HORTIN II Co Innovation Programme

Towards cost effective, high quality value chains

Developments in postharvest technology for rambutan

HORTIN-II Research Report nr. 17

Sri Yuliani (ICAPRD)
Setyadjit (ICAPRD)
Jeroen Knol (Wageningen UR, AFSG)
Maxence Paillart (Wageningen UR, AFSG)

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The purpose of the HORTIN-II programme is to contribute to the development of cost effective high quality value chains for vegetables and fruits. Among others this can be achieved when technology development takes place in close collaboration between public institutions, farmers and private companies.

On the Indonesian side the programme is carried out by the Indonesian Centre for Horticultural Research and Development **(ICHORD),** Jakarta, with the Indonesian Vegetable Research Institute **(IVEGRI)**, Lembang, and the Indonesian Centre for Agricultural Postharvest Research and Development **(ICAPRD)** in Bogor.

In the Netherlands the Agricultural Economics Research Institute **(AEI)**, Den Haag, the Agrotechnology and Food Sciences Group **(ASFG)**, Wageningen, Applied Plant Research **(APR)**, Lelystad, and WUR-Greenhouse Horticulture **(WUR-GH)**, Bleiswijk, all partners in Wageningen University and Research centre, are involved in the programme.

Addresses:

Indonesian Centre for Horticultural Research and Development (ICHORD)
Address : Jl. Ragunan 29A, Pasarminggu, Jakarta 12520, Indonesia
Tel. : +62 21 7890990
Fax : +62 21 7805135
E-mail : pushor@rad.net.id or pushorti@yahoo.com
Internet : www.litbanghortikultura.go.id

Indonesian Vegetable Research Institute (IVEGRI)
Address : Jl. Tangkuban Perahu 517, Lembang-Bandung 40391, West Java, Indonesia
Tel. : +62 22 2786 245
Fax : +62 22 2786 416
E-mail : dir_ivegri@balits.org or balitsa@balitsa.org
Internet : www.balitsa.org

Indonesian Centre for Agricultural Postharvest Research and Development (ICAPRD)
Address : Kampus Penelitian Pertanian, Cimanggu, Bogor 16114, West Java, Indonesia
Tel. : + 62 251 321762
Fax : + 62 251 350920
E-mail : bb_pascapanen@litbang.deptan.go.id or bb_pascapanen@yahoo.com
Internet : www.pascapanen.litbang.deptan.go.id

Agricultural Economics Research Institute (AEI)
Address : Alexanderveld 5, Den Haag, The Netherlands
: PO Box 29703, 2502 LS Den Haag, The Netherlands
Tel. : +31 70 335 83 30
Fax : +31 70 361 56 24
E-mail : informatie.lei@wur.nl
Internet : www.lei.wur.nl

Agrotechnology and Food Sciences Group (ASFG)
Address : Building 118, Bornsesteeg 59, Wageningen, The Netherlands
: PO Box 17, 6700 AA, Wageningen, The Netherlands
Tel. : +31 317 480 084
Fax : +31 317 483 011
E-mail : info.asfg@wur.nl
Internet : www.asfg.wur.nl

Applied Plant Research (APR)
AGV Research Unit
Address : Edelhertweg 1, Lelystad, The Netherlands
: PO Box 430, 8200 AK Lelystad, The Netherlands
Tel. : +31 320 29 11 11
Fax : +31 320 23 04 79
E-mail : infoagv.ppo@wur.nl
Internet : www.ppo.wur.nl

WUR-Greenhouse Horticulture (WUR-GH)
Address : Violierenweg 1, Bleiswijk, The Netherlands
: PO Box 20, 2665 ZG Bleiswijk, The Netherlands
Tel. : +31 317 48 56 06
Fax : +31 10 52 25 193
E-mail : glastuinbouw@wur.nl
Internet : www.glastuinbouw.wur.nl

