

## HIGHER PLANT UTILIZATION AS COAGULANTS FOR MAKING NATIVE MILK PRODUCTS IN INDONESIA

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### ABSTRACT

Five native milk products in Indonesia, i.e. butter-like "*minyak samin*" in Aceh and a part of North Sumatera, yoghurt-like "*dadih*" in West Sumatera and cheese-like products such as "*bagot ni horbo*" in Tapanuli, Sumatera, "*litsusu*" in Nusatenggara and "*dangke*" in South Sulawesi, were studied. In making "*minyak samin*", ground *Solanum aculeatissimum* is added to milk to coagulate and *Pandanus amaryllifolius* is used to improve aroma. The milk is kept for 24 hr and heated to separate fat which is allowed to crystallize; the curd "*tahi minyak*" is also used. "*Dadih*" made by incubating fresh buffalo milk in bamboo tubes for one day, has intermediate characteristics between cultured butter milk and unripened cheese. Average contents of protein and fat in the total solid were 39.8% and 34.4%, respectively. Superior number of bacteria to yeast was observed. "*Bagot ni horbo*" is a curd made by clotting boiled buffalo milk with juice from papaya leaves or pineapple fruit. Various coagulants obtained from trees can be used in making "*litsusu*" in Nusatenggara, Fruit or bark from *Wrightiana calysina* being most effective. The curd formed after incubating milk with coagulant for 2—3 hr in bamboo tubes is dried in the sun. "*Dangke*" is made by clotting boiled milk (90°C) with leaves, stems or young fruits of *Carica papaya* and maturing the curd in banana leaves. The relative milk clotting activity of latex from papaya fruits was maximum at 90°C, while the relative proteolytic activity was only 9% of the maximum at this temperature.

### INTRODUCTION

In tropical areas particularly, there are many plants from which milk-coagulating enzymes can be isolated. Veringa reviewed varieties of rennet substitutes from higher plants in tropical areas<sup>1</sup>. They are *Ficus* sp., *Streblus asper*, *Withania coagulans*, *Carica papaya*, *Cynara cardunculus*, *Solanum indicum*, *Solanum elaeagnifolium*, *Calotropis gigantea*, *Calotropis procera*, *Pinguicula vulgaris*, *Withania somnifexa* and *Castiolla elastica*. Most of attempts to use them as coagulants for the manufacture of various types of cheeses usually have met with disappointment, because most plant proteases have strong proteolytic activities and cause extensive digestion of the curd prepared. However, milk products which have traditionally been manufactured in Indonesia are successful cases<sup>2,3</sup>.

In this report, we describe varieties and manufacturing method of the traditional native milk products in Indonesia.

## INVESTIGATION

### A General View of Native Milk Products in Indonesia

Indonesia is characterized by her great ethnic diversification. These groups lived formerly apart from each in isolated islands and have created their own cultures. Thus, it is a matter of course that there is also a great variety of foods and food habits due to the diversity of ethnic groups.

In historical point of view, fresh cow's milk has not long been used for drinking and manufacturing of milk products across all over the country, although Indonesia is one of the countries in the world where buffaloes have been domesticated in a large number. However, some districts in Sumatra, Sulawesi and Nusatenggara are exceptional ones, where they have traditionally manufactured unusual types of milk products from buffalo milk by use of higher plants as coagulants. These milk products are "dangke" in South Sulawesi, "bagot ni horbo" in Tapanuli, North Sumatra, "dadih" in West Sumatra, "litsusu" in East Nusatenggara, and "minyak samin" in Aceh, Northern Sumatra.

As illustrated in Fig. 1, "minyak samin" is butter oil-like, "dadih" is yogurt-like, and "bagot ni horbo", "litsusu" and "dangke" are cheese like products.

