Potential Development of Makapuno coconut in the Mekong Delta of Vietnam

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Abstract

In the Mekong delta of Vietnam, there is a coconut variety called Sap coconut or makapuno coconut. Perhaps, this is a mutant coconut type which produced very thick endosperm and viscidity with little or no water. Nowadays, makapuno nuts are used mainly for food processing, very promising for biodiesel in future. The price of makapuno nuts has been rising each year. So the demand of seedlings is also to increase yearly. Based on the demand of makapuno for many different purposes, potential development of makapuno in the Mekong Delta is very high. Studies of the inheritance on makapuno in the Mekong Delta are restricted. However, study results of the inheritance pattern on makapuno bearing trees in the Philippines are very useful for application in the Mekong Delta. Propagation techniques of makapuno could be applied from traditional to modern such as embryo culture. Potential development of makapuno in the Mekong Delta of Vietnam is very promising. Products and by products from makapuno coconut are very diversified and useful and bring back more benefices for farmers. Combination between experiences of farmers and scientific studies will help to develop makapuno plantation obtaining success.

Keywords: *green biomass, makapuno, biodiesel, products, propagation*

1. Introduction

The Mekong Delta is located in south western of Vietnam where the Mekong River run into the sea through a network of distributaries. The Mekong delta region encompasses a large portion of south western Vietnam of 39,000 square kilometers. The soil of the lower Delta consists mainly of sediment from the Mekong and its tributaries, deposited over millions of years as the river changed its course due to the flatness of the low-lying terrain.

In the Mekong delta of Vietnam, there is a coconut variety called "Dừa sáp" or Sap coconut. Dừa, in Vietnamese, means coconut and sáp means viscidity. Perhaps, this is a mutant coconut type which produced very thick endosperm and viscidity (as cream) with little or no water. Sap coconut was detected by a monk of Botum Sako Pagoda in CauKe district of Travinh Province in 1924. Almost botanical and agronomical characteristics of this coconut are similar to makapuno coconut of the Philippines.

Makapuno coconut of the Philippines has been known and studied very long time since 1914 [1] and makapuno named word is very popular. Meanwhile Sap coconut was studied within recent two decades. So makapuno word is used in this text to replace sap coconut. However, all studies were carried out on sap coconut in Vietnam.

Nowadays, makapuno nuts are used mainly for food processing. The demand of makapuno nuts depends on festival and tourist months in year. The price of makapuno nuts has been rising each year, for example, in 2004, the price of makapuno was 1.5 USD/nut and in 2010 it is 10 USD/nut. The high price of makapuno nuts showed that the demand is higher than the supply. So the demand of seedlings is also to increase yearly. Beside food processing, one new problem of makapuno has been suggested by late prof.Hirata to be the use of makapuno for biodiesel, a biofuel of future.

Based on the demand of makapuno for food processing, the demand of seedlings for growing, biodiesel for future, potential development of makapuno coconut in the Mekong Delta of Vietnam is very promising.

2. Potential development of makapuno coconut in the Mekong Delta of Vietnam

2.1 Green biomass studies and products of makapuno

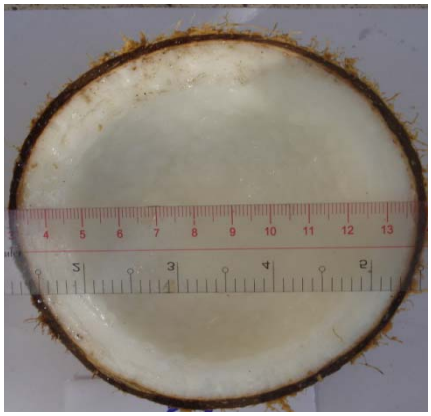
2.1.1 Green biomass of fruit

Makapuno coconut tree is a tall coconut variety with good characteristics like big fruit, big nut, and high weight of fresh meat. Table 1 showed that an average weight of makapuno fruit is 1827.3 grams Among them coconut husk obtains 852.3 g, 975 g of nut, 262.3 g of coconut water, 224.1 g of nut shell and 488.6 g of fresh meat. However the weight of fresh meat could change from this type to other type (A,B or C).

