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Natural Rubber : Agromanagement and Crop Processing
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## Chapter 20

# Crop collection and pre-processing

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## 1. INTRODUCTION

Natural rubber is collected from plantations as latex and field coagulum (scrap rubber). Generally, latex accounts for 70 to 80 per cent of the crop, the rest being field coagulum. The ratio of latex to field coagulum varies depending on the age of the trees, tapping system, climatic conditions, clone, stimulation, time of collection, stability of latex, *etc.* All forms of coagulated rubber obtained from the field are collectively known as field coagulum. It includes the rubber removed from the collection cup (cup lump, shell scrap or cup scrap), tapping cut (tree lace, panel scrap), trunk of the tree (dried rubber from the latex overflown from the tapping cut), the cup once in a year (black shell) and from the ground beneath the collection cup (earth scrap). Latex can be processed into (1) ribbed sheets, (2) pale latex crepe (PLC) or sole crepe, (3) technically specified rubbers (TSR) and speciality rubbers, and (4) preserved field latex and latex concentrate. Field coagulum is processed into crepe rubbers or TSR.

## 2. LATEX COLLECTION

Flow of latex usually ceases 2 to 3 h after tapping. In some high yielding clones, dripping continues even after this period, but the rate of flow is greatly diminished. Latex should be collected from the trees when the flow ceases or when the rate of flow is very low. During rainy days, latex is very often collected early for preventing possible wash off or contamination of latex with rain water. Latex is transferred from collection cups to buckets by pouring, followed by wiping with thumb and forefinger. Wiping with fingers is avoided to prevent any coagulation due to contamination if the latex is to be processed as latex concentrate. Buckets containing latex should not be kept exposed to sunlight.

### 2.1 Precoagulation

Normally field latex coagulates after 4 to 6 h of tapping. But a tendency for premature coagulation (precoagulation) is observed under certain conditions. These are wintering, clonal variations and rain water contamination. During wintering, leaves are shed and the greater exposure of latex to sunlight leads to precoagulation (Barney, 1968). The higher proportion of magnesium in latex prior to wintering also enhances the tendency for precoagulation.Clones with high magnesium content in latex (*e.g.* Gl 1, Tjir 1, Tjir 16, LCB 1320) are more susceptible to precoagulation (Philpott, 1951). Mature trees, during the first two or three years after opening, contain high magnesium in latex and hence show increased tendency for precoagulation. During rainy season precoagulation takes place due to the contamination of latex with water soluble bark substances or by enzyme activators (Cook and McMullen, 1951).

#### 2.1.1 Anticoagulants for short-term preservation

Latex coagulation during collection and/or transportation is undesirable as it hampers further processing operations and hence be avoided using a suitable anticoagulant. Anticoagulants are chemicals that are added in very small quantities to normal latex for arresting precoagulation or thickening for a short period. The popular anticoagulants are sodium sulphite, formalin and ammonia and its combinations with hydroxylamine or boric acid.

##### 2.1.1.1 Sodium sulphite

This is available commercially as a white powder and is usually 90 to 98 per cent pure. It is not stable under tropical conditions and is to be stored in a cool place in airtight containers. A five per cent stock solution is prepared by dissolving 50 g of the chemical in 1 L of water. Addition of 100 ml of this stock solution to 10 L of field latex gives a concentration of 0.05 per cent by volume. This is adequate for anticoagulant action. Use of excess sodium sulphite retards drying of sheet rubber and causes tackiness due to absorption of moisture by the residual salt that remains on the surface of sheets (RRIM, 1966). It is different from the tackiness observed on oxidized sheet rubber. Sodium sulphite solution should be freshly prepared as it deteriorates on keeping.

##### 2.1.1.2 Ammonia

Ammonia is commercially available as liquefied gas in cylinders of 40, 50 or 60 kg or as 25 per cent solution in water. A one per cent stock solution can be prepared by dissolving 1 kg of the gas in 100 L of water or by diluting 40 ml of the 25 per cent solution to 1 L using water. To be effective as an anticoagulant, 0.01 per cent by volume of latex is required and for getting this concentration 100 ml of the stock solution is to be added to 10 L of field latex.