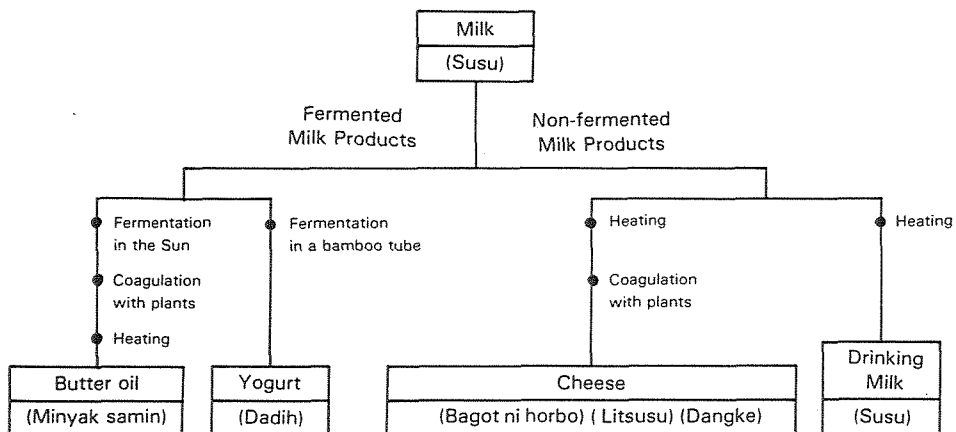


Fig. 1. Varieties of milk products in Indonesia.

Table 1. Milk products native to Indonesia.

Milk products	(Type)	Plant materials used for manufacturing
Minyak samin (Tahi minyak)	(Butter-like)	<i>Solanum aculeatissimum</i> (coagulant) <i>Pandanus amarylifolius</i> (aroma)
Dadih	(Yogurt-like)	Bamboo stem (coagulation vessel)
Bagot ni horbo	(Cheese-like)	Papaya-leaf juice (coagulant) Young pineapple fruit (coagulant)
Litsusu	(Cheese-like)	Leaf of papaya and <i>Mimosa pudica</i> Young fruit of papaya, pineapple and <i>Solanum</i> sp. ( <i>S. quitoense</i> , <i>S. torvum</i> , <i>S. melongena</i> ) Latex of tree bark of <i>Wrightiana calysina</i> , <i>Ficus</i> sp., <i>Calotropis gigantea</i> , <i>Planchonella oxynedra</i> and <i>Cerbera manghas</i> (coagulant)
Dangke	(Cheese-like)	Sliced <i>Carica papaya</i> leaf, stem or young fruit

### Minyak Samin

A kind of butter oil is made in Aceh. This product is white in colour and high viscous, and called "minyak samin" in this area. "Minyak samin" is usually prepared from cow's and/or buffalo milk. Buffalo milk churns more easily than cow's milk, and owing to the higher fat content of buffalo milk yield is greater.

"Minyak samin" is manufactured in the following way: fresh milk in an earthenware jar is stood in the sun for one hour. To the milk is added certain amount of grinded *Solanum aculeatissimum* to coagulate milk. At this moment, certain amount of "pandan" (*Pandanus amarylifolius*) is also added to get good smell. After the milk is stood for 24 to 48 h at room temperature, the cream layer is collected and heated until fat on the top layer becomes separable. The fat is collected and emptied into a glass bottle or a can and allowed to crystalize.

The curd heated is called "tahi minyak", which is a brown coloured substance, and also eaten by the local people in this area.

### Dadih

In West Sumatra, the native people of Minangkabaus have developed a traditional fermented milk product. This product is called "dadih" in Indonesian. "Dadih" is traditional in type and the most popular dairy product among the people living in West Sumatra including such areas as Bukittinggi, Padang Panjang, Solok, Lima Puluh Koto and Tanah Datar.

The manufacturing method of "*dadih*" is considerably simpler than that of western-type yogurt and similar to "*dahi*" in India and Nepal: freshly drawn buffalo milk is poured in fresh bamboo tubes, then kept in a dark like a garret or room corner for 24 h. On the next day, the bamboo tubes with "*dadih*" are capped with banana leaves for the market. In this way, "*dadih*" can be edible for three or four days, or sometimes more than 7 days.

"*Dadih*" has intermediate characteristics between cultured butter milk and unripened cheese. The texture varies from a rennet-like custard to a creamy and high viscous liquid depending on the milk solid and fat content. Especially, higher fat content contributes a smoother body and texture of the product. The people usually eat "*dadih*" in different ways: one of the "*dadih*" dishes is a mixture of cooked-glutinous rice, "*dadih*", shredded coconut flesh (inner soft tissue in white colour) and various palm-sugar dressing. This dish is known by the name of "*ampiang dadih*" or "*ampiang dadiah*" in these area. Another "*dadih*" dish is "*samba lado*" or "*samba cabe*", a mixture of "*dadih*", onion, red pepper and cooked rice.

