PROCEEDINGS

2015 3rd International Conference on Adaptive and Intelligent Agroindustry (ICAIA)

ICAIA 2015

August 3rd - 4th, 2015
IPB International Convention Center
Bogor, Indonesia

ISBN : 978-1-4673-7404-0
IEEE Catalog Number : CFP15C67-CDR

IEEE
INDONESIA SECTION

Proceedings of

2015 3rd International Conference on

Adaptive and Intelligent Agroindustry (ICAIA)

IPB International Convention Center, Bogor, Indonesia

August 3rd – 4th, 2015

Published by :

Department of Agroindustrial Technology

Bogor Agricultural University

Bogor, Indonesia

Welcome Message from The General Chairs of ICAIA 2015

On behalf of the organizing committee, it is our pleasure to welcome you to International Conference on Adaptive and Intelligent Agroindustry, Bogor, Indonesia. This is the 3rd conference on the topic that is held by the Department of Agroindustrial Technology, Bogor Agricultural University, Indonesia.

The conference is expected to provide excellent opportunity to meet experts, to exchange information, and to strengthen the collaboration among researchers, engineers, and scholars from academia, government, and industry. In addition, the conference committee invited five renowned keynote speakers, i.e. Prof Irawadi from Bogor Agricultural University; Prof Kenneth De Jong from George Mason University, USA; Dr Yandra Arkeman from Bogor Agricultural University; and Dr Guillermo Baigorria from University of Nebraska-Lincoln, USA.

The conference committee also invited Prof Noel Lindsay from University of Adelaide, Australia; Kiyotada Hayashi from National Agricultural Research Center-Tsukuba, Japan; Prof Margareth Gfrerer from Islamic State University of Jakarta, Indonesia; Dr Barry Elsey from University of Adelaide, Australia; Dr Gajendran Kandasamy from Melbourne University, Autralia; and Imperial College London-British, Prof Allan O'Connor from University of Adelaide, Australia; Dr Wisnu Ananta Kusuma from Bogor Agricultural University ,Indonesia; and Dr Frank Neumann from University of Adelaide, Australia, as invited speakers.

This conference was organized by Department of Agroindustrial Technology, Bogor Agricultural University and Asosiasi Agroindustri Indonesia, and technically sponsored by IEEE Indonesia Section. Furthermore, it was supported by Departement of Computer Science, Bogor Agricultural University; Surfactant amd Bionegergy Research Center; PT Bogor Life Science and Technology; Indonesian Ministry of Industry; PT Pachira Distrinusa; and PT Kelola Mina Laut.

I would like to take this opportunity to express my deep appreciation to the conference's committee members for their hard work and contribution throughout this conference. I would like to thank authors, reviewers, speakers, and session chairs for their support to participate in the Conference. Lastly, I would like to welcome you to join ICAIA 2015 and wish you all an enjoyable stay in Bogor.

Sincerely,
Dr Yandra Arkeman
General Chairs, ICAIA 2015

WELCOMING ADDRESS

Prof. Dr. Ir. Nastiti Siswi Indrasti
Head of Agroindustrial Technology Department
Faculty of Agricultural Engineering and Technology
Bogor Agricultural University

on

3rdInternational Conference on Adaptive and Intelligence Agroindustry (3rd ICAIA)

Bogor, August, 3 – 4, 2015

Assalamu'alaikum Warohmatullahi Wabarokatuh
In the name of Allah, the beneficent and the merciful,

Distinguish Guest, Ladies and Gentlemen
Let me first thank you all for accepting the invitation to participate in this 3rd International Conference on Adaptive and Intelligence Agroindustry (ICAIA). In particular I would like to thank Rector of IPB (Institut Pertanian Bogor/Bogor Agricultural University) Prof. Herry Suhardiyanto for supporting this event as part of the series academic event in celebrating the 52nd Anniversary of Bogor Agricultural University.

We are certainly proud to have been able to assemble this event in IPB, Bogor. The range of participants and audience at this conference is precisely something I would like to stress. Participants who followed the event more than 150 people, coming from various countries including the USA, Australia, Japan, Vietnam, Philippine, Germany and Indonesia. The main goal of the conference is to provide an effective forum for distinguished speakers, academicians, professional and practitioners coming from universities, research institutions, government agencies and industries to share or exchange their ideas, experience and recent progress in Adaptive and Intelligent Agroindustry.