At higher temperatures, ammonia gas escapes into the air from solution. Hence it shall be kept in tightly-stoppered bottles. The drums and jars containing ammonia shall be stored in the coolest place available. Ammonia containers are to be opened carefully. The stopper or lid may be loosened slowly, in order to release the pressure gradually. It is advisable for the operator to wear goggles and keep his face away from the direction of opening. Concentrated ammonia solution is toxic and if body contact occurs, the affected area shall be thoroughly washed in running water immediately and medical attention may be sought if irritation persists.

**2.1.1.3 Formalin**

Commercially available formalin is a solution of formaldehyde in water, approximately 40 per cent in strength. The formaldehyde slowly gets oxidized to formic acid in solution and therefore, before use it is advisable to neutralize the acid by adding a small quantity of commercial sodium carbonate (washing soda) which is alkaline in nature. The neutral point can be judged by using a red litmus paper which turns blue in alkaline medium.

A two per cent stock solution can be prepared by adding 50 ml of formalin to 1 L of water. For providing good anticoagulant action, 0.02 per cent by volume formalin has to be present in latex. Addition of 100 ml of the stock solution to 10 L field latex will result in 0.02 per cent formalin in latex. For latex with high tendency for precoagulation, a combination of 0.02 per cent formalin and 0.02 per cent sodium sulphite is more useful.

**2.1.1.4 Hydroxylamine-ammonia systems**

Hydroxylamine neutral sulphate (HNS) along with ammonia is recommended for preservation of field latex to be used for the production of constant viscosity (CV) and low viscosity (LV) rubber. Good anticoagulant effect can be obtained by using 0.05 per cent HNS and 0.03 per cent ammonia in latex by volume.

The mixture of hydroxylamine neutral sulphate and ammonia shall be prepared as a single stock solution. The solution can be prepared by dissolving 50 g HNS in 3 L of one per cent ammonia solution. This will be sufficient for 100 L of field latex to give a concentration of 0.05 per cent hydroxylamine and 0.03 per cent ammonia in latex. The stock solution should be freshly prepared. The concentrations to be used in latex from different sources have been assessed (Sidek and Cheong, 1980) and are given in Table 1.

**Table 1. Hydroxylamine-ammonia anticoagulant systems**

| Per cent weight by volume of latex | | Period of preservation (h) | |
|---|---|---|---|
| HNS | Ammonia | Estate latex | Smallholder latex |
| 0.05 | 0.03 | <11 | <5 |
| 0.05 | 0.05 | 11 - 15 | 5 - 11 |
| 0.05 | 0.07 | 11 - 19 | 11 - 20 |

Even though hydroxylamine-ammonia system provides adequate anticoagulant action for longer duration, it causes discolouration of the rubber. However, it imparts constant viscosity to the rubber.

#### 2.1.1.5 Boric acid-ammonia systems

A combination of 0.4 to 0.5 per cent boric acid and 0.07 per cent ammonia has long-term anticoagulant action and can be used in the production of light-coloured rubber. However, economically this system is not very attractive. Changes in the dosage of ammonia and boric acid are necessary depending on the source of latex and the period required for anticoagulant action. This can be determined after necessary trials. The concentrations to be used for latex from different sources are given in Table 2 (Sidek and Cheong, 1980).

Table 2. Boric acid-ammonia anticoagulant systems

| Per cent weight by volume of latex | | Period of preservation (h) | |
|---|---|---|---|
| Boric acid | Ammonia | Estate latex | Smallholder latex |
| 0.2 | 0.03 | <16 | 11 - 15 |
| 0.3 | 0.07 | 32 - 60 | 29 - 40 |
| 0.5 | 0.03 | 34 - 44 | 20 - 27 |

Sodium hypochlorite is reported to be as effective as ammonia for normal field latex, but is markedly less effective for latex showing abnormal tendency for precoagulation. It does not make the latex unduly alkaline and hence extra acid is not required for coagulation (John, 1976).

### 2.1.2 Choice of anticoagulant

The main factor in the choice of an anticoagulant is the form into which the latex is to be processed. For producing sheet rubber, ammonia is the most preferred anti-coagulant. However, excess ammonia creates problems during acid coagulation. If precoagulation tendency is mild, either sodium sulphite or formalin or a combination of both can be used. Acid consumption for coagulation in this case is less. But excess sodium sulphite may lead to bubble formation in sheets and retards drying. Use of formalin results in darker sheets. A combination of 0.05 per cent formalin with 0.1 per cent sodium metasilicate is an ideal anticoagulant system for latex to be processed into RSS (Cook, 1960).