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Programme Team

	Indonesia	The Netherlands
Programme management	Dr. Yusdar Hilman, Director ICHORD Telephone +62 21 7890990 Fax +62 21 7805135 E-mail: YHILMAN@INDO.NET.ID	Dr. Arij Everaarts, APR, General management Telephone +31 320 291 671 Fax +31 320 230 479 E-mail: ARIJ.EVERAARTS@WUR.NL Mrs. Myrtille Danse, AEI, Supply Chain Management
Sweet pepper pilot project	Dr. Nikardi Gunadi, IVEGRI Telephone +62 22 2786 245 Fax +62 22 2786 416 E-mail: NGUNADI@BDG.CENTRIN.NET.ID	Mrs. Marieke van der Staaij, Ruud Maaswinkel, WUR-Greenhouse Horticulture Telephone +31 317 485 537 Fax +31 105 225 193 E-mail: MARIEKE.VANDERSTAAIJ@WUR.NL RUUD.MAASWINKEL@WUR.NL
Shallot pilot project	Dr. Rofik Sinung Basuki, IVEGRI Telephone +62 22 2786 245 Fax +62 22 2786 416 E-mail: ROFIK@HOTMAIL.COM	Lubbert van den Brink, APR Telephone +31 320 291 353 Fax +31 320 230 479 E-mail: LUBBERT.VANDENBRINK@WUR.NL
Hot pepper pilot project	Dr. Witono Adiyoga, IVEGRI Telephone +62 22 2786 245 Fax +62 22 2786 416 E-mail: VICIANTI@YAHOO.CO.ID	Herman de Putter, APR Telephone +31 320 291 614 Fax:+31 320 230 479 E-mail: HERMAN.DEPUTTER@WUR.NL
Supply chain management	Dr. Witono Adiyoga, Dr. Nikardi Gunadi, Dr. Rofik Sinung Basuki, IVEGRI	Mrs. Myrtille Danse, Mrs. Rolien Wiersinga, Mrs. Olga van der Valk, AEI Telephone +31 70 3358 341 Fax +31 70 3615 624 E-mail: MYRTILLE.DANSE@WUR.NL ROLIEN.WIERSINGA@WUR.NL OLGA.VANDERVALK@WUR.NL
Quantitative Economic Analysis	Dr. Witono Adiyoga, IVEGRI	Marcel van der Voort, APR Telephone +31 320 291 312 Fax +31 320 230 479 E-mail: MARCEL.VANDERVOORT@WUR.NL
Fruit supply chains	Dr. Sri Yuliani, ICAPRD Telephone +62 251 321762 Fax +62 251 350920 E-mail: S.YULIANI@GMAIL.COM	Dr. Jeroen Knol, ASFG Telephone +31 317 480177 Fax +31 317 483011 E-mail: JEROEN.KNOL@WUR.NL

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Executive summary

Rambutan is a tropical fruit appreciated by Indonesian consumers and by European consumers. Rambutan is a non-climacteric fruit, which must be harvested when it has reached an optimal eating quality and visual appearance, since it will not continue to ripen once removed from the tree. Once harvested, quality decays are initialized. These decays can be slowed down by conditioning correctly the fruit from producer to consumer areas or by can be processed with different technologies to extend shelf life.

An overview has been presented of a whole range of processing technologies that can be applied to extend the shelf life and quality of rambutan. All technologies reported have been evaluated based on their effect on quality, appearance and costs (table 1, chapter 4). Not all technologies are feasible to implement on the Indonesian market, due to regulations and high investments for novel processing. However, juice processing and preservation seem promising. First experiments have shown that the shelf life of rambutan can be greatly extended by these relatively cheap and proven processes, making them ideal for implementation in Indonesia. Processed rambutan can be stored at ambient temperatures (30˚C) for 2 months. Rambutan juice can have a storage life up to 4 months.

It has been established that several packages and concepts permit to extend significantly the shelf life of fresh Rambutan fruits. The majority of them are actually or on the market or easily applicable. Modified atmosphere packaging is suitable to extend shelf life of rambutan in two ways. Firstly, it helps to reduce or prevent browning by maintaining a higher relative humidity around fruits inside the sealed film, which prevents water loss due to transpirations. Secondly, modified atmosphere packaging prevents cross contamination during transportation and storage. However it is important to check the feasibility of implementing these concepts to the specific Indonesian Rambutan production. Recommendations are made specifically for the local and export market.

Experiments conducted by ICAPRD and AFSG have shown that by choosing optimal packaging and controlling the cold chain, shelf life of 21 days can be achieved. The packaging materials should answer to the following requirements:

- Relative humidity inside the bag around 95%.
- Condensation controlled by Antifog material or water free absorber
- Permeability properties of packaging material should avoid any anaerobic condition and assure a carbon dioxide concentration between 9 and 12%
- As the packaging facilities at the exporter location are non-existing or extremely limited, the MAP packaging shouldn't require high-tech equipment. The optimum gas concentrations should be reached by the natural respiration rate of the rambutan fruits.