General chemical composition of "*dadih*" is characterized by high protein and fat contents, that is average contents of protein and fat in the total solid were 39.8% and 34.4%, respectively. Superior number of bacteria to yeasts is usually observed.

#### **Bagot ni horbo**

"*Bagot ni horbo*" is a cheese type product which has been traditionally manufactured and eaten by Batak people in Tapanuli area. In the local language of Tapanuli "*bagot*" means "*milk*", "*ni*" means "of", and "*horbo*" means "*buffalo*" in English.

The manufacturing method of "*bagot ni horbo*" is very simple: fresh buffalo milk is poured into a pan and brought to the boiling slowly with continuous stirring. After the milk come to the boiling, certain amount of juice derived from papaya leaves on fresh young-pineapple fruits is added to the milk until the milk coagulates, and afterwards the whey may or not may be removed. They eat this product ("*bagot ni horbo*") as such or with rice after frying.

Coagulation of milk may occur due to both actions of proteolytic activity and of acidity of pineapple juice, because blommelain is a well-known protease found in pineapple fruits, and pH of fresh pineapple fruits is usually in a range of 3.2 to 3.5.

#### **Litsusu**

In Nusatenggara, a cheese-like product called "*litsusu*" has been manufactured. In this area, cattle breeding is extensively carried on, because the amount of precipitation throughout a year is very much smaller compared with those in other districts in Indonesia.

Manufacture of "litsusu" is characterized by using of varieties of coagulants from tropical plants. As we reported previously, the plant parts being used for coagulation of milk are leaves of papaya and *Mimosa pudica*, fruits of young papaya, young pineapple, and *Solanum* sp. (*S. quitoense*, *S. torvum*, *S. melongena*, and latex of tree bark of *Wrightiana calysina*, *Ficus* sp., *Calotropis gigantea*, *Planchonella oxynedra*, and *Cerbera manghas*<sup>31</sup>. Among these plants, the fruits of *W. calysina* producing much latex is more effective in coagulating the milk. *W. calysina* is called "pohon litsusu" ("litsusu" tree) by the Timor natives. Tree bark is more commonly used than the fruits, because the fruits contain insects. Fig. 2 shows coagulation of milk by "litsusu" tree pieces in relation to milk temperature. Milk coagulation is observed to occur more rapidly at temperatures higher than 70°C. Hosono *et al.* prepared an extract (pH 6.3, N content; 473 µg/ml) from a twig of

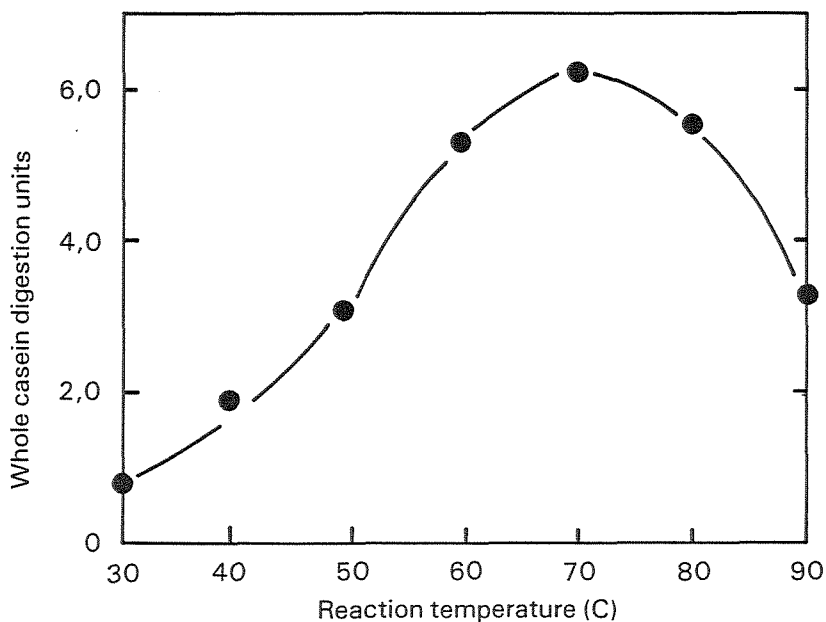


Fig. 2. Effect of temperature on proteolytic activity of the milk-clotting enzyme.

The reaction mixtures contained 0.5 ml of 4% whole casein solution, 1.25 ml of 0.02 M phosphate buffer, pH 6.0 and 0.25 ml of the enzyme preparation. The mixture were incubated at a given temperature for 30 min.

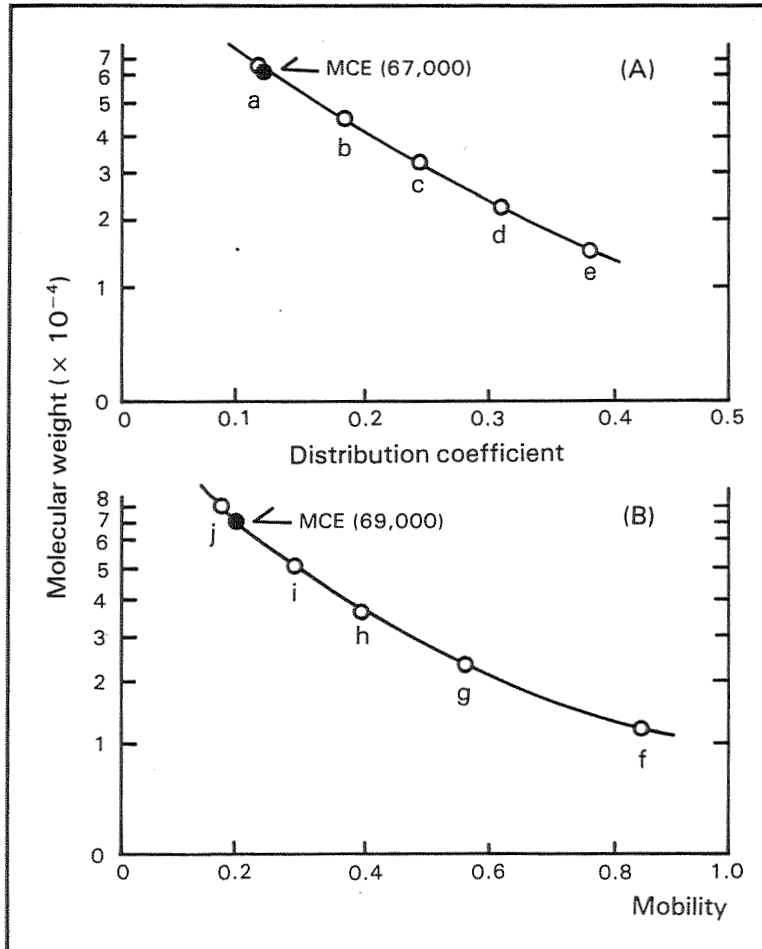


Fig. 3. Molecular weight determination of the purified milk clotting enzyme in the litsusu extract by means of gel filtration with a Sephadex G-100 column (A) and SDS-polyacrylamide gel electrophoresis (B). a; bovine serum albumin (68,000), b; ovoalbumin (43,000), c;  $\beta$ -lactoglobulin (dimer, 36,800), d; chymotrypsin (24,000), e; myoglobin (17,200), f; cytochrome c (monomer, 12,400), g; cytochrome c (dimer, 24,800), h; cytochrome c (trimer, 37,200), i; cytochrome c (tetramer, 49,600), j; cytochrome c (hexamer, 74,400), MCE; the purified milk clotting enzyme.

"litsusu" and examined its milk-clotting and proteolytic properties<sup>4</sup>. The "litsusu" extract exhibited maximum milk-clotting activity at pH 6.0, whereas the optimum pH curve of the proteolytic activity fluctuated with two maxima at pH 7.5 and 8.5. The optimum temperatures for milk-clotting and proteolytic activities were both 70°C. Milk-clotting of the "litsusu" extract was very stable at temperatures even higher than 70°C, and 70% of original milk-clotting activity remained after heating the "litsusu" extract at 90°C for 30 min and at pH 6.3. A scanning electron microscopic comparison among the curds prepared by coagulating milk with rennet, the "litsusu" extract and HCl indicated that the surfaces of rennet- and "litsusu"-curds had several common features.

The molecular weight of the enzyme purified about 468 fold by a procedure involving ammonium sulfate fractionation, DEAE-cellulose, CM-cellulose and Sephadex G-100 chromatographies was 67,000 by Sephadex G-100 chromatography or 69,000 by SDS-gel electrophoresis (Fig. 3)<sup>5</sup>. The molecular weight is considerably higher than these papain (MW: 23,400)<sup>6</sup> and bromelains (MW: 31,000)<sup>7</sup>.

*Wrightiana calysina* is one of the species in plant family, *Apocynaceae*, and phylogenetical relation of this plant either to *Ficus carica*, *Carica papaya* or *Ananas comosus* is distant as shown in Fig. 4. From these respects, we suppose that the properties of the milk clotting enzyme from *Wrightiana*

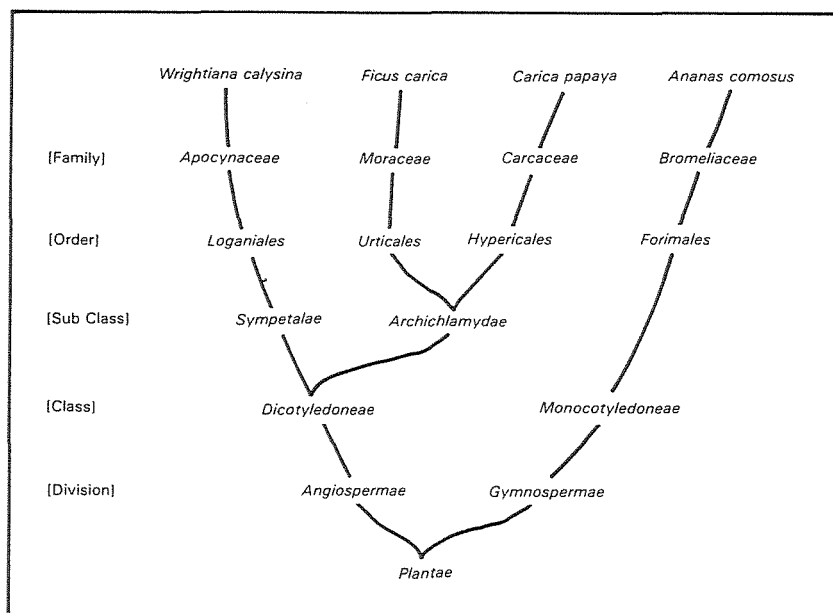


Fig. 4. Location of *Wrightiana calysina* in the phylogenetic system.

*calysina* as a proteolytic enzyme may be clearly distinguishable from the properties of these proteases.

"Litsusu" in West Timor is manufactured in the following way: to two to three liters of milk in a bamboo tube is added a bark of "*pohon litsusu*" (4 × 2 × 5 cm), and the milk is stood for 2 to 3 h. After the coagulation of milk, whey is removed by pressing the curd with fingers. The curd is then made into hemispherical shape and dried in the sun for one hour. The curd dried is called "litsusu".

Instead of "*pohon litsusu*", such plants like "*perah*", "*cologanti*", "*susu kaya*", "*segan gadi*" and "*pesjada*" are used to coagulate milk in West Nusatenggara. "*Rembiga*" tree (*Calotropis gigantea*), "*ridi*" tree (*C. manghas*) and "*jeliti*" tree (*Planchonella oxynedra*) are also used in this area.

### **Dangke**

"*Dangke*" is a well-known traditional cheese in Indonesia. This product has been manufactured in the districts of Enrekang, Baraka, Anggeraja and Alla in South Sulawesi. The name of "*dangke*" was derived from "dank U wel" which is Duch language for "thank you very much". The local people in South Sulawesi historically called this type of cheese "*dangke*". As for the name of the product, there is a local story that the Dutch who first visited to South Sulawesi received this product from the local people, saying "dank je" ("Dank je" is a shortened form of "dank U well") in return.

"*Dangke*" is usually manufactured in the following way: freshly drawn buffalo milk is poured into a pan and heated until boiling. Then milk is stood for cooling. After temperature of the milk goes down to about 90°C, a certain amount of sliced papaya (*Carica papaya*) leaves, stems or young fruits is added to the milk. At this moment, careful attention is usually paid so that excess amount of sliced papaya leaves, stems or fruits should not be added, because such parts of papaya have very strong bitter taste. After the addition of papaya leaves, stems or fruits, the milk is stirred slowly in a manner of a continuous circular motion for approximately 15 minutes. When the curd becomes to be separable from whey, the curd is ladled into a coconut shell, in which it is pressed into its final hemispherical shape.