For producing PLC, the most suitable anticoagulant is sodium sulphite. Formalin may cause discolouration of the crepe. Only ammonia can safely be used in latex to be concentrated. If formalin is used as anticoagulant, it may react with ammonia which is used for long-term preservation of latex.

For processing into TSR, centralized processing necessitates transportation of latex over long distances, which obviously demands higher stability for longer periods. In such cases, use of ammonia at a low level as anticoagulant may not be sufficient to maintain the latex in fluid condition. On the other hand, a high level of ammonia will create problems at the coagulation and drying stages. It also affects the colour of the final product. Hence, anticoagulants which do not have these disadvantages have been developed. Composite systems of either HNS or boric acid and ammonia are more economical and effective than ammonia alone. The anticoagulants shall be added as soon after tapping as possible.

## 2.2 Hygiene in tapping and collection

NR processing, no matter what its type be, demands good latex free from pre-coagulation. Latex in the rubber tree is sterile (McMullen, 1951). Once it is tapped, it gets contaminated with bacteria and yeast from the tapping knife, tapping panel, spout and collection cups. About 20 per cent of the bacterial population in field latex is from the tapping cut, 20 per cent from the spout and 60 per cent from the collection cups. Latex after routine collection contains about 2 x $10^6$ to 4 x $10^6$ viable bacteria per ml (Lowe, 1959). The bacterial population may be slightly higher in stimulated trees. The bacteria find ample nutrients for rapid proliferation in the non-rubber constituents of latex (Philpott and Sekar, 1953) and produce volatile fatty acids (VFA). The main substrate whose decomposition leads to the formation of volatile acids is believed to be the carbohydrates. As the VFA content increases the latex coagulates (John *et al.*, 1976).

Hence, it is of utmost importance that a high level of field hygiene is maintained. This applies to collection cups and buckets, storage tanks, barrels, *etc.* Dirty cups are a source of contamination leading to precoagulation in the field and fermentation and mould infection in the factory. Collection cups shall not be allowed to lie about on the ground. Some of the spouts have hooks by which the cups should be hung when not in use. Alternatively, these can be kept on special cup hangers fixed to the trees or inverted on wooden pegs driven into the ground close to each tree. Scrap rubber shall be removed from the tapping cut, spout and the cup before tapping commences. Cups shall not be kept in position until the tapping operation is completed, as otherwise bark shavings may get into the cups and thereby into the latex.

Contamination is also possible during collection, transportation and storage. The collection buckets, transportation tanks and storage tanks shall be cleaned daily and disinfected every week to eliminate bacteria. Common disinfectants are Lysol (0.3%) and formalin (1%).

A collection station is normally an open shed. Provision for adequate water supply shall be made so that utensils and shed can be washed and kept clean. The location of collection stations and arrangements for transportation shall be such that the latex arrives at the factory within the minimum possible time.

## 2.3 Utensils

### 2.3.1 Collection cups

Coconut shell cups are popularly used in rubber plantations for latex collection. These are readily available at low cost. The shell cups are cleaned to remove fibres and other forms of dirt before use. In the course of a year, the cup picks up dirt and the rubber sticking to it gets oxidized. The original brown colour of the shell changes to black. It is preferable to replace the shell annually. The replacement is normally done during the resumption of tapping after the rest period. Some of the high yielding clones produce large quantity of latex per tree per tapping and a normal coconut shell cup is not large enough to hold latex from such trees. In such cases, it is customary to use more than one cup, one below the other. Alternatively, plastic cups made from high density polyethylene which can hold up to 700 ml of latex have been introduced. The use of plastic cups instead of coconut shells reduces the amount of shell scrap and hence is more preferable (Venketesan, 1987). Removal of shell scrap is also easier with plastic cups.

Collection of latex from several tappings could also be done in disposable polythene bags fixed to the tree. The latex collected in such bags gets coagulated and the coagulum is removed periodically for processing into crepe or TSR. Although studies conducted at RRII (Nair *et al.*, 1988) revealed that technically good quality rubber can be produced by this method, it is not yet adopted in India. A new method incorporating stimulation and collection of latex has been reported. The method known as REACTO RRIM system with RRIM cup and RRIM tap is claimed to be a cheaper alternative to polybag collection (RRIM, 1993).