The 2015 3rd International Conference on Adaptive and Intelligent Agro-industry (ICAIA) is the third forum for the presentation of new advances and research results on various topics in all aspects of innovative agro-industry that highlights the development and improvement for today and tomorrow's global need for food, energy, water and medicine. The aim of the conference is to stimulate interaction and cohesiveness among researchers in the vast areas of innovative agro-industry. Innovative Agro-industry has the ability to adapt intelligently to future global challenges, i.e. food, energy, water, and medical. Global challenges needs a new breed of Agroindustry which could produce innovative products to fulfill the needs through advanced processing technology, production systems and business strategy supported by cutting-edge information and communication technology.

The topic for this event is "Empowering Innovative Agroindustry for Natural Resources, Bioenergy and Food Sovereignty". The topics clustered into four main parts:
Track 1 : Innovative Agroindustrial and Business System Engineering

Track 2 : Frontier Approaches in Process and Bioprocess Engineering
Track 3 : Frontier Approaches in Industrial Environmental Engineering
Track 4 : Intelligent Information and Communication Technology for Adaptive Agroindustry of the Future

This event also hosts four (4) workshops: (1) Strategies for Agroindustry Development (2) LCA for Agroindustry (3) Innovation and Technopreneurship for Agroindustry and (4) Agroindustry Informatics.

Distinguish Guest, Ladies and Gentlement,
Agroindustry transforms agricultural commodities into high value-added products. Agroindustry is industry that process agricultural products to increase their value added significantly by using technology and by considering environmental aspect and sustainability. However, with changing global demand and technology advancement, innovative agroindustry is needed in order to be competitive as well as sustainable. The challenge of future agroindustry is not merely efficiency and productivity anymore, but also the challenge to appropriately apply frontier technology as well as meeting future global demands.

Agroindustry needs to deal with the application of advance technologies and cope future global issues. Current global issues which arise and expected to exist in the future are food sovereignty, renewable energy, sustainable water management and pharmacy. The ability of agro-industry to respond the future global issues and the undoubtedly substantial increase in demand in future decades will be highly dependent on the increased application of existing technologies as well as the exploitation of new and innovative technologies.

The emergence of high technology could be applied in the agro-industry are: nanotechnology, biotechnology, bioinformatics, food processing, food packaging-waste, state-of-the-art computation and many others. The aforementioned high-technology along with computation technology could greatly advance agro-industry from a traditional system into a smart-intelligent and innovative technology. Therefore, in the new millennia, adaptive-intelligent and innovative agro-industry will contribute to solutions to global problems and brings agriculture into perfection.

Hope this conference will also discuss this issue in more detail as it is an important matter for all of us. We should no more think just how to produce high value product but it is also necessarily important how to keep our live in good quality by understanding following old saying… “You do not live at once. You only die once and live every day”.

I do not to take up any more of your time with these opening remarks. Let me simply thank you once again for sharing your thoughts with us. Here’s wishing every success for the conference. May Allah bless all of us.

Thank you for your kind attention,
Wassalamu’alaikum Warohmatullahi Wabarokatuh

COMMITTEE

Condescendent
Prof. Dr. Ir. Herry Suhardiyanto, M.Sc (IPB's Rector)

Steering Committee
Chairman
Prof. Dr. Ir. Nastiti Siswi Indrasti

Vice
Dr. Ir. Yandra Arkeman, M.Eng

Board member
Prof. Dr. Ir. Aziz Darwis
Prof. Dr. Ir. Irawadi Djamaran
Prof. Dr. Ir. Eriyatno, MSAE
Prof. Dr. Ir. Anas M. Fauzi
Prof. Dr. Ir. Syamsul Maarif, M.Eng
Prof. Dr. Ir. Machfud, MS
Prof. Dr. Ir. Djumali Mangunwidjaja