Good handling of the products is necessary to assure the optimal initial quality and the maximum shelf life of rambutan. Gentle handling during harvest and transport minimizes mechanical damages and avoids any enzymatic decays of fruits.

Output:

- Recommendation on packaging for MAP
- Processing techniques to produce preserved rambutan
- Processing techniques to produce rambutan juice

1. Introduction

Rambutan is a tropical fruit appreciated by Indonesian consumers and by European consumers. Indonesia produces each year an average of 350000MT of Rambutan that is essentially destined for local market (Poerwanto 2005). The exportation of Rambutan produced by Indonesian farmers is localized to United Arab Emirate, Europe and lands in neighbour of Indonesia. Whereas the export distribution appears large, the total quantity of export is limited by transport conditions and the short shelf life of product.

Under normal atmosphere conditions, the expected shelf life of Rambutan doesn't exceed one week (cultivar dependant). Studies about extension of shelf life of Rambutan produced in tropical countries have shown a possible extension until 20 days. To reach this additional shelf life, particular cares and packaging/storage materials should be implemented.

Rambutan is a tropical fruit that grows in the majority of the western Indonesian islands between 0 and 600 meters above see level. Indonesian Rambutan production amounts to 3.5% of total fruit production. Despite of the important demand of consumer, distribution is limited by the short shelf life of the fruits after harvesting. Rambutan is a non-climacteric fruit, which must be harvested when it has reached an optimal eating quality and visual appearance, since it will not continue to ripen once removed from the tree. Rambutan is of acceptable appearance between 16 and 28 days after colour-break when the skin and spinterns (hair-like protuberances) are brightest and most evenly coloured (Wanichkul and Kosiyachinda, 1982). When rambutan is harvested too early, acidity and a lack of sweetness arise, while fruit harvested too late can be bland. Once harvested, quality decays are initialized. These decays can be slowed down by conditioning correctly the fruit from producer to consumer areas or by can be processed with different technologies to extend shelf life. Maturity of fruit is determined according to several criteria (Ketsa and Paull) :

- Size of fruit
- Skin and spintern coloration
- Sugar and acid content

As the majority of tropical fruit, Rambutan is sensible to chilling injury during storage. Depending to the cultivars, the fruits can be stored at 10°C minimum. The main chilling injury is the development of brown coloration on the skin and spintern. This decay reduces the shelf life of the fruit, as the consumer judges brown fruit not acceptable (O'Hare et al. 1994). However chilling injury doesn't affect the taste of the fruit. Storage at local room temperature induces higher respiration rate of the fruit. Enzymatic reaction and dehydration of the fruit are speed up under this storage conditions and short shelf life of approximately 4 to 6 days is the result. Development of off-taste and browning of Rambutan skin are the main quality decays observed during storage at high temperature (>25°C). Due to climatic condition of Indonesia and the lack of cooling equipments, the shelf life of Rambutan normally handled is similar to the short shelf life described previously.

2. Processing possibilities for rambutan

As discussed in the previous chapter, the deterioration of rambutan starts directly after harvesting, so it is important to start directly with proper handling techniques to extend shelf life. Important quality parameters during the storage of rambutan are skin and spinterns colour of the fruit, flavour, moisture level, injuries, level of titratable acid, level of total soluble solids, and level of pathogens. In this chapter, the results from the experiments with juice .

A whole range of processing technologies can be applied to extend the shelf life and quality of rambutan. All technologies reported have been evaluated based on their effect on quality, appearance and costs. Table 2.1 shows an overview of all technologies and their effect on quality, appearance and costs.

Table 2.1. Overview of processing methods and their effect on quality, appearance and costs