Galvanized iron (GI) spouts are commonly used for channelling the latex from the tapping cuts to the collection cups. The scrap adhering to spouts should be removed daily to keep them clean and to allow free flow of latex to collection cups.

### 2.3.2 Buckets and other containers

Buckets or other containers made of GI are mostly used for collecting latex (Plate 61. a) from the field. These should be washed thoroughly after use. Cleaning is easy at this stage. If delayed, latex dries up inside the vessels and washing will be difficult. Unclean buckets or vessels may induce precoagulation. In estate practice, tappers use two types of containers for collection, a small bucket for collecting latex from each tree and a large container for transporting it to the collection centre or processing factory.

### 2.4 Preservation

Field latex can be preserved for long periods by the addition of certain chemicals known as preservatives. Ammonia is the most widely used preservative. A composite preservation system consisting of ammonia, tetramethylthiuram disulphide (TMTD) and zinc oxide (LATZ system) has gained wide acceptance (John *et al.*, 1975) and is commercially used for preserving latex to be processed into latex concentrate. A non-toxic system consisting of 0.4 per cent ammonia and 0.05 per cent Dowicil 150 [cis-1-(3chloroallyl)-3,5,7 triaza-1-azoniaadamantane chloride] is as good as the LATZ system (John *et al.*, 1985). Another system containing 0.3 per cent ammonia and 0.05 per cent of a biocide containing triazine/benzotriazole derivative is also effective in preserving field latex up to one week (John *et al.*, 1986). A satisfactory alternative to the LATZ system is the LABZ system in which TMTD is replaced by zinc dibenzyldithiocarbamate (Wong *et al.*, 1991).

## 3. COLLECTION OF FIELD COAGULUM

The different forms of field coagulum also need proper handling. The coagula removed from the tapping cut and collection cup are kept in a basket carried by the tapper. The tree lace pulled out from the tapping cut is more susceptible to oxidation as it remains exposed to atmosphere as a thin film. Moreover, as it had remained in contact with the bark, contamination by pro-oxidants present in the bark (*e.g.* manganese) is also more. In high yielding clones, the quantity of coagulum in the collection cups is generally more. This phenomenon is observed in stimulated trees also and is due to late dripping in both cases. Daily tapping as well as double cut or full spiral tapping may also induce late dripping.

Field coagula shall be sorted and stored separately. It is preferable to process them fresh. Processing of wet coagulum ensures proper dirt removal and provides better colour to the processed rubber. When coagulum rubbers are to be stored, they should be partially dried in smoke houses. Exposing scrap rubbers to sunlight or soaking in water for long periods may accelerate degradation. Earth scrap is normally collected once in a year or once in six months. This generally contains more than 50 per cent dirt.

## 4. TRANSPORTATION

In order to avoid any premature coagulation, latex meant for processing into sheet, pale latex crepe or light-coloured block rubber has to be delivered to the processing factory as early after collection as possible. In small- and medium-sized rubber estates, transportation of the crop to processing factories is done by the tappers (Plate 61. b). Large estates have latex collection centres at suitable locations in the estate. The latex brought by the tappers is weighed and collected in a bulking tank at the latex collection centre and suitable anticoagulants are added. If the latex is meant for concentration, it is preserved using ammonia or the LATZ system. The latex is then delivered into tankers by gravity flow and transported to the processing factory. Sometimes latex is collected directly in barrels and transported to the factory. Tanks are usually fabricated in mild steel, and shall be provided with a manhole for proper cleaning. The capacity of tanks in common use in estates is 2000 to 3000 L and are transported to the processing factory either by tractor or jeep. If latex is collected in barrels, transportation is usually done in jeeps, tractor or trucks. A suitable overhead carrier fixed to the tanker can carry field coagulum also.

## 5. PRE-PROCESSING OF LATEX

### 5.1 Weighing

Latex brought by each tapper to the collection centre (Plate 61. c) or the factory is separately weighed in a common weighing bucket or vessel after straining (Plate 61. d) and the weight is recorded. Spring and platform scales are commonly used. For correct weighing, a platform scale is preferred. Weighing is necessary to assess the quantity of latex brought by each tapper. When additional incentives based on harvested crop are given, determination of dry rubber content (DRC)) of the latex is necessary to estimate the total quantity of rubber brought by the tapper.

