

# 2015 3<sup>rd</sup> International Conference on Adaptive and Intelligent Agroindustry (ICAIA)

## ICAIA 2015



August 3<sup>rd</sup> - 4<sup>th</sup>, 2015

IPB International Convention Center  
Bogor, Indonesia

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August 3<sup>rd</sup> – 4<sup>th</sup>, 2015

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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, Australia; 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 Department of Computer Science, Bogor Agricultural University; Surfactant and Bionergy 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**

**3<sup>rd</sup> International Conference on Adaptive and Intelligence Agroindustry (3<sup>rd</sup>  
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 3<sup>rd</sup> 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 52<sup>nd</sup> 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 3<sup>rd</sup> 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

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## AGENDA

Time	Activities
<b>Monday, August 3<sup>rd</sup> 2015</b>	
08.00 - 09.00	Registration
09.00 - 10.00	Opening Ceremony <ul style="list-style-type: none"> <li>• Welcoming Address: Prof. Nastiti Siswi Indrasti (Head of DAT, Fateta, IPB)</li> <li>• Welcoming Speech Head of Bogor Regency</li> <li>• Conference Opening: Prof. Herry Suhardiyanto (Rector of IPB)</li> <li>• Opening Speech and Conference Opening : Minister of Industry Indonesia *</li> <li>• Launching Expose International program DAT</li> </ul>
10.00 – 10.05	<i>Photo Session</i>
10.05 - 10.15	<i>Coffee break</i>
10.15 - 10.45	Keynote Speech :
10. 45 - 11.30	1. Prof Irawadi (Bogor Agricultural University, Indonesia)
11.30 – 12.00	2. Prof. Kenneth De Jong (George Mason University, USA)
12.00 – 12.30	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	Plenary Session 1 :
13.50 – 14.10	Prof. Noel Lindsay (University of Adelaide, Australia)
14.10 – 14.30	Dr. Kiyotada Hayashi (National Agricultural Research Center, Tsukuba, Japan)
14.30 – 14.50	Prof. Margareth Gfrerer (Islamic State University of Jakarta, Indonesia)
14.50 – 15.10	Dr. Barry Elsey (University of Adelaide, Australia)
15.10 – 15.45	Ir. M. Novi Saputra (Marketing Director KML Food Group)
	<i>Discussion</i>
15.30 – 15.45	<i>Coffee break</i>
15.45 – 18.00	Parallel session A, B and C
18.00 – 21.00	Welcome Dinner

<b>Time</b>	<b>Activities</b>
<b>Tuesday, August 4<sup>rd</sup> 2015</b>	
08.30 – 09.00	Registration
09.00 – 09.20	Plenary Session 2 : Dr. Gajendran Kandasamy (PhD in Physic, Melbourne University ; PhD in Innovation Imperial Collage, London)
09.20 – 09.40	Prof. Allan O'Connor (University of Adelaide, Australia)
09.40 – 10.00	Dr. Eng. Wisnu Ananta Kusuma, ST, MT (Bogor Agricultural University, Indonesia)
10.00 – 10.20	Dr. Frank Neumann (University of Adelaide, Australia)
10.20 – 10.45	<i>Discussion</i>
10.45 – 13.00	Parallel Session A, B and C
13.00 – 14.00	Lunch break
14.00 – 15.30	Parallel Workshop <ul style="list-style-type: none"> <li>• Strategies for Agroindustry Development</li> <li>• LCA for Agroindustry</li> <li>• Innovation and Technopreneurship for Agroindustry</li> <li>• Agroindustrial Informatics</li> </ul>
15.30 – 15.45	Coffee Break
15.45 – 16.15	Closing remark



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# The Effect of Nano Zinc Oxide on Characteristic Bionanocomposite

Siti Agustina<sup>1,2</sup>, Nastiti Siswi Indrasti<sup>2</sup>, Suprihatin<sup>2</sup>, Nurul Taufiqu Rochman<sup>3</sup>