The cheese, "*dangke*" is then wrapped with banana leaves and kept at room temperature until it becomes ready to be consumed. In order to increase keeping quality, the cheese is sometimes soaked overnight in a salt solution before wrapping with banana leaves.

Fresh "*dangke*" is white in colour and has an elastic texture in the best quality. Sometimes, a certain amount of tapioca, rice flour or wheat flour is added to liquid milk to increase the yield of curd. In this case, "*dangke*" is pale yellow in colour and has no elastic texture.



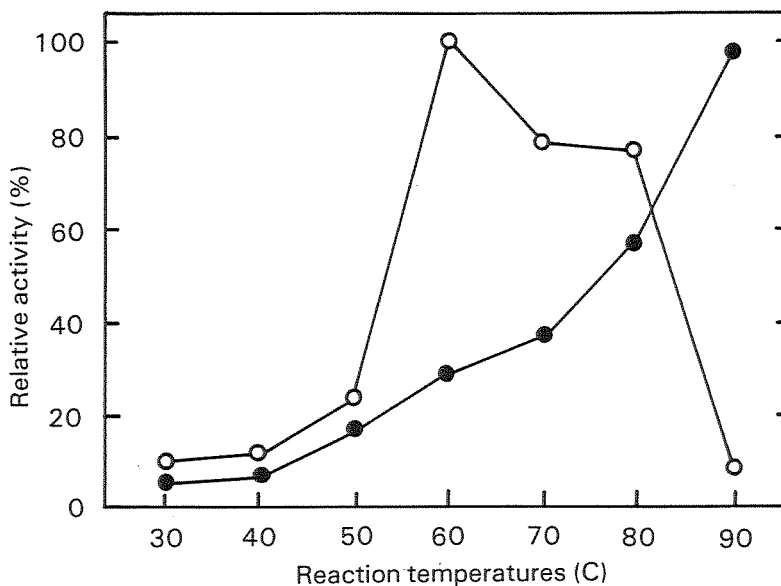


Fig. 5. Effect of incubation temperature on milk clotting and proteolytic activities in papaya latex.

○ shows relative proteolytic activity and ● relative milk clotting activity. To 3 ml of skim milk was added 0.5 ml of papaya latex dilution. The mixture was incubated at various temperatures until the skim milk coagulated.

It has long been suggested that enzyme from higher plants might be useful in cheese making, and some have been tried. However, most of attempts to use them usually have met with disappointment due to extensive digestion of the curd. In spite of these trials and errors, "dangke" is the only cheese in the world which is successfully manufactured by use of leaves or fruits of papaya. The authors investigated effect of temperature on milk-clotting and proteolytic activities of the latex prepared from young papaya fruits. The milk clotting activity rised with the increase of temperature up to 90°C where the relative proteolytic activity was 9.0%, as shown in Fig. 5. This fact strictly explains the reason why strong bitter taste does not develop in "dangke" cheese.

## SUMMARY

Five native milk products in Indonesia, i.e., butter-like "minyak samin" in Aceh and a part of North Sumatra, yogurt-like "dadih" in West Sumatra and cheese-like products such as "bagot ni horbo" in Tapanuli, Sumatra, "litsusu" in Nusatenggara and "dangke" in South Sulawesi, were studied. In making "minyak samin", ground *Solanum aculeatissimum* is added to milk to coagulate and *Pandanus amarylifolius* is used to improve aroma. The milk is kept for 24 h and heated to separate fat which is allowed to crystalize; the curd "tahi minyak" is also used. "Dadih" made by incubating fresh buffaloes' milk in bamboo tubes for one day, has intermediate characteristics between cultured butter milk and unripened cheese. Average contents of protein and fat in the total solid were 39.8% and 34.4%, respectively. Superior number of bacteria to yeasts was observed. "Bagot ni horbo" is a curd made by clotting boiled buffaloes' milk with juice from papaya leaves or pineapple fruit. Various coagulants obtained from trees can be used in making "litsusu" in Nusatenggara, fruit or bark from *Wrightiana calysina* being most effective. The curd formed after incubating milk with coagulant for 2 - 3 h in bamboo tubes is dried in the sun. "Dangke" is made by clotting boiled milk (90°C) with leaves, stems or young fruits of *Carica papaya* and maturing the curd in banana leaves. The relative milk clotting activity of latex from papaya fruits was max. at 90°C, while the relative proteolytic activity was only 9% of maximum at this temperature.

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