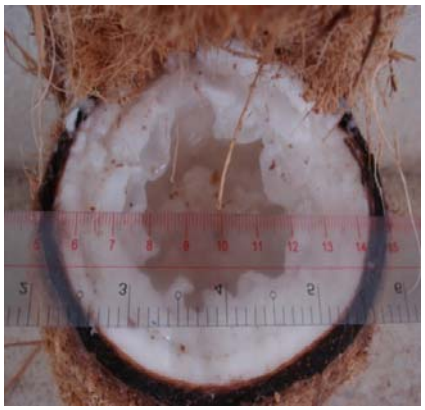
Table 1 An average weight of 22 makapuno fruits

Components	Weight (g)
Fruit	1827.3
Coconut husk	852.3
Nut	975.0
Coconut water	262.3
Nut shell	224.1
Fresh meat	488.6

Morphologically, the makapuno bearing trees in Vietnam are similar to normal coconut trees in all traits such as leaves, trunk, height and size of nut. For makapuno nuts, they were classified to three nut phenotypes (A, B and C) (Fig 1). Type A is slightly thicker and softer endosperm than normal coconut. Type B has endosperm filled about 50% of the cavity; type C has a endosperm almost occupied the cavity, little or no water



Type A is slightly thicker and softer than normal coconut



Type B, soft solid endosperm fills about 50%; the rest is filled with thick liquid.

Type C, soft solid endosperm almost filled the cavity

Fig. 1 Three types of makapuno endosperm

2.1.2 Products from coconut green biomas

All components of makapuno fruit have been used for different purposes. There are many products made from makapuno fruit and bring more benefits for farmers (Fig 2).

- Coconut husk

This is the outside cover of the nut. This part contains two main materials; (1) fiber from the coconut husk is used for handicraft, mattress fibers, filter pads, carpets, erosion nets, insulation material, biodegradable pots, orchid and ornamental planting media, etc. and (2) cocopeat (powder) is the part after separating the fiber from the husk. It has very good water retention thus used mainly as hydroponics substrates or potting medium.

- Coconut shell

This is the protective cover of the coconut meat and water. This part is very good source for making activated charcoal and handicrafts.

- Coconut water

The liquid is stored inside the coconut. In mature fruit, coconut water is used for making coco candy. However in normal coconut, amount of coconut water is very much but very little in makapuno.

- Copra

Copra is the dried coconut meat (kernel or endosperm). It is the most important part of makapuno. Because it is used to extract oil using for many different purposes such as cosmetics, medicines, soaps and detergents, paints, biofuels, etc.

According to Ramirez and Mendoza, (1998) makapuno endosperm lipids have higher levels of glycolipids and phospholipids and lower level of neutral lipid than normal coconut. The fatty acid profiles of the various lipid fractions of the normal and makapuno are similar except for a few: oleic acid, 40% higher and palmitic acid, 32% higher in makapuno glycolipid than in normal coconut glycolipid [2]

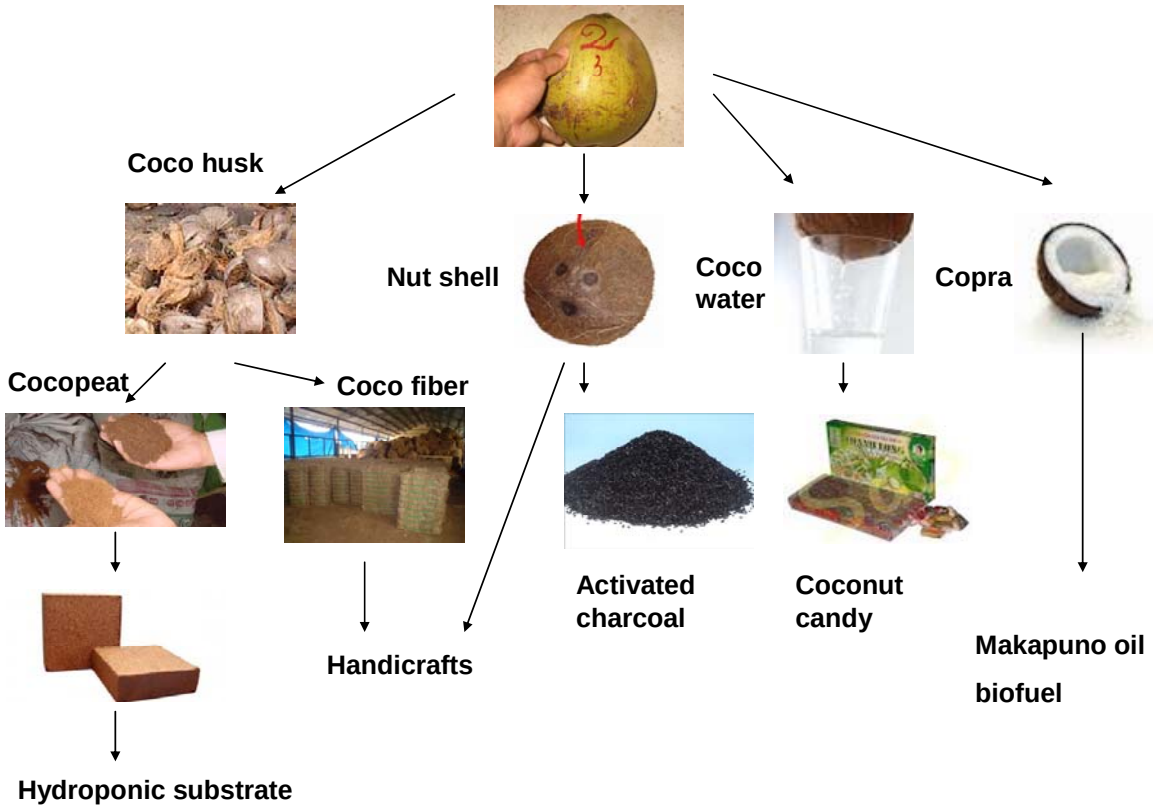


Fig. 2 Typical products made from normal and makapuno coconuts in Vietnam

The main objective of makapuno development is to aim exploitation of fresh meat for food processing and oil to process biodiesel. Once this development obtains the success, it will pull more different careers (Fig 2) such as to product activated charcoal, handicrafts and hydroponics substrates.

2.2 Inheritance and propagation of makapuno coconut

2.2.1 Cultivars

In the Mekong delta, there are two makapuno cultivars detected based on color of fruits. One is yellow and another one is green. All agronomical characters of these two cultivars are the same (Figure 3) and up to now, there are not any studies about inheritance characteristics of them.

The makapuno tree (yellow)

The makapuno tree (green)

Fig. 3 Two makapuno cultivars: yellow (left side) and green (right side)

2.2.2 Inheritance

Nowaday, studies of the inheritance on makapuno in the Mekong Delta still are restricted. In the Philippines, studies of the inheritance pattern on makapuno bearing trees indicated that the makapuno endosperm of coconut is controlled by a single recessive gene and that the macapuno bearing trees which occasionally bears macapuno nuts is heterozygous for character. The makapuno character is controlled by a single gene [3]. Based on these studies, there were three genotypes, MM, Mm and mm, on makapuno bearing trees. M, the factor for normal endosperm which was dominant and m, the factor for makapuno endosperm which was recessive. MM and Mm were normal coconut, mm was makapuno. Theoretically, MM coconut trees were self pollinated produce normal nuts, Mm trees were self pollinated produce normal nuts and makapuno and mm trees were self pollinated produce all makapuno nuts. Ramirez and Mendoza, (1998) indicated that embryo cultured makapuno trees were self pollinated by another embryo cultured makapuno tree. All nuts produced were makapuno. On the other hand, when these embryo cultured trees were cross pollinated with a normal tree (MM), all nuts produced were normal (Mm). These results showed that the embryo cultured makapuno coconut were homogenous for the makapuno character (mm) and potientially can produce all makapuno nuts. Combination between theory and practice showed that to obtain all quite makapuno nuts, embryo cultured makapuno trees should be grown and makapuno embryo culture technique should be learned. In addition, Mm trees should also be grown although they produce lower makapuno nuts. Poor farmers are not enough money to buy embryo cultured makapuno seedlings. Thus they still apply traditional propagation from nuts on makapuno bearing trees. Presently, in the Mekong Delta farmers extent area of makapuno cultivation by two ways. The first they cultivate from seedlings of makapuno bearing trees and the second they cultivate from embryo cultured makapuno seedlings. The second way farmers invest more capital than the first.

2.2.3 Propagation

- *Traditional propagation*

Traditional propagation is the easiest way. With experiences, farmers collected nuts from bunches which bore makapuno nuts (Figure 4). Then they sowed all nuts in shading and wet places until seedlings developed and obtained 5-6 leave; they bring these seedlings growing them in gardens. By this way they obtained relative low makapuno bearing trees. Scientifically, they planted two normal coconut trees (MM or Mm). If they remove MM trees and plant Mm trees they will harvest more makapuno. The price of makapuno nuts is very high (around 10-15 USD/nut), nut is very difficult to germinate *in situ*. Former farmers have never used makapuno for traditional propagation.

In Philippines, all nuts from makapuno bearing trees are planted in cluters.This will result in a plantation with 2:1 ratio of makapuno bearing trees to normal ones with makapuno bearing trees producing 3:1 normal to makapuno nuts. Any normal trees found in such clusters can be removed to minimize pollination of the surrounding makapuno bearing trees with pollen from normal trees (Ramirez and Mendoza, 1998). These experiences are very useful for Vietnamese farmers.

Fig. 4 Traditional propagation from makapuno bearing trees in the Mekong Delta of Vietnam. Most of them are MM and Mm genotype nuts

- *Application of SDS-PAGE protein electrophoresis to identify the makapuno genotypes*

The differences between species should be based on gene differences, but direct comparison of genes is difficult and time-consuming. Therefore, the differences can probably be measured by comparing the products of gene activity. Electrophoretic techniques are used on large scales in protein and enzyme analysis to identify and characterize the genotype differences among plant species and varieties. Many authors used the electrophoretic tool to characterize the differences and similarities between plants. Among these authors are: Vries (1996) and Kamel and Hassan (2001) [4,5].

One technique of SDS-PAGE protein electrophoresis was developed by Dr Vo Cong Thanh (unpublished) to detected genotypes of MM and Mm. With protein profile (Figure 7) there were two protein bands stained different dying with Coomasive Brilliant Blue R250, CBBR250, (arrows) according samples or varieties, in the same well one protein band looks slightly lighter than the desired upper band staining level. Compared with the control leaf sample, the two bands in the same

well is both bolder staining level. These proved that those proteins in relation were naturally mutated and not interact with basic amino acids such as lysine, histidine or arginine, in other word, this mutated band is lighter than the other. We supposed the protein bands of leaf control were controlled by allele m or MM genotype, the protein mutated band of makapuno expressed lighter dying controlled allele m, or mm genotype (makapuno type) which is very difficult to propagate by normal farmer's way except by embryo culture.. Based on the mechanism we mentioned above, we identified two genotypes of our results presented for each well (Figure 7 and 8). While waiting for micropropagation by tissue culture or embryo culture (very high price of seedlings), we still use farmer's traditional propagation way but we could apply SDS-PAGE technique to detect and remove MM genotype in the young seedling stage.

1 2 3 4 5 6 7 8 9 10

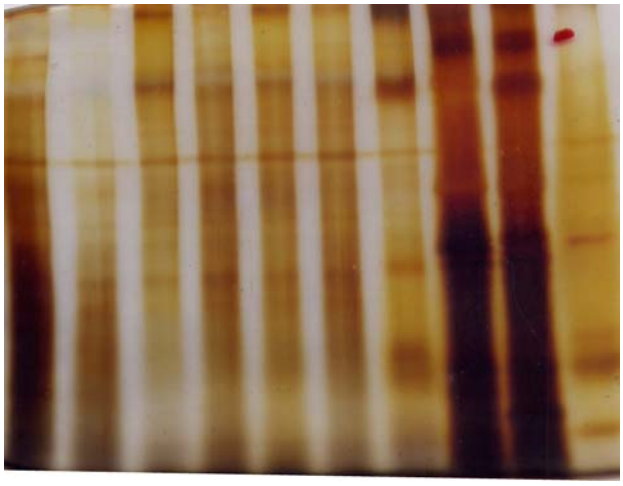


Fig. 7 Protein profile of makapuno
1 Mm; 2Mm; 3 Mm; 4 Mm; 5 Mm,6 Mm,
7 Mm, 8-9: MM (controls) , 10 Mm

1 2 3 4 5 6 7 8 9 10

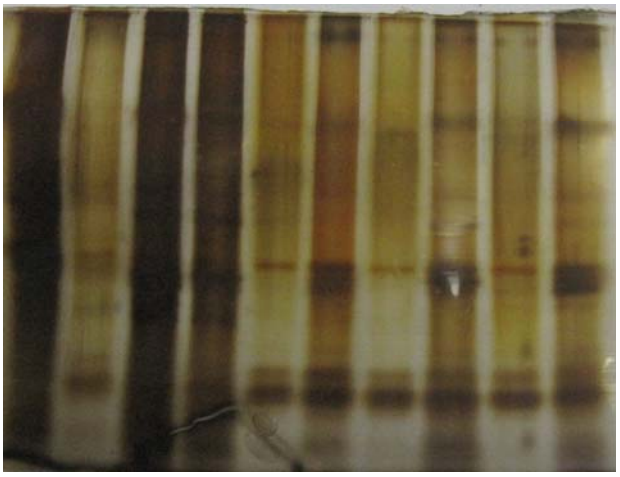


Fig. 8 Protein profile of makapuno Control wells 8 and 10
1 MM; 2MM; 3 Mm; 4 Mm; 5 Mm;6 MM;
7 Mm; 8 MM, 9 Mm, 10 MM

- *Embryo culture*

Makapuno embryo culture technique is suitable for laboratory. This technique was applied successfully in the Philippines and obtained ratio of makapuno survived seedlings. Our results of makapuno embryo culture showed that one embryo produces less than one seedling [6]. Makapuno nuts in Vietnam were classified to three phenotypes (A, B and C) as mentinioned above. In vitro germination of type B is lower than type A. Type C is almost not germination. These results are similar to ones in makapuno of the Philippines [7].

Makapuno nut splitted into two parts

Embryo isolated and cultured into medium

Embryo germinated to seedling

Seedling after one year in soil plastic bag

Fig. 5 Steps of makapuno embryo culture in Can Tho University

Up to now, embryo culture techniques could be established for tissue culture laboratories in the Mekong Delta. Results obtained very well. The current problem is due to the high price of makapuno nuts and ratio of germination is very low. Thus the price of makapuno seedling is very high. Farmers are not enough money to buy embryo cultured makapuno seedlings.

- *Micropropagation of makapuno*

Makapuno micropropagation has been studied in several countries. However, makapuno was a difficult tree to manipulate *in vitro* because of browning. We obtained some results in callus formation on Y3 medium [8] added NAA 4 mg/l + BA 8 mg/l after 3 months in culture from makapuno plumule explants (Le hong Giang et al., 2010)(Figure 6). However we have not obtained success yet in conversion from somatic embryos to plantlets. Hopefully, one year more we can produce a mass of makapuno seedlings from this technique.

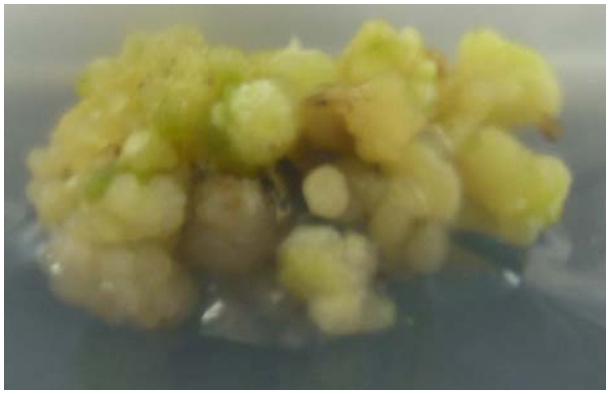


Fig. 6 Induction of makapuno calli from plumule

3. Conclusions

Based on green biomass, inheritance, propagation and the demand of seedlings, potential development of makapuno in the Mekong Delta of Vietnam is very promising. Products and by products from makapuno coconut are very diversified and useful and bring back more benefices for farmers. Combination between experiences of farmers and scientific studies will help to develop makapuno plantation obtaining success.

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