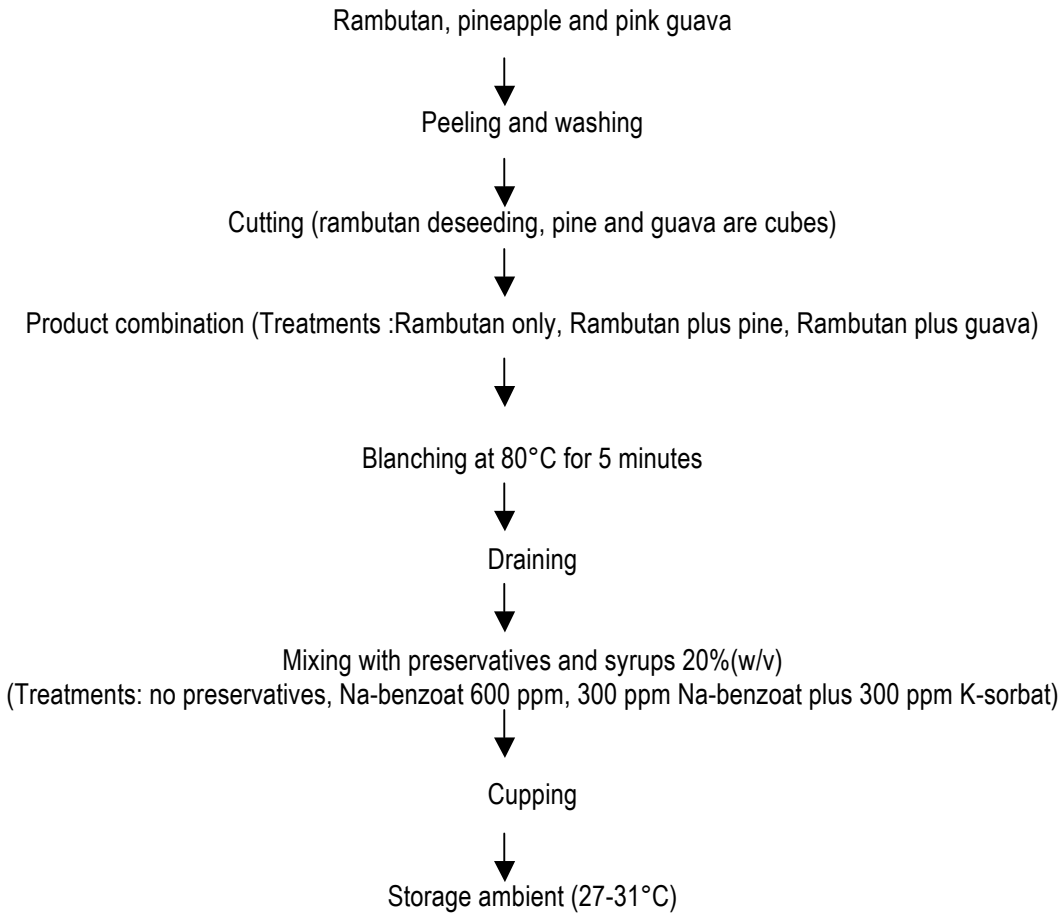
Processing	removes water	pasteurization	sterilization	vegetative cells	enzymes inactivated	micro organisms. inactivated	spores inactivated	modified	shelf life extension	product properties affected	costs	suitable for rambutan
Curing	✓					✓	✓	✓	weeks	yes	€	no
Drying	✓			✓	✓	✓			months	yes	€	yes
Canning		✓	✓	✓	✓	✓	✓	✓	months	yes	€	yes
Addition of chemical additives						✓			months ?	possibl y	€€	no
Chilling				✓	✓	✓			days	no	€	Yes > 5°C
Freezing				✓	✓	✓			weeks	yes	€	no
Controlled atmosphere packaging				✓	✓			✓	weeks	no	€	yes
Modified atmosphere packaging						✓[1)]		✓	weeks	no	€	yes
Aseptic packaging			✓	✓	✓	✓	✓		months	yes	€€	yes
Irradiation				✓	?	✓			weeks	yes	€€€	yes; depen-ding on local regulations
Fermentation					✓	✓			months	yes	€€	probably/yes
Pasteurization		✓		✓	✓	✓			weeks	yes	€	yes
Preservation with sugar	✓					✓			weeks	yes	€	yes
Jellying	✓					✓			weeks	yes	€	yes
Wax / coating									days-weeks	no	€€	yes
High pressure processing		✓	✓	✓	✓	✓	✓		weeks-months	yes	€€€	no; too expensive
Hot water treatment									days-weeks	no	€	yes
Processing using ultrasound				✓	✓	✓			weeks	yes	€€€	no
Vacuum frying	✓			✓	✓	✓			months	yes	€€	yes

1) spoilage bacteria

Not all technologies are feasible to implement on the Indonesian market, due to regulations and high investments for novel processing. Since there is a lot of variety in ripeness between the harvested rambutan within each bunch, it is advised to classify the rambutans in three categories; unripe, ripe and overripe rambutan. Each of these categories can be treated with an own processing technology, which gives the easiest handling and best quality products. Unripe rambutan (harvested approximately 15 days too early) can be used for canning, overripe rambutan can be used for fermentation or processing with sugar / yelling due to its flavour and high sugar content, and ripe rambutan can be used for all other processes. Juice processing and preservation (canning) seem promising and have been studied with in the HORTIN II project. The results are discussed in the following sections.

