PROCEEDING

INTERNATIONAL SEMINAR ON SCIENCE AND TECHNOLOGY 2014

October 23, 2014

Tegalboto Campus, University of Jember
Jember, Indonesia

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Proceeding of The International Seminar on Science & Technology 2014 (**ISOSTECH '14**)

The editing of this proceeding has been carried out by **Siswoyo & B. Kuswandi** with assisted by the Scientific Committee of ISOSTECH'14.

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Foreword by Organising Committee

Assalamu'alaikum Wr. Wb.

Distinguished guests and delegates

On behalf of the organizing committee, I am deeply grateful to your present in the International Seminar on Science & Technology 2014 (**ISOSTECH '14**) that already held in Universitas Jember, Jember Indonesia on thirsday, 23 October 2014.

The **ISOSTECH '14** is jointly seminar between University of Jember (UNEJ), Indonesia and Universiti Sains Islam Malalaysia (USIM), it was arranged with substantive elements such as seminar pertaining to current advance on science and technology together with posters.

The seminar was provide an excellent platform for knowledge exchange between the academicians, researchers, scientists and engineers working in areas of mathematic and basic sciences, agricultural and food Technology, health sciences and enggineering as well as information technology. In addition, it provides an opportunity for the participants from Indonesia, Malaysia and Philiphine to share research findings, to establish networking and to encourage academic and student exchange and other participation in this exciting seminar.

We also would like to express our deep appreciation to the all organising committee members and steering committee, especially Dr. Zulfikar, on behalf of Rector, as Vice Rector of UNEJ who officially opens this seminar. Last but not least our appreciation to all participants especially delegate from USIM, IIU Malaysia and San Carlos University, Philiphines. We convey our great gratitude for your scientific speech and contribution. We do hope that all these research results are useful for further research progress and development in these fields.

Enjoy the conference proceeding and hope it will give inpiration on your research projects.

Wassalamu'alaikum Wr. Wb.

Mrs. L. Wulandary
Chairperson
University of Jember

Preface

The first International Seminar On Science & Technology 2014 (**ISOSTECH '14**), took place in University of Jember, Jember East Java Indonesia on 23 October 2014. This first seminar series is focused on all aspects related to recent advance in science and technology.

This proceeding contains papers that have been presented at **ISOSTECH '14** as plenary lectures, invited, oral and poster presentations. About 100 participants attended the conference, with 4 plenary lectures, 35 oral and 24 poster presentations. The proceeding of **ISOSTECH '14** has been published in electronic form as *.pdf file for simple and easy publication and to avoid heavy book of proceeding. We hope that this publication can be easily read, handled and transferred to other form. Furthermore, this paperless proceeding can be fruitful for all participants of the conference.

My sincerely thanks go to all the members of Scientific Committee for their valuable help in the review of the submitted papers, and also to the authors for their collaborative attitude. A special mention must go to **Mrs. L Wulandary**, our Conference Chairperson, who has put in a terrific amount of effort not only in general conference matter but also in the assembly of the papers for this proceeding. Finally, I congratulate the authors of all papers for producing the new and novel idea for research on mathematic and basic sciences, agricultural and food Technology, health sciences and enggineering as well as information technology.

Jember, October 2014

Siswoyo & B. Kuswandi
Editors

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POSTER SESSION

Carbohydrate and Protein Interaction in Edible Film Production by Extruder as Mixing Unit and Compression Molder as Molding Unit

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Abstract - In edible film production by compression molder, preparing uniform dough is one of major problem that should be overcome. Extruder already widely use as mixing unit in plastic production that will be used in this research by some modification. This research was studied carbohydrate and protein interaction during preparation of dough in edible film making by extruder as mixing unit and compresion molder as molding unit. Tapioca would be used as source of carbohydrate and Soy Protein Concentrate (SPC) would be used as source of protein. The concentration of SPC was varied 0%, 20%, 40%, 60%, 80% and 100%. Increasing of SPC concentration would increase Water Holding Capacity of dough. Dough's texture would increase if SPC concentration increased from 0% to 20% but decreased if concentration increased from 30% to 100%. Result from Rapid Visco Analyzer study showed that increasing of SPC concentration would decrease final viscosity and increase peak time. Microstructure analysis by Scanning Electron Mycrograph showed that during mixing, protein would perform network like fiber and part of tapioca granule break. After mixing by extruder, the dough would be mould by compression molding to produce edible film whereas increasing of SPC concentration would increase tensile strength and solubility of edible film but decreased film's solubility **.**

Key words : tapioca, Soy Protein Concentrate, dough, Rapid Visco Analyzer, Scanning Electron Micrograph.

1. Introduction

Research on edible films and coatings in foods is partly driven by industry due to high demand of consumers for longer shelf-life and better quality of foods as well as environmentally friendly materials. Edible films are generally formed from hydrophilic components such as proteins or polysaccharides. Biopolymer films, which contain both protein and polysaccharide ingredients, may advantageously use the distinct functional characteristic of film-forming ingredients. Soy Protein and tapioca already widely used as edible film's based material (Brandenburg *et al.,* 1993; Gennadios *et al.,* 1993; Choi *et al.*, 2003; Marseno dkk. 1999; Harris 2001; Bergo *et al.*, 2007; Chillo *et al.*, 2008; Perez *et al.*, 2009)). This research used Soy Protein Concentrate (SPC) and tapioca as edible film based component. Previous study (Lindriati *et al.* ,2007a; 2007b), showed that *edible film* from protein combined with carbohydrate could produce better physical and mechanical properties than protein or carbohydrate alone.

Much of the research into edible films has involved the production of films from the method of solvent casting. There are many researches try to develop thermal processing methods such as compression molding and extrusion (Cunningham et al., 2000; Sothornvit et al., 2003; Pommet et al., 2003; Sothornvit et al., 2007; Hernandez-Izquierdo et al., 2007; Guerrero et al., 2010). Extrusion is an attractive alternative method for protein and polysaccharide film formation, because its speeds processing and requires less space compare to the traditional solution-casting method. Generally, compression molding of sheet is studied as a precursor to extrusion, in order to demonstrate material flowability and fusion and identify conditions suitable for extrusion (Sothornvit et al., 2007).

Previous study showed that before molded based material must be mixed intensifly to let water and glycerol molecules penentrated in to carbohydrate and protein macromolecule otherwise we could not produce a transparant films. Lindriati and Arbiantara (2009) used mortar porcelain to mix edible film based material and aged the dough for one week to produce transparant and flexible film but at least one night aging still needed. Extruder already widely used in plastic industry as intensif mixing unit. This research would use extruder that modified for intensif mixing unit in preparing dough of SPC and tapioca before molded by compression molder. This research objective was to study effect of SPC : tapioca ratio on dough and edible film properties. Dough was prepared by single screw extruder and edible film produced by compression molder.

2. Material and Method

2.1 Material

SPC powder was obtained from local market (industrial grade). The composition of the SPC powder was reported as 76% protein, 19% carbohydrate, 4% and 1% ash. Tapioca starch was obtained from local market. The composition of tapioca was reported as 4% protein, 93% carbohydrate, 2% fat and 1% ash. Glycerol was used as plasticizer that was p.a grade (merck).

2.2 Dough formation

Mixtures of SPC powder and tapioca (100 g) with addition of glycerol (20% v/w) and deionized water (70% v/w) were mixed in a single screw extruder. The proportion of ISP:tapioca was varied (0:100, 10:90, 20:80, 30:70, 40:60, 50:50). All materials were thoroughly blended with single screw extruder at room temperature and operated at speed of 100 rpm. The dough then thermally compacted using a prototype *compression molding*.

A prototype modular single screw extruder with L/D ratio of 1:5 and a barrel diameter (D) of 30 mm was used. The channel depth (H) in the metering zone has 2 mm, while in the feed section were used 5 mm (compression ratios-CR- of 2.5) as shown in figure 1. The axial length of feed, compression and metering sections (L_1, L_2 and L_3) are the same and equal to 150 mm.

Figure 1. Screw geometry

2.3 Edible film formation

About 10 gram of dough that was prepared with single screw extruder was placed between two sheets of aluminium (0,2 mm thick and 100 cm^2) and then thermally compacted using a prototype compression molder (Figure 2)

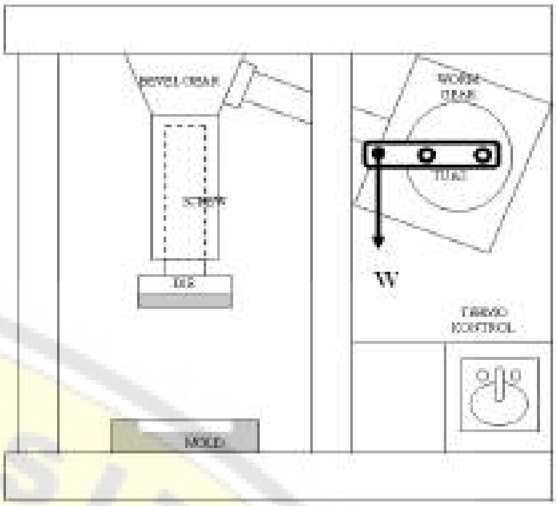

Figure 2. Prototype of compression molder

The compression molder was operated at 150^{o}C, a pressure of 1,1 Mpa was applied for 10 min. The aluminium sheets were allowed to cool for 3 min before removing films samples. The films were kept in to a chamber that already conditioned with silica gel.

2.4 Dough Characterization

Water Holding Capacity (WHC) (AACC, 1991, modified)

An empty centrifuge tