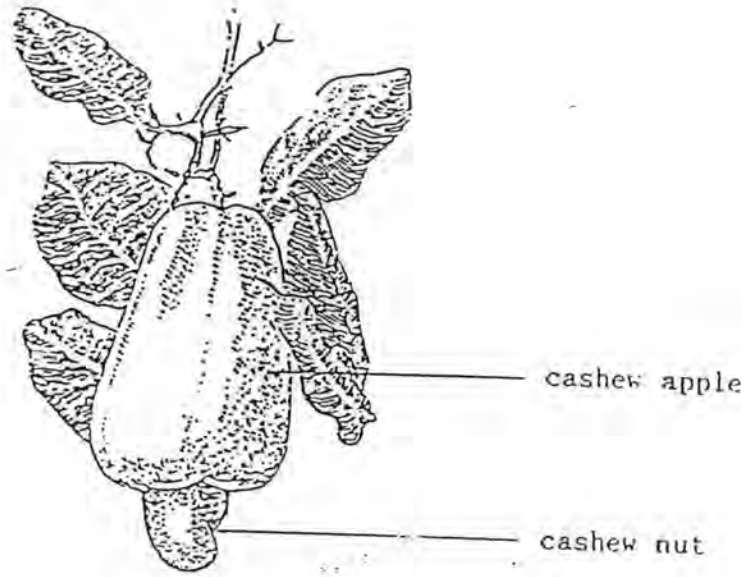
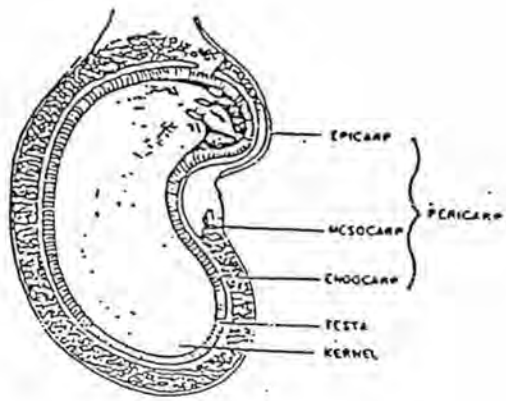


Figure 1.4 Cashew nuts



(a)



(b)

Figure 1.5 a) Cashew apple and cashew nut.

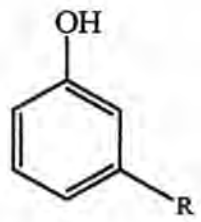
b) Section of a cashew nut.

There are four main processes for the production of CNSL [4]:

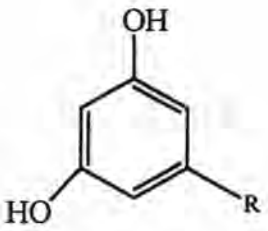
1. Roasting the shell in an open perforated dorm and collecting the expelled liquid. This is the Indian native method and only about half of liquid is extracted by this process.
2. Extracting the liquid from the whole nuts with hot CNSL maintained at 370 –380 °F which will not char the kernels. This method enables 85 to 90 percent of the CNSL to be recovered.
3. Treatment of the shell with super – heated steam and collecting the condensate. This process claims to produce a better grade of CNSL and is sometime used in conjunction with extracting by hot CNSL to improve yield.
4. Solvent extraction of the shell such as extraction with light petroleum (40–60 °C) was effective on comparatively large batches of half-shells.

CNSL is a mixture of four groups of phenolic compounds; cardanol (I), cardol (II), 2-methyl cardol (III) and anacardic acid (IV) (Figure 1.6) [4]. It was found that the composition of CNSL consists of about 80% anacardic acid, 10-15% cardol and small amounts of other materials, notably the 2–methyl derivative of cardol [6].

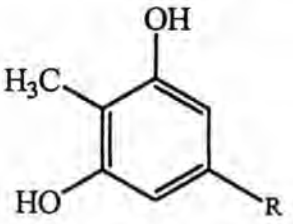
Because anacardic acid is easily decarboxylated to give cardanol, the cardanol is obtained more from the CNSL in commercial use by heating at a high temperature and using calcium hydroxide as an activated catalyst [7].



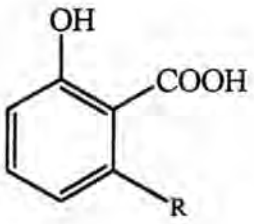
Cardanol(I)



Cardol(II)



2-methyl cardol(III)



Anacardic acid(IV)

R = C_{15} saturated hydrocarbons or

C_{15} unsaturated hydrocarbons containing 1-3 double bonds at the end of the side chain.

Figure 1.6 Composition of naturally occurring CNSL

1.2 Use and application of cashew nut shell liquid

With recent advances in chemical technology, the CNSL is finding many new industrial applications. It is used commercially as a phenolic raw material for the manufacture of certain resins and plastics. In particular, it is used as a friction modifier in the manufacture of brake–linings, industrial belling and clothes. It is claimed to possess excellent frictional properties and low friction " fade ", i.e., the fall in coefficient of friction with increase in temperature, and long wear. It is also used in rubber compounds, where it acts as reinforcing fillers, which tensile strength, hardness and abrasion-resistance are improved. The resin from CNSL is used in laminating for papers, clothes and glass fibers.