2.1. Rambutan in syrup (Cv. Lebak Bulus)

The rambutan was processed according to the following steps:



After 1 month of storage at ambient temperature, the best treatments were 'rambutan only in syrup' with mixed preservatives such as 300 ppm Na-benzoate and 300 ppm K-sorbate. The values of the organoleptic parameters are:

- Aroma 3.26 (neutral to like),
- Texture 3.3 (neutral to like),
- Taste 3.33 (neutral to like).

Total soluble solids (TTS), pH, total microbes, and vitamin C of samples were analyzed. The following products were still edible:

- Rambutan only in mixed preservatives (A1B3)

- Rambutan plus pineapple in Na-benzoate 600 ppm (A2B2)
- Rambutan plus pineapple in mixed preservatives (A2B3)
- Rambutan plus guava in Na-benzoate 600 ppm (A3B2)
- Rambutan plus guava in mixed preservatives (A3B3)

Rambutan only in Na-benzoate 600 ppm (A1B2) was not edible since the total microbes were more than 'Standar National Indonesia' (100 CFU/ml).

Figure 2.1. Preserved rambutan: stuffed with pineapple, storage life 2 months at ambient temp. (30 ˚C)

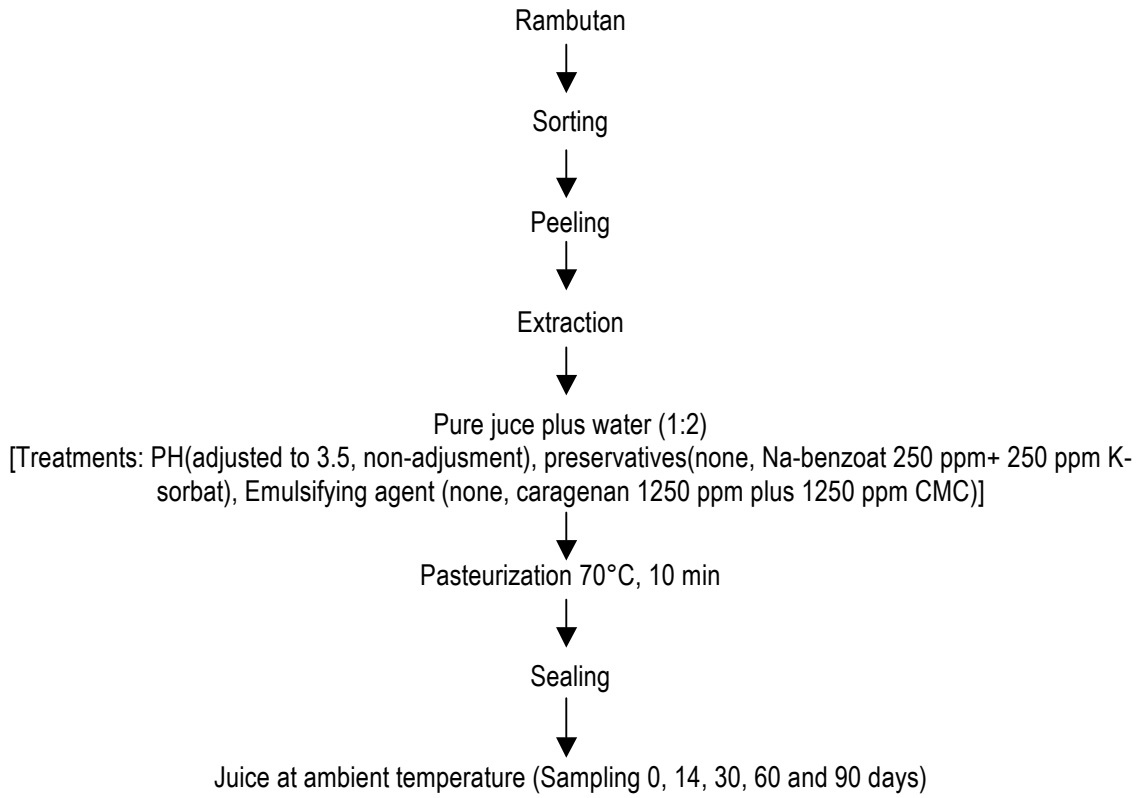
With the selling price of Rp. 1.650, - per cup; normal price NPV Rp. 280 383 971.48; IRR 42.23 %, Net B/C at 16 % 1.12, and PBP 1 year and 6 month. Then the decrease of selling price and increase production cost 10%; the industry is still feasible. The plant assumed to build in Bogor.