Organizing Committee
Chairman
Dr. Ir. Yandra Arkeman, M.Eng
Co-chairs :
Prof. Dr. Ir. Suprihatin
Prof. Dr. Ono Suparno, S.TP, MT

Treasury
Dr. Indah Yuliasih, S.TP, M.Si
Dr. Elisa Anggraeni, S.TP, MSc

Programs
Dr. Hartrisari Hardjomidjojo, DEA
Dr. Endang Warsiki
Ir. Lien Herlina, MSc
Dr. Ika Amalia Kartika

Funding
Dr. Meika Syahbana Rusli
Dr. Dwi Setyaningsih
Prof. Erliza Hambali
Dr. Mulyorini Rahayuningsih

Secretariat
Dr. Titi Candra Sunarti
Dr. Prayoga Suryadharma
Dr. Sugiarto, MS
Dr. Faqih Uddin
Niken Ayu Permatasari, STP, MSi
Angga Yuhistira, STP, MSi
Luthfa Jamilah, STP
Yulianti
Elvin Septiana

Paper & Proceedings
Prof. M. Romli
Prof. Marimin
Prof. Ani Suryani
Prof. Erliza Noor
Dr. Liesbetini Hartoto
Dr. Moch Yani

Accomodation dan Logistics
Dr. Andes Ismayana
Dr. Ade Iskandar
Dr. Muslich
Dr. Sapta Raharja

Design, Web and Publication
Dr. Taufik Djatna
Dr. Aji Hermawan
M. Arif Darmawan, MT
Teguh Adi Setia, AMd

AGENDA

Time	Activities
Monday, August 3rd 2015	
08.00 - 09.00	Registration
09.00 - 10.00	Opening Ceremony • Welcoming Address: Prof. Nastiti Siswi Indrasti (Head of DAT, Fateta, IPB) • Welcoming Speech Head of Bogor Regency • Conference Opening: Prof. Herry Suhardiyanto (Rector of IPB) • Opening Speech and Conference Opening : Minister of Industry Indonesia * • Launching Expose International program DAT
10.00 – 10.05	*Photo Session*
10.05 - 10.15	*Coffee break*
10.15 - 10.45 10. 45 - 11.30 11.30 – 12.00 12.00 – 12.30	Keynote Speech : 1. Prof Irawadi (Bogor Agricultural University, Indonesia) 2. Prof. Kenneth De Jong (George Mason University, USA) 3. Dr. Yandra Arkeman (Bogor Agricultural University, Indonesia) 4. Dr. Guillermo Baigorria (University of Nebraska, Lincoln, USA)
12.30 – 13.30	Lunch break
13.30 – 13.50 13.50 – 14.10 14.10 – 14.30 14.30 – 14.50 14.50 – 15.10 15.10 – 15.45	Plenary Session 1 : Prof. Noel Lindsay (University of Adelaide, Australia) Dr. Kiyotada Hayashi (National Agricultural Research Center, Tsukuba, Japan) Prof. Margareth Gfrerer (Islamic State University of Jakarta, Indonesia) Dr. Barry Elsey (University of Adelaide, Australia) Ir. M. Novi Saputra (Marketing Director KML Food Group) *Discussion*
15.30 – 15.45	*Coffee break*
15.45 – 18.00	Parallel session A, B and C
18.00 – 21.00	Welcome Dinner

Time	Activities
Tuesday, August 4rd 2015	
08.30 – 09.00	Registration
09.00 – 09.20 09.20 – 09.40 09.40 – 10.00 10.00 – 10.20 10.20 – 10.45	Plenary Session 2 : Dr. Gajendran Kandasamy (PhD in Physic, Melbourne University ; PhD in Innovation Imperial Collage, London) Prof. Allan O'Connor (University of Adelaide, Australia) Dr. Eng. Wisnu Ananta Kusuma, ST, MT (Bogor Agricultural University, Indonesia) Dr. Frank Neumann (University of Adelaide, Australia) *Discussion*
10.45 – 13.00	Parallel Session A, B and C
13.00 – 14.00	Lunch break
14.00 – 15.30	Parallel Workshop • Strategies for Agroindustry Development • LCA for Agroindustry • Innovation and Technopreneurship for Agroindustry • Agroindustrial Informatics
15.30 – 15.45	Coffee Break
15.45 – 16.15	Closing remark

TABLE OF CONTENTS

  ISBN : 978-1-4673-7404-0

Increasing Added Value of Banana by Producing Synbiotic Banana "*Sale*" Using Innovation & Technology Strategy Approach

Eka Ruriani, Nurhayati, Syamsul Ma'arif
Laboratory of Process Engineering of Agroindustrial Products
Faculty of Agricultural Technology, University of Jember and Department od Agroindustrial Technology, Faculty of Agricultural Technology, Faculty Bogor Agricultural University
E-mail: *rurianiftp@yahoo.com, nhyati04@yahoo.com, syamsul4958@gmail.com*

***Abstract*— Banana is a potential agricultural commodity cultivated widely in tropical and subtropical area. It has a high nutritional value such as carbohydrate, dietary fiber, antioxidant, vitamins and mineral. However, it is a climateric fruit that its quality will be gradually decline after post harvest. This condition leads to a decrease of its nutritional and economical value. Therefore, the product diversification of banana is really needed to increase these values. An innovative approach has been taken to explore banana as a functional food that can be expected to confer health benefits in humans and raise the sale price of banana. A synbiotic banana "Sale" was a semi-wet product of banana considered as an prebiotic because of its natural resistant-starch content, and the addition of *Lactobacillus acidophillus* has made this product considered as probiotic food. The purposes of this product development are to improve their health effects, extend the shelf life of banana products, and increase its economic value. Therefore, this product was also use natural lactic acid of *Lactobacillus plantarum* kik as natural preservative and its financial analysis was also carried out to describe its ecomics potency.**

I. Introduction

Innovation and technology strategy has to be developed to reach competitive advantage in order to win the competition in the market. This approach will increase the value added of the product by providing the customer satisfaction to raise the selling point and extend the product life cycle. The high competition of agroindustrial market, especially will be more increasing as the Asian Economic Community (AEC) applied at the end of 2015, have forced the manufacturers to share the market with local and overseas competitor. AEC create a global market for all the member of Asian countries that joint at the community. The acces of international trade will be wider opened, and the products and investment flow are easier to be transferred. It has to be a crucial need that producers should develop a continous innovation on their products. It has been stated that an innovation strategy is an essential tool for product development and continued growth even in difficult times [1].

Banana (Musa spp.) is an important food crop cultivated widely in tropical and subtropical areas. It is one of potential commodity in Indonesia, because the productivity of this plants is very high. Reference [2] stated that Indonesia produced 5.814.580 ton of Banana and its plantation area was about 98.000 ha in 2010. Besides that Banana plantation is also easy to be cultivated by the farmer, and it has a high nutrition value, so that it can be consumed an fresh fruit or processed banana. The common processed banana products manufactured include banana puree, banana pulp, banana figs, banana flour or powder, banana chips, canned banana slices, banana jam, banana vinegar, banana wine, and banana juice. Banana is well known as good sources of dietary energy [3], rich in starch and that green bananas have high levels of resistant starch [4]. The latest characteristic has made the banana becomes the candidate of prebiotic, that is a one of functional food.

The conversion of banana into its derivative product will increase its added value by reduce the risk of decay process and improve its functional health. As banana is a climateric fruit, its respiration rate is very high after harvesting, and this condition lead the decay process of banana occures in a rapid rate. Therefore it need to be processed to extend the shelf-life. The aim of conversion banana in to functional banana "Sale" not only could prolong its shelf-life, but also improve

Manuscript received June 6, 2015. This work was supported in part by the Indonesian Department of Higher Education under Research Grant of "*Dosen Muda*" goes to Eka Ruriani as the head of researcher.

E. R. Lecturer of Department of Agroindustrial Technology, Faculty of Agricultural Technology, University of Jember, Kalimantan Street I Number 37 Jember postal code 26181, East Java, Indonesia (corresponding author phone number: +62331-321-786; fax: +62331-321-786; e-mail: rurianiftp@yahoo.com).

N. Lecturer of Department of Technology of Agricultural Products, Faculty of Agricultural Technology, University of Jember, Kalimantan Street I Number 37 Jember postal code 26181, East Java, Indonesia (e-mail: nhyati04@yahoo.com).

S. M. Lecturer of Department of Agroindustrial Technology, Faculty of Agricultural Technology, Bogor Agricultural University, Dramaga Campus, Bogor, West Java, Indonesia (e-mail: *syamsul4958@gmail.com*).

  ISBN : 978-1-4673-7404-0

the intrinsic value of local commodity, by adding functional effect of banana. Some researches has tried explore the functional properties of banana. It has been reported that banana contains certain amounts of fructooligosaccharides (FOS) which have been shown to exhibit beneficial health effects by stimulating the growth of lactic acid bacteria in the human colon, by surpression of putrefactive pathogens, and by reduction of serum cholesterol concentrations [5]-[7]. The biomass of green banana added by vitamins A, C and B complex (B1, B2 and niacin) has made this products rich in minerals essential for the proper functioning of the human body [8]. Several researches have been also published about the properties of green banana, which revealed the beneficial effects on some diseases such as colorectal cancer, diarrhea, glycemic index, insulin response, dyslipidemia, cardiovascular disease and celiac disease [9]-[14].

Based on the high productivity and its functional propertis, this research explored an innovative approach to improve banana as a functional food that can be expected to confer health benefits in humans and raise the sale price of banana. The purposes of this product development are to improve its health effects, extend the shelf life of banana products, and increase its economic value.

II. INNOVATION OF SYNBIOTIC BANANA "*SALE*"

An innovative strategy should fulfil the requirement of feasibility. It should be consider three aspects, ie. the economics, technology and market. It has been indicated that a useful representation of a product is a vector of attributes, which they consider also to include customer needs, customer requirements, product specifications, engineering characteristics, and technical performance metrics [15]. The customer need and demand lead the manufacturers to explore the technology to produce innovative products with a high acceptance of the consumer. Reference [16] also stated that conceptually, understanding customer needs leads to products that are desirable, feasible, and salable (to the mass market). According to reference [17] the success or failure of an innovation or a new product in the marketplace is determined by how well it is accepted by customers, how fast it diffuses among the adopter population, and how large a market it creates over a period of time. New product entry strategy and competitor responses to the entry also play important roles in the success or failure of the innovation.

The demand of specific products has continously increased. There are some attributes those should be developed to enter the exclusive market segmentation, such as local comodity utilization, environmental friendly process and products, eco-labelling, and functional effect improvement of the products. The special characteristic of the product will be a competitive and comparative advantage to get the high market share. It is proposed that among innovation characteristics, relative advantage refers to the functional superiority of the innovation over other alternatives [18]. It was mainly the advances in understanding the relationship between nutrition and health that resulted in the development of the concept of functional foods, which means a practical and new approach to achieve optimal health status by promoting the state of well-being and possibly reducing the risk of disease. Modern consumers are increasingly interested in their personal health, and expect the food that they eat to be healthy or even capable of preventing illness.

The need for improved health leads the consumers to seek out specific foods or physiologically active food components, also called the functional food. In recent years, the term functional, applied to food, has taken different connotation that is to provide an additional physiological benefit, beyond the basic nutritional needs [19].

The technology approach in combining local commodity utilization and functional effect improvement to increase the added value of banana was resulted in synbiotic banana "*Sale*" (SBS). This product development used banana of plantain variety (*Musa paradisiaca* formatypica) (Fig 1a) that was originated from Lumajang regency. It is located in East Java Province Indonesia. SBS is a semi-wet product of banana containing about 65-80% of water. The apperance of SBS is presented in Figure 1b.

F m
kik and L. acidophilus could inhibit the growth of contaminant microorganism : banana "*Sale*" control (a) and synbiotic banana "*Sale*" (b)

SBS is considered as prebiotic because of its natural resistant-starch content, and the addition of *Lactobacillus acidophillus* has made this product considered as probiotic food. Probiotics are defined as live microorganisms, as they are consumed in adequate numbers confer a health benefit on the host, with on going controversy as to whether cultures must be viable for effifacy in all cases [20]. *L. acidophilus* is one of lactic acid bacteria used in industry that has shown probiotic effects and has been applied extensively in food processing [21]. *L. acidophilus* colonises the intestinal tracts of man and higher animals and exerts a protective role by suppression of pathogenic microorganisms [22], and it has been reported that this bacteria possess antitumor activity, hypocholesterolemic actions, and the ability to

  ISBN : 978-1-4673-7404-0

synthesize various vitamins [21]. On the other hand, prebiotics are non-digestible dietary components that pass through to the colon and selectively stimulate the proliferation and/or activity of populations of desirable bacteria in situ [7], [23]. Due to the potential synergy between probiotics and prebiotics, foods containing a combination of these ingredients are often referred to as synbiotics. According to reference [24] products combining *L. acidophilus* (as probiotic) and certain fruits, such as banana (as prebiotic) that might provide functional benefits (as synbiotic). Furthermore, it has been combined the *L. acidophilus* and banana in a direct fermentation using banana puree as the medium [25].

This product was also use natural lactic acid of *Lactobacillus plantarum* kik as natural preservative to extend it shelf-life. This preservative could subtitute the synthetic preservative that is usually added into the food and considered give carsinogenic effect to the health. Based on the improved quality of this product, it is expected that the SBS will have much higher added value.

There were some steps in production of SBS. The first step was production of probiotic by cultivating *L.acidophillus* in coconut water as the substrate at temperature of 37°C for 16-18 hour. The cell then was separated by centrifugation and used for probiotic. The second step was production of natural preservative by cultivating *L.plantarum* kik in MRSB as the medium. After incubation the cell was separated by centrifugation, and the supernatant would be used for the preservative. The next step was production SBS by immersing the banana slice in the preservative liquid for approximately 1 hour, then the banana was removed and inoculated with probiotic that has been prepared in the previous step. The incubation took about 30 minutes, then the SBS was dried (sun drying) until the water content was about 65-80%.

This tecnology innovation could produce a probiotic food, such as Yakult and Activia, commercialized probiotics product. Probiotic foods should contain specific probiotic strains and maintain a suitable level of viable cells during the product's shelf life. In this SBS the viability of *L. acidophilus* is approximately 10^8 CFU/g. It can be explained that in 1 g of SBS the cells that retain to live under processed condition is about 10^8 CFU.

The synergy of natural lactic acid as preservative and *L. acidophillus* as probiotic was also able to inhibit the growth of contaminant microorganism such as yeast and mould that would lead to shorten the product shelf-life. Figure 1 showed that SBS the contaminant was not detected in SBS (Figure 1b). In contrast, the banana "*Sale*" without any addition of natural preservative and probiotic was contaminated by mould and yeast (Figure 1a).

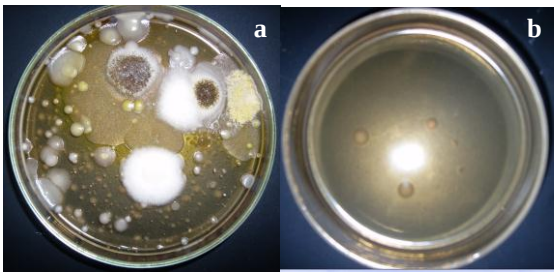

Fig 1 The synergy of lactic acid from L. plantarum kik and L. acidophilus could inhibit the growth of contaminant microorganism : banana "*Sale*" control (a) and synbiotic banana "*Sale*" (b)

III. ECONOMIC VALUE OF SYNBIOTIC BANANA "*SALE*"

Musa paradisiaca formatypica is an abundant agricultural commodities in Indonesia. This commodity is categorized as plaintain banana that should be processed before consumption. Nowdays it is usually only commerced as banana chip. This minimal processed has been already extended the added value of banana, however, its functional effect is low and its competitive advantage is still minimum. Table I showed product diversification of banana and its added value prediction.

TABLE I
ADDED VALUE PREDICTION OF BANANA PRODUCT DIVERSIVICATION

Products	Yield (%)	Added Value
Chips	20	100-150
Ledre	17-20	200-250
Sale	12-17	100-150
Gethuk	20-30	50-100
Puree	20-30	150-200
Flour	29-32	350-450
Jam	70-75	200-250

Table II explained that conversion banana to "*Sale*" will improve its added value 100-150% from its raw material with yield of the process 12-17% [26]. Although the added value of this product is not the highest among the derivative products, the "*Sale*" is the most potential product that could be developed as functional product, since it is a semi-wet product, so that the water content is suitable for probiotic growth. Another reason that the technology is easy to be applied in any scale of industry, so that it is impossible for the small medium enterprises to develop the products. This reason will be a crucial consideration, because almost the banana plantation is cultivated by smallholder farmers in Indonesia. Furthermore, the improvement of its functional properties by producing SBS is expected able to much more increase its added value rather than the original banana "*Sale*". It will be a beneficial advantage for the smallholder farmers to

  ISBN : 978-1-4673-7404-0

generate a higher income by processing the banana into SBS.

The feasibility study was carried out to calculate the economically feasibility of SBS. Some assumptions was used in the study, such as: the funding of the project was 100% self-finance, all the products was sold and the project period was 5 year. The economic feasibility presented in Table II.

Based on the Table the prospect of SBS business was economically feasible, since all the criteria of feasibility was well provided. It can be seen that the investment needs a short period to be returned, since the payback period is less than 1 year. The B/C ratio was 1.17 higher than 1. It means that that the business of SBS profitable with break even poin at revenue point 14,522,449 rupiahs. This calculation based on the price of product 10,000 rupiahs/100 g, whereas the the banana price is approximately 3,000 rupiah/100 g. It means that the added value was triple as stated in the reference [28].

TABLE II
FEASIBILITY STUDY OF SYNBIOTIC BANANA "*SALE*"

Parameters	Value	Decision
break even poin (Rupiah)	14,522,449	*economically feasible*
payback period (year)	0.98	
net present value	20,024,534.47	
internal rate return (IRR)	65.69%	
B/C ratio	1.17	

IV. CONCLUSION

The innovation of synbiotic banana "*Sale*" (SBS) increased the added value of banana. The technoloy of production should be developed to increase the product quality, especially the size, shape, colour and the availibility of *L.acidophilus*. It should be studied deeply about the role of lactic acid from *L. plantarum* kik to extend the product shelf life, therefore it is required to carry out analysis of product shelf life. Furthermore, the improvement of packaging design, labelling and marketing strategy will be the next challenge to reach the higher competitive and comparative advantage for this new product.

REFERENCES

[1] R. G. Cooper and S.J. Edget, "Developing a product innovation and technology strategy for your business," *Product Development Institute Inc*, 2010, www.stage-gate.com

[2] Biro Pusat Statistika (BPS), "Berita resmi statistik", 2011, www.bps.go.id

[3] I. S. Arvanitoyannis, A. G. Manromatis, G. Grammatikaki-Avgeli and M. Sakellariou, "Banana: cultivar, biotechnological approaches and genetic transformation," *International Journal of Food Science and Technology*, vol. 43, pp. 1871-1879, 2008.

[4] P. Zhang, R. L. Whistler, J. N. BeMiller and B. R. Hamaker, "Banana starch: production, physicochemical properties, and digestibility a review," *Carbohydrate Polymers*, vol. 59, pp. 443-458, 2005.

[5] H. Hidaka, T. Eida, T. Takizawa, T. Tokanaga, and Y. Tashiro, "Effects of fructooligosaccharides on intestinal flora and human health," *Bifidobacteria and Microflora*, vol. 5, pp. 37-50, 1986.

[6] H. Tomomatsu, "Health effects of oligosaccharides," *Food Technology*, vol. 48, pp 61-65

[7] G. R Gibson and M. B. Roberfroid, "Dietary modulation of the human colonic microbiota: Introducing the concept of prebiotics," *Journal of Nutrition*, vol. 125, pp. 1401–1412, 1995.

[8] M. C. J. Freitas and D. Q. Tavares, Characterization of starch granules from bananas nanicao and daterra," Ciencia e Tecnologia de Alimentos, vol. 25, pp. 217-225, 2005.