In 1967 Winc, Chittaranjan and Banwari extracted non-ionic surfactant from CNSL. It is known that for the non-ionic agents the surface-active properties result from the water-soluble hydrophilic residues and the oil soluble hydrophobic part. It is known to produce CNSL, adding may be made in gaseous or liquid-state to the phenols at a temperature lying generally between 80 and 200 ^{o}C in closed vessel and preferably in an inert atmostsphere of nitrogen [8].

In today's chemical industries, anionic surfactants like sodium dodecylbenzene sulfonate (Figure 1.7) are used extensively. The structure of CNSL is similar to dodecylbenzene sulfonate in aromatic and the side chain of hydrocarbon. Therefore it is presumed that the chemical reaction is attached to aromatic ring, an agent, the product has the same properties as dodecylbenzene sulfonate.

Figure 1.7 Structure of sodium dodecylbenzene sulfonate

In this research, the synthesis of the material that has properties as a detergent from cashew nut shell liquid (CNSL) by using the sulfonation with the acid, that can gives the sulfonate group such as chlorosulfonic acid. After that, a base, such as sodium bicarbonate can neutralizes it. Many different parameters such as reaction time and reaction temperature were taken into account. Furthermore, its characteristics were finally considered for physical properties such as stability in hard water, surface tension, critical micelle concentration (C.M.C.) and detergency.

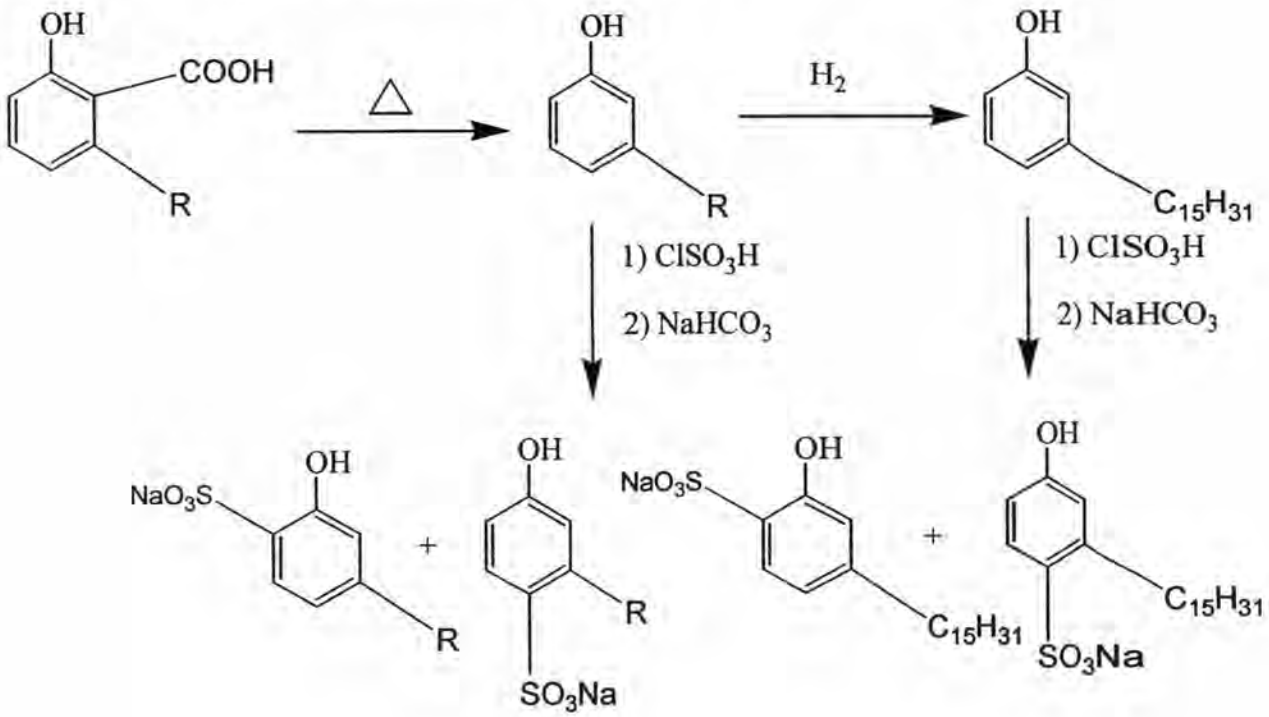


Figure 1.8 Chemical reactions used in this research

Objectives

1. To synthesize sodium cardanol sulfonate from purified CNSL (cardanol) by sulfonation and then neutralize it for form the salts.
2. To investigate the mechanical properties of produce in reference to the standard (ISO and ICS Standard).

Scope of Investigation

The investigation procedures were carried out as follows:

1. Literature survey and in depth study of this research work.
2. Designed and preparation of apparatus and chemical substances.
3. Decarboxylation of CNSL, Purify of CNSL and hydrogenation of purified CNSL.
4. Synthesis of sodium cardanol sulfonate by sulfonation and neutralization. The appropriate reaction conditions were determined by changing the parameters such as the effect of reaction temperature and reaction time.
5. Characterization of CNSL, decarboxylated CNSL, cardanol, hydrogenated cardanol, cardanol sulfonate and hydrogenated cardanol sulfonate by TLC, IR and NMR.
6. Testing of physical properties such as C.M.C., surface tension and detergency.
7. Summarization of the results.