Figure 2.2. Rambutan juice. Storage life of 4 months

2.2. Rambutan juice (Cv. Lebak Bulus)

2.2.1. Simple juice technology

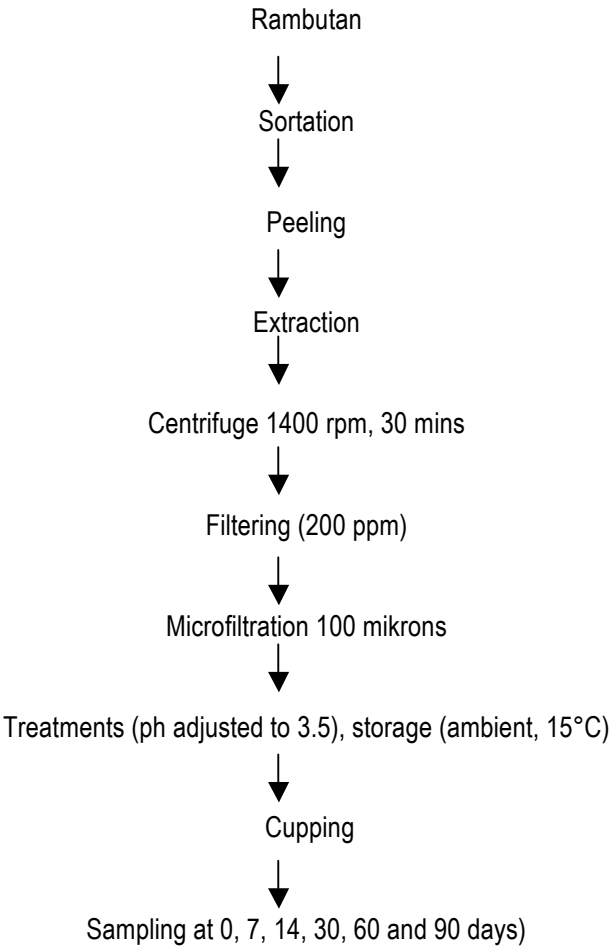
The rambutan was processed according to the following steps:



The best technology is emulsifying agent Carragenan 125 ppm + CMC 125 ppm with mixed preservatives (250 ppm Na-benzoate plus 250 ppm K-sorbat). With product price per 300 ml cup was Rp. 3000. At interest rate 17%/year NPV Rp 3 177 472 143., IRR 41.83%, net B/C ratio 1.72%, PBP after 2.9 year and BEP 77316 unit.

2.2.2 Microfiltration

The rambutan was processed according to the following steps:



Microfiltration, the when pH adjusted storage at 5°C, up to 4 moths. With the same interest rate 17%/year NPV was Rp. 926 042 744., IRR 20.93%, net B/C ratio 1.72%, PBP after 2.9 year and BEP 77316 unit. This product can be sold at Rp. 5000 per 300 ml cups.

To increase the juice profit, since the efficiency is only 20-25%, it is recommended that as raw material Cv. Sinyonya rather than Lebak Bulus is used for the processing. Sinyonya can be lower than Rp. 2000 per kg since Sinyonya is not sold as table fruit, only for production of rootstock. It has to be informed to the farmer so that the farmer does not cut their trees.

3. Packaging possibilities for rambutan

It has been established that several packages and concepts permit to extend significantly the shelf life of fresh rambutan fruits. The majority of them are actually or on the market or easily applicable. However it is important to check the feasibility of implementing these concepts to the specific Indonesian rambutan production.

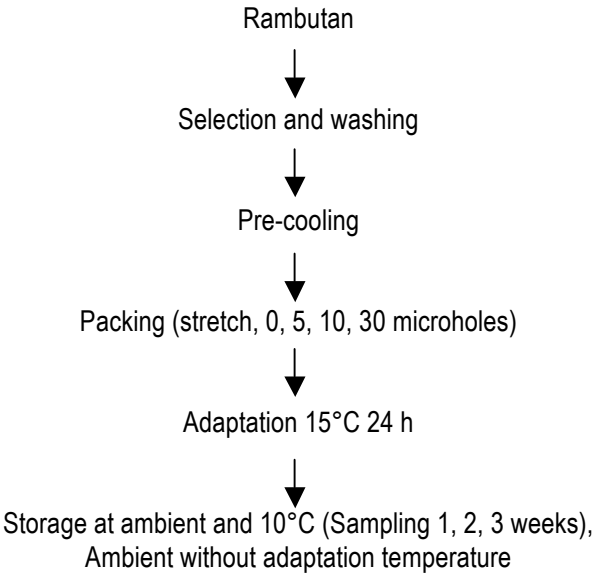
Experiments conducted by ICAPRD and AFSG have shown that by choosing optimal packaging and controlling the cold chain, shelf life of 21 days can be achieved. The packaging materials should answer to the following requirements:

- Relative humidity inside the bag around 95%.
- Condensation controlled by Antifog material or water free absorber
- Permeability properties of packaging material should avoid any anaerobic condition and assure a carbon dioxide concentration between 9 and 12%
- As the packaging facilities at the exporter location are non-existing or extremely limited, the MAP packaging shouldn't require high-tech equipment. The optimum gas concentrations should be reached by the natural respiration rate of the rambutan fruits.

Good handling of the products is necessary to assure the optimal initial quality and the maximum shelf life of rambutan. Gentle handling during harvest and transport minimizes mechanical damages and avoids any enzymatic decays of fruits.

3.1. Modified Atmosphere Packaging

The rambutan was packed according to the following scheme:



On CV. Binjai, the effect was only on external quality such as hair score (0-4), skin colour (0-4), texture (0-4), and off flavour (0-4); whilst there is not any effect on internal quality such as total soluble solids (TTS), total acidity, vitamin C and pH of the flesh.

The MA packaging with 5 holes, at low temperature storage was the best in retaining hair colour but there is not any difference with other treatments at low temperature such as stretch film, 0, 10 and 30 holes. At low temperature storage, the hair colour scores ranged, after 14 days storage, from 3.1 to 3.8, and at day 21 were ranging from 3.53 to 4. Ranking the hair scores from lower score to the higher score, the following list can be made at 10°C storage:

- 5 microholes
- 0 microholes
- 30 microholes
- Stretch film

Whilst at ambient storage, the ranking was as follows:
- 30 microholes
- 5 microholes
- 0 microholes
- 10 microholes
- Stretch film

Details can be seen in the Figure 3.1. The best is 5 microholes per packaging with a storage temperature of 10°C.

Skin colour: from the lowest score to the highest, at 10˚C, are:
- 10 microholes
- 5 microholes
- 30 microholes
- 0 microholes
- Stretch film

Skin colour: from the lowest score to the highest, at ambient temperature, are:
- Stretch film
- 30 microholes
- 5 microholes
- 10 microholes
- 0 microholes

The best results are made with 10 microholes per packaging with a storage temperature of 10°C.

Texture: the scores were from lowest to highest at 10˚C:
- 0 microholes
- 5 microholes
- 10 microholes
- 30 microholes
- Stretch film

Texture: the scores were from lowest to highest at ambient temperature:
- 5 microholes
- 10 microholes
- 30 microholes
- 0 microholes
- Stretch film.

Off flavour: the scores were from lowest to highest at 10˚C:
- 0 microholes
- 5 microholes
- 10 microholes
- 30 microholes
- Stretch film

Off flavour: the scores were from lowest to highest at ambient temperatures:
- 30 microholes
- Stretch film

- 10 microholes
- 0 microholes

Storage at 10°C caused higher TSS compared to ambient temperature whilst acidity was higher at ambient compared to 10°C. Best are 5 and 10 microholes per package for hair score, skin colour; 0,5 and 10 microholes for texture and off flavour. The most prominent quality attribute is skin colour, 10 microholes per packaging can be considered as the best option to extent the shelf life.

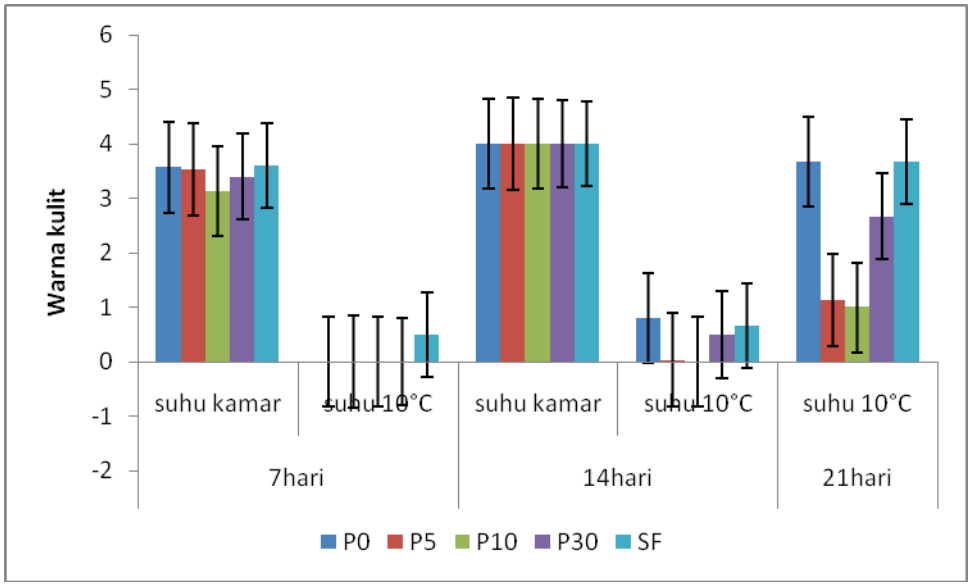


Figure 3.1. Changes in colour score of rambutan cv Binjai during storage

On Cv. Lebak Bulus score from the lowest to highest scores, at 10 ˚C are:

- 5 microholes
- 0 microholes
- 30 microholes
- 10 microholes
- Stretch film

Whilst at ambient:

- 30 microholes
- 5 microholes
- 0 microholes
- 10 microholes
- Stretch film

Skin colour scores, at 10˚C are:

- 10 microholes
- 5 microholes
- 30 microholes
- 0 microholes
- Stretch film

Skin colour scores, at ambient temperature, are:

- Stretch film
- 30 microholes
- 5 microholes
- 10 microholes
- 0 microholes

Texture: the scores were from lowest to highest at 10˚C:

- 0 microholes
- 5 microholes
- 10 microholes
- 30 microholes
- Stretch film

Texture: the scores were from lowest to highest at ambient temperature:

- 5 microholes
- 10 microholes
- 30 microholes
- 0 microholes
- Stretch film at ambient.

Off flavour: the scores were from lowest to highest at 10˚C:

- 0 microholes
- 5 microholes
- 10 microholes
- 30 microholes
- Stretch film at 10°C

Off flavour: the scores were from lowest to highest at ambient temperatures

- 30 microholes
- Stretch film
- 5 microholes
- 10 microholes
- 0 microholes

At low temperature storage, 10°C, TSS was not higher than at storage at ambient temperature, whilst acidity was higher at ambient.

Skin colour was used to choose the best treatment, and the best treatment can be considered 10 micro perforations per packaging.

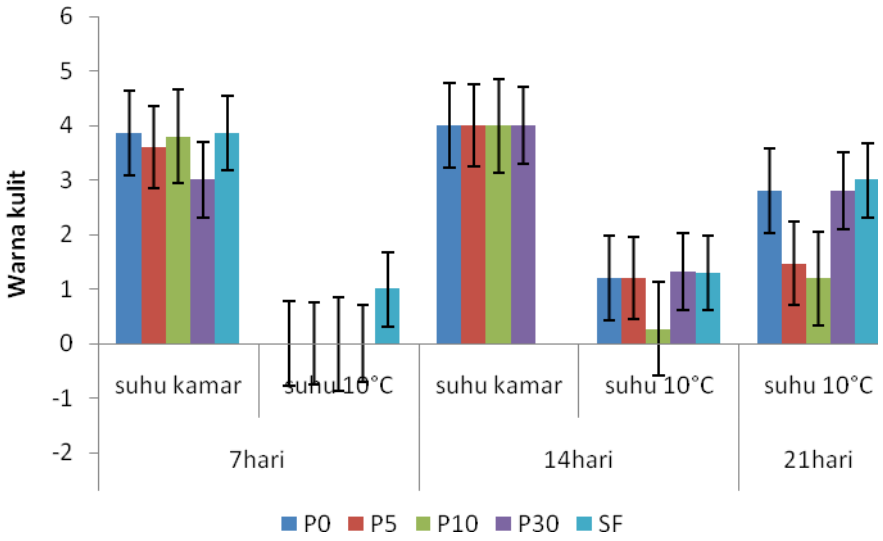


Figure 3.2. Changes in colour score of rambutan cv Lebak Bulus during storage

Table 3.1 Day 21, 10°C various treatments

Treatments	Binjai	Lebak Bulus
Stretch		
0		
5		
10		
30		

Table 3.2. Day 7 ambient various treatments

Treatments	Cv. Binjai	Cv. Lebak Bulus
Stretch		
0		
5		
10		
30