[9] L. A., Bello-Perez, R. A. Gonzales-Soto, M. M. Sanchez-Rivero, F. Gutierrez-Merazza and A. Vargas-Torres, "Extrusion of starches from non-conventional sources for resistant starch production. *Agrociencia*. vol. 40, pp. 441-448

[10] H. N. Englyst, and J. H. Gummings, "Digestion of the carbohydrates of banana (Musa paradisiaca sapientum) in the human small intestine," *American Journal of Clinical Nutrition*, vol. 44, pp. 42-50, 1986.

[11] A. M. Langkilde, M. Champ, and H. Anderson, "Effects of high-resistant starch banana flour (RS2) in vitro fermentation and small-bowel excretion of energy, nutrients and sterols: an ileostomy study," American Journal Clinical Nutrition, vol. 75, pp. 104-111

[12] W. C. Lee, S. Yusof, N. S. A. Hamid and B. S. Baharinn, "Optimizing conditions for hot water extraction of banana juice using Response Surface Methodology (RSM)," Journal of Food Engineering, vol. 75, pp. 473-479, 2006

[13] D. L. Topping, M. Fukushima, and A. R Bird, "Resistant starch as a prebiotic and synbiotic: state of the art," *Proceedings of the Nutrition Society*, vol. 62, pp. 171-176, 2003.

[14] R. P. Zandonadi, "Green banana mass: an alternative to exclusion of gluten," *Doctoral Thesis*, (Doctorate in Health Sciences), University of Brasilia – School of Health Sciences, Brasilia, Brazil, 2009.

[15] V. Krishnan and K. Ulrich,"Product development decisions : are view of the literature," *Management Science*, vol. 47, no. 1, pp. 1–21, 2001

  ISBN : 978-1-4673-7404-0

[16] B. L. Bayus, "Understanding customer needs," in *Handbook of Technology and Innovation Management*, S. Shane, Ed. New York: A John Wiley and Sons, 2008, pp. 115–141.
[17] V. Shankar, "The evolution of markets: innovation adoption, diffusion, market growth, new product entry, and competitor responses," in *Handbook of Technology and Innovation Management*, S. Shane, Ed. New York: A John Wiley and Sons, 2008, pp. 57-112.
[18] E.M. Rogers, *Diffusion of Innovations*, 5th edition, New York: The Free Press, 2003
[19] R. K. Oi, E. B. Tambourgi and D. Moraes Jr., "Study of green banana biomass drying in a spray dryer," *Engevista*, vol. 14, no. 2, pp. 165-171, 2012.
[20] C. Stanton, R. P. Ross, G. F. Fitzgerald, and D. Van Sinderen, "Fermented functional food based on probiotics and their biogenic metabolites," *Current Opinion in Biotechnology*, vol. 16, pp. 198-203
[21] A. M. Gomes, F.X. Malcata, and F. A. Klaver, "Growth enhancement of Bifidobacterium lactis Bo and Lactobacillus acidophilus Ki by milk hydrolyzates," *Journal of Dairy Science*, vol. 81, pp. 2817–2825, 1998.
[22] D. H. Bergey and J. G. Holt. 1994. Bergeys Manual of Determinitive Becteriology, 9th edition, Baltimore USA: Williams and Wilkins
[23] J. Van Loo *et al*., "Functional food properties of non-digestible oligosaccharides: A consensus report from the ENDO project (DGXII AIRII-CT94- 1095)," *British Journal of Nutrition*, vol. 81, pp. 121–132, 1999.
[24] J. B. Prajapati, R. K. Shah, and J. M. Dave, "Survival of Lactobacillus acidophilus in blended-spray dried preparations," *Australian Journal of Dairy Technology*, vol. 42, pp. 17-21
[25] Tsen *et al*. (2004) J-H Tsen, Y-P Lin, and A-E King, "Fermentation of banana media by using K-carrageanan immobilized Lactobacillus acidophilus," *International Journal of Food Microbiology*, vol. 91, pp. 215–220, 2004
[26] Department of Agriculture, " Prospect and direction of banana agribusiness," 2008, www.deptan.go.id