### 5.2 Estimation of DRC

DRC is defined as the mass in grams of rubber present in 100 g of latex. The DRC of field latex varies depending on age of the tree, tapping intensity, season, climate, clone, stimulation practices, soil conditions, *etc.* Estimation of correct DRC is necessary to assess the quantity of rubber transacted particularly when sold as latex. Several methods are followed for estimating DRC.

#### 5.2.1 Hydrometric (metrolac) method

Metrolac, an instrument which uses density difference of rubber and water, is used for quick DRC measurement in estates. One part of well-stirred field latex is mixed with two parts of water. The diluted latex is filled in a tall cylindrical jar with a diameter of around 7.5 cm. Air bubbles and froth remaining on the latex surface are removed by blowing off the surface. The metrolac, after washing in water, is immersed in the latex (Plate 61. e) and allowed to come to rest without touching the side of the cylinder. The reading on the metrolac stem is noted. The DRC of the latex is obtained by multiplying the reading by three (since two parts of water are added) and dividing by ten.

The method, though quick, simple and easy, is not very accurate. The error is in the range of 5 to 10 per cent. However, this method is still in use in estates for assessing the DRC of latex for making sheets on a large-scale and also for calculating the quantity of rubber brought in by a tapper. In order to minimize the error, a correction factor is applied based on the actual laboratory estimation of the bulk latex DRC or from the actual rubber obtained from the bulk latex.

### 5.2.2 Standard laboratory method

This is the most accurate method of determining the DRC of latex. About 10 to 15 g of latex is accurately weighed by difference into a 250 ml beaker or aluminium container from a stoppered 50 ml conical flask. The latex is then diluted with equal quantity of water and then coagulated with two per cent acetic acid or one per cent formic acid and heated on a steam bath, if necessary. The clear serum formed is removed and the coagulum is thoroughly washed, rolled into a thin sheet and dried in an air oven at 70°C for 16 h. Several modifications have been suggested for reducing the drying time. Using smaller quantities of latex (around 5 g), the drying time can be reduced to 3 h (RRIM, 1973). The dried film is cooled in a desiccator and accurately weighed. From the weight of the latex and the dry film, the DRC is calculated.

### 5.2.3 Rapid method

Determination of DRC by this method can be carried out rapidly and with reasonable accuracy. A clean and dry aluminium dish is weighed accurately to which 2 to 3 ml of latex is poured. The dish with the latex is reweighed and 4 to 5 ml of acetic acid - alcohol mixture (5:95) is added to coagulate the latex. The coagulum is pressed into a thin film and dried in an oven at 100°C for 20 min. The dry coagulum is cooled, weighed and the DRC calculated.

### 5.2.4 Microwave technique

Use of microwave technique for determining the DRC of latex has also been reported (Khalid *et al.*, 1991). The technique is based on the principle that the permittivity of water is much higher than that of the solid substances in the latex. The instrument consists of a microwave oscillator, sensor, microwave detector and amplifier. The sensor is dipped into the latex so that the level of the liquid covers the transmitter and the receiver sections. The reflector signal from the sensor is detected by a crystal detector, amplified and then displayed by the meter. This technique, though rapid and easy, needs to be perfected.

## 5.3 Sieving and bulking

Latex collected from the field is likely to be contaminated with bark shavings, dry leaves, small clots of rubber and sand and dust particles. For removing these, the latex is sieved through 40- and 60-mesh sieves into a common bulking tank. Stainless steel sieves are preferred due to their durability. Sieves made of copper or its alloys shall not be used.

Latex collected from various fields may differ in colour, viscosity, DRC, *etc.* Hence to ensure uniformity, it is essential that latex from different fields are blended in a common tank called bulking tank. Bulking is also helpful in the sedimentation of heavier impurities in latex. Bulking tanks are usually lined inside with glazed tiles. Mild steel tanks can also be used, provided the inside is painted with epoxy or bituminous paint. A tap fixed slightly above the bottom of the tank is useful in transferring the latex without disturbing the sediments.

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