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**Abstract.** Demand of plastic is increasing along with the increasing use of plastics in various fields. Plastics are hard to decompose biologically, so that it will give negative impacts to environment. One of ways to decrease those negative impacts is by using eco-friendly materials. Bionanocomposite is one of eco-friendly materials for plastics; this composite can be made from natural polymer and nano particle. This research used nano zinc oxide as nano particle for bionanocomposite. Bionanocomposite can be used as packaging, semiconductor, and medical materials. This research aims to know the effects of various type of nano zinc oxide (nano zinc oxide from galvanic industry waste, commercial, and without nano zinc oxide), and concentration of poly vinyl alcohol (0.5%, 1%, and 1.5%) on the bionanocomposite characteristics. The produced bionanocomposites was analyzed based on its mechanical properties, morphology, and biodegradation. The result showed that nano zinc oxide have effects to tensile strength and elongation of bionanocomposite, it also produces homogenous structure. Bionanocomposite can be degraded for 4 weeks.

**Keyword:** Bionanocomposite, nanoparticle, plastic, nano zinc oxide, eco-friendly materials

## I. INTRODUCTION

The demand of plastic packaging is increasing because of the increasing demand on food or non-food packaging materials. The type of plastics consumed in Indonesia in year 2010 were polypropylene (34%), polyethylene (29%), polyethylene terephthalate (15%), polyvinyl carbonate (12%), polystyrene (5%), and others (5%) [1]. Plastics contributed significantly to the waste

generation. In DKI Jakarta only, plastic waste production in 2010 reached 523.6 ton/day [2].

Awareness on green environment are increasing. It leads to the increasing demand of eco-friendly packaging materials, which are renewable and mostly come from natural polymers. The natural polymers are categorized into four groups, namely (1) agro-polymer produced from biomass, (2) polyester produced from fermentation of biomass, (3) polyester produced from synthesis from biomass monomer, and (4) polyester produced from synthesis of petroleum [3]. The application of natural polymer can be divided into three generations, namely the natural polymer content of 5%-20% (decomposable for 3-5 years), natural polymer content of 40% - 70% (decomposable for 2 - 3 years), and the total natural polymer which are completely compostable [4].

Polymer can be used also as composite. It is made from combination two or more materials, which have different of mechanic properties. The mixture will then produce new materials that will have new mechanic properties and characteristic different from original material [5]. If one of component (matrix, amplifier or additive) has a nanoparticle size, it will be called nanocomposite [6]. Nano zinc oxide is often used for nanocomposite, because of its photocatalytic characteristics [7], semiconductor [8], antimicrobial [9], sunscreen [10], antibacterial [11]. Research's used nanoparticle as nanocomposite film from mixture of nano argentums oxide and nano zinc oxide showed that it could decreased microbial content [12]. Combination of chitosan with nano zinc oxide could also increase antimicrobial activity [10].

The development of composite is not only from synthetic composites but also biopolymer composites, because the biopolymer is quantitatively available, renewable, biodegradable, light and strong. So, it leads to reduce the polymer consumption from

petrochemicals that are pollutants of the environment [13]. Bionanocomposite is a packaging material consisted of biopolymer in nanoparticle size, so it has new functional material. The natural polymer is used as matrix and organic/anorganic materials as filler or amplifier or additive [6]. The characteristic of bionanocomposite shows the increased mechanical characteristics and thermal stability. It has some advantages, such as biocompatible, biodegradable, and unique functionality according to the inorganic materials added [14].

This research aimed to evaluate the effects of nano zinc oxide from waste industrial galvanized to the bionanocomposite characteristic.

## II. METHOD

### *a. Materials and equipment's*

Materials used in this research included nano zinc oxide (produce from synthesis of zinc acetate from waste zinc dross). Tapioca starch (Orang Tani brand), polyvinil alcohol (PVOH) from Bratachem, caragenan, glycerol from Bratachem, nano zinc oxide from Sigma Aldrich, aquadest, and chemicals for analysis. Equipment which used in this research include oven memmert, magnetic stirrer magsuda 5N, glassware, molding, stirrer, Sartorius analytic scale BSA 2245-CW, tensile strength and elongation analysis equipment.

### *b. Methods*

**Nano zinc oxide process.** Ten gram zinc acetate (product from extraction of zinc dross with acetic acid) was filled in 100 ml methanol and mixed for 30 minutes. The solution of zinc acetate were applied by ultrasonification for 30 minutes, it was then added with natrium hidroxide 10% to adjust pH 10. It was applied again by ultrasonification for 30 minutes. The sedimentation process was conducted for 24 hour and then the liquid was filtrated. The sediment was dried at 100°C for 8 hours and was calcinated at 800°C for 3 hour. It was then grinded to puree.

**Preparation of Bionanocomposite Film.** Bionanocomposite film were prepared under various condition, namely polyvinyl alcohol concentrations (0.5%, 1.0% and 1.5%) and nano zinc oxide types (nano zinc oxide from waste, nano zinc oxide commercial, and no nano zinc oxide). The nano zinc oxide was dissolved with 200 ml distillate water; it was mixed for 1 hour. It was added with glycerol 1%, and was mixed for 15 minutes. The mixture was then added with carrageenan 1%, and mixed for 15

minutes. The mixture was preheated and added with polyvinyl alcohol, it was then preheat until 70 °C with addition of tapioca starch 5%. It was preheated again to 125°C until the gelatinization process occurred. It was poured in mold (30cmx20cm). It was dried in oven at 50 °C for 48 hour, chilled at 27 °C and the film was removed from mold, saved in desiccator.

In the further research step, the production of bionanocomposite film were realized with polyvinyl alcohol concentrations of 0.5%, 1.0%, and 1.5%, and nano zinc oxide concentrations of 0.05%, 0.10% and 0.15%.

### **Characterization of the Bionanocomposite Film.**

Bionanocomposite film were analyzed its mechanical properties to know thickness, tensile strength and elongation, analysis of morphology to know nanoparticle of nano zinc oxide position and analysis biodegradation of bionanocomposite using burial method.

## III. RESULT AND DISCUSSION

### *a. Formulation of bionanocomposite as eco-friendly material*

The bionanocomposite formulation used some materials, such as tapioca starch, polyvinyl alcohol (PVOH), carrageenan, and glycerol and nano zinc oxide. The materials have unique function in the preparation process of bionanocomposite. The polymer film formation can be done with were dry process or wet process. The dry process use low water content using extruder. In the wet process the polymers were dispersed with solution and pourit in mold allowing it will dry [15].

There are there methods for bio-nanocomposite preparation, namely (1) in situ polymerization, the nanoparticles were mixed with monomer solution, and preheated or given radiation, (2) Solution casting, the polymer was dissolved with solvent or nanoparticle and was dispersed with solvent, and (3) melt processing, the nanoparticle was mixed with polymer in batch, and stirred and heated until polymer to be nanocomposite film [16]. This research used solution casting method. This method used water for media dispersion, because water is good media for nano zinc oxide, cheap, safe and eco-friendly.

### *b. Mechanical properties of bionanocomposite film*

Analysis of bionanocomposite film mechanical properties aimed to know the homogeneous of bionanocomposite materials. The bionanocomposite mechanical properties included the thickness, the tensile strength and the elongation. Nano zinc oxide was added

as additive of bionanocomposite, so it can effect the thickness, tensile strenght and elongation. Analysis the thickness of bionanocomposite film is shown at Fig. 1. The bionanocomposite film used nano zinc oxide from waste was thicker bio-nanocomposite film than the bionanocomposite film used commercial nano zinc oxide or without nano zinc oxide. The film's thickness was influenced by concentration of nano oxide and homogeneous of materials, this was due to molecual density decrease and free space at matrixes film increase so the film thickness increase.

The tensile strength of bionanocomposite film is shown in Fig. 2. The bionanocomposite film used nano zinc oxide from waste has the tensile strength higher than the bionanocomposite film used commercial nano zinc oxide or without nano zinc oxide. Analysis for the elongation of bionanocomposite film is shown in Fig. 3. The bionanocomposite film used nano zinc oxide from waste has the elongation higher than the bionanocomposite film used commercial nano zinc oxide or without nano zinc oxide. Analysis from mechanical properties above showed that the nano zinc oxide from waste has a potential to be used for preparation of bionanocomposite film.

Analysis of the thickness of bionanocomposite film use various concentrations of nano zinc oxide and various concentrations of polyvinyl alcohol is shown in Fig. 4. It was shown that the thickness of bionanocomposite film was 0.35 mm – 0.47 mm. The bionanocomposite film has the highest thickness at a nano zinc oxide concentration of 0.15% and a polyvinyl alcohol concentration of 1.0%. The tensile strength of bionanocomposite film is showed in Fig. 5. The tensile strength bionanocomposite film were 0.23MPa–9.57MPa. The bionanocomposite film has the highest tensile strength at a nano zinc oxide concentration of 1.0% with a polyvinyl alcohol concentration of 0.05%. The tensile strength explains about homogeneity of materials mixture in the bionanocomposite film.

The latest research explained that the higher addition of magnesium hydroxide, the lower tensile strength of bionanocomposite film

produce [10]. Thermoplastic starch (TPS) decreased the tensile strength of bionanocomposite film, while compatibilizer increased the tensile strength of bionanocomposite film [17].

The elongation of film bionanocomposite film used concentration of nano zinc oxide with concentration of polyvinyl alcohol is shown in Fig. 6. The film elongations of 9.95%-37.85% were observed then at a polyvinyl alcohol concentration of 1.0% with nano zinc oxide concentration of 0.1%. The elongation of bionanocomposite film shows that it has good flexibility for material packaging. Bio-nanocomposite was used for medical, agricultural, packaging, sunscreen, pharmacy [18]. The filler with nanoparticle starch increased the tensile strength and decreased the elongation of bionanocomposite film [19]. The bionanocomposite film have sago starch as matrix and nano zinc oxide as filler increased the tensile strength and decreased the bionanocomposite film elongation [20]. Glycerol in bionanocomposite can decrease the tensile strength and the elongation [21].

Analysis for mechanical properties of bionanocomposite film had the best thickness of 0.37%, the tensile strength of 6.99 MPa and the elongation of 37.85%, observed at a nano zinc oxide concentration of 0.10% and a polyvinyl alcohol concentration of 1.0%. This showed that this film has good thickness, strength and elasticity, so it is suitable for material packaging.

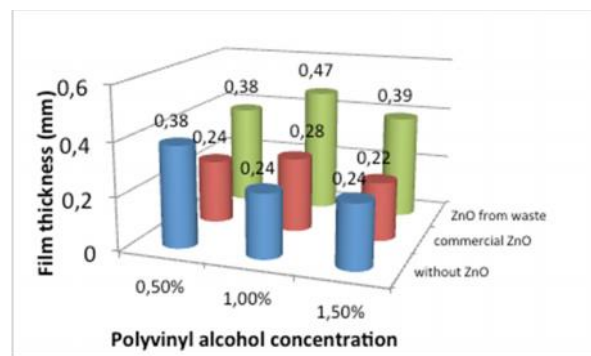


Figure 1. Analysis of the film thickness of bionanocomposite based on nano ZnO types



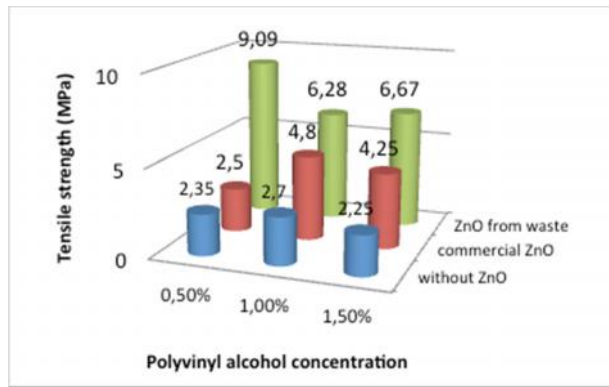


Figure 2. Analysis of the tensile strength of bionanocomposite based on nano ZnO types

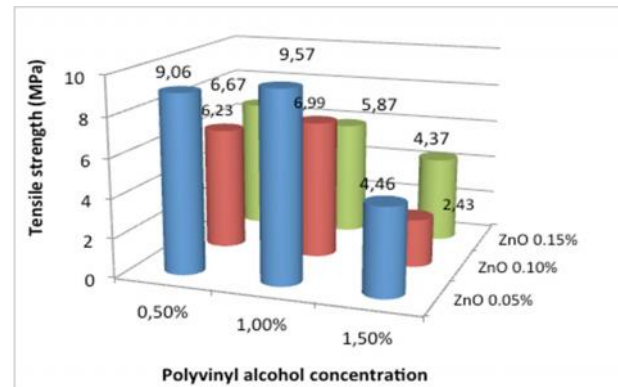


Figure 5. Analysis of the tensile strength of bionanocomposite based on nano ZnO concentration

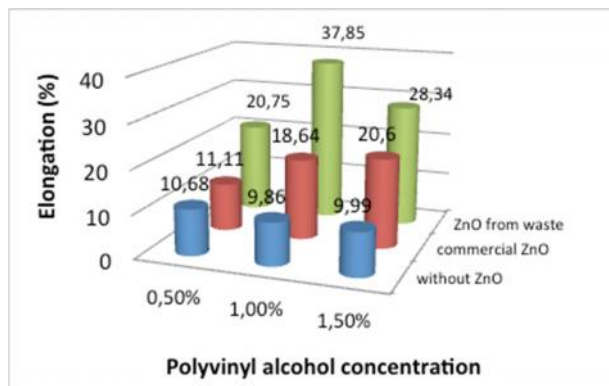


Figure 3. Analysis of the elongation of bionanocomposite based on nano ZnO types

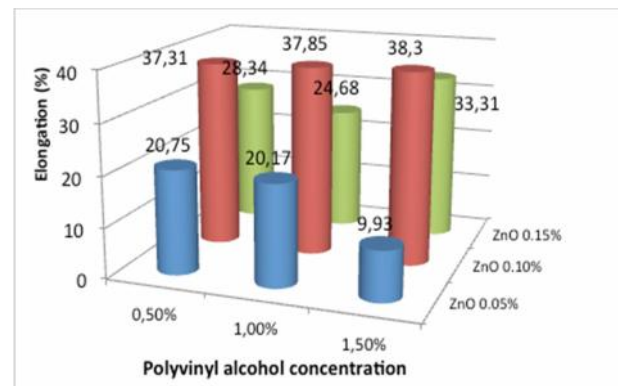


Figure 6. Analysis of the elongation of bionanocomposite based on nano ZnO concentration

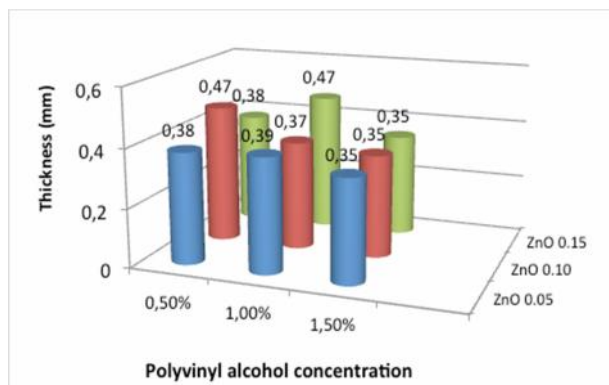


Figure 4. Analysis of the film thickness of bionanocomposite based on nano ZnO concentration

### c. The morphology of nano zinc oxide

Characterization of the bionanocomposite film morphology aimed to know the nanoparticle zinc oxide position in the bionanocomposite film. This was analyzed by using Scanning Electron Microscope (SEM) [16]. The morphology of nano particle zinc oxide bionanocomposite is shown in Fig 7. The composite of particle are isotropic, and the articles were interface bond with the matrix. This composite have advantages of small particle size [22].

The figure depicts that the nano zinc oxide concentration of 0.10% is more spread on the bionanocomposite surface. In hot water, glycerol and tapioca starch mode adhesion bond, so the nano zinc oxide can be bound in the matrix [18].

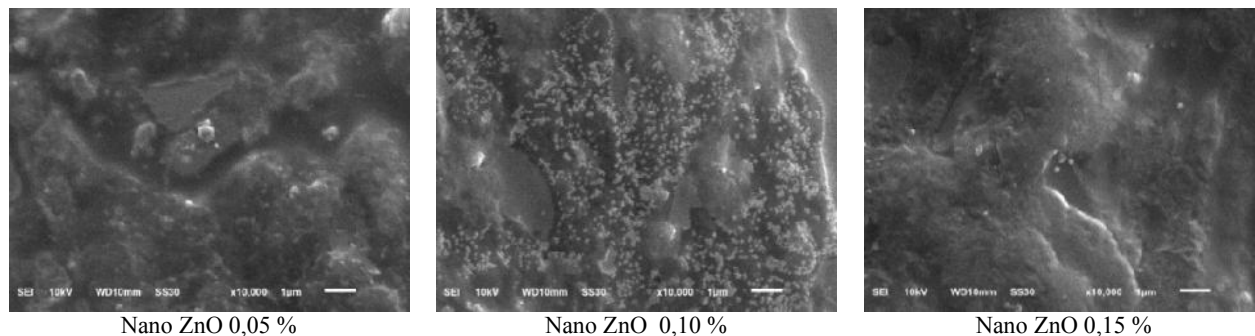


Fig.7. Morphology of nano partikel zinc oxide bionanocomposite

Fig 7 also shows that the bionanocomposite film are homogenous mixture of polyvinyl alcohol, tapioca starch and carrageenan, so surface area is good and flat, and the nanoparticle zinc oxide was attached on the matrix.

#### d. Biodegradability of bionanocomposite

Analysis for the bionanocomposite film biodegradability aimed to know the degradability of polymer in the bionanocomposite film. The biodegradation process was observed in several ways, in which oxidation and radiation were applied. The plastic waste containing content dissolve polymer could be processed by the activated sludge and composting methods. The activated sludge method degraded the polymer waste for 2 weeks, while the composting method degraded the polymer waste in several weeks [23].

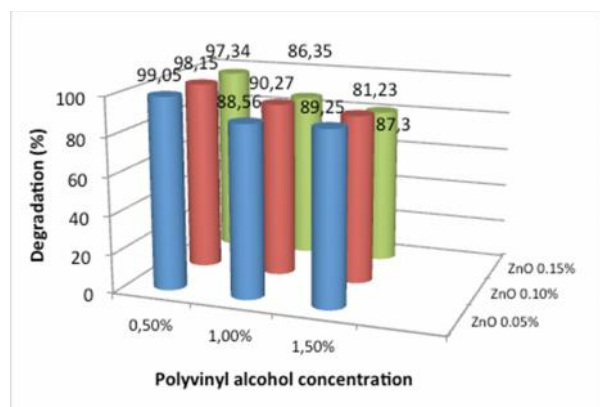


Figure 8. Film degradation of bionanocomposite for 4 weeks

The soil burial method can degrade the natural polymer [17]. The increase of starch concentration and period of soil burial increased the weight loss, because many starch was degrade by microbial in composting soil [24]. This research used soil burial test. The result of soil burial test during 4 weeks was shown at Fig. 8. The highest degradation level of bionanocomposite film of 99.05% was observed at polyvinyl alcohol concentration of 0.5% with nano zinc oxide concentration of 0.05%.

#### IV. CONCLUSION

Bionanocomposite can be made by formulation of tapioca starch, carrageenan, glycerol, polyvinyl alcohol and nano zinc oxide. Nano zinc oxide from waste of industrial galvanized can be used for bionanocomposite film process as additive. The bionanocomposite film prepared from nano zinc oxide from waste of industrial galvanized was characterized by higher thickness, tensile strength and elongation than the bionanocomposite films without nano zinc oxide addition, or with the commercial nano zinc oxide. The best thickness, tensile strength and elongation of bionanocomposite film were observed at nano zinc oxide concentration of 0.10%. Good structure of the bionanocomposite film was found at a nano zinc oxide concentration of 0.10%. Approximately 81.23%-99.05% of the bionanocomposite film could be degraded with soil burial method for 4 weeks. The bionanocomposite film content nano zinc oxide from waste industrial galvanized could be used for ecofriendly packaging material 0.10% and polyvinyl alcohol concentration of 1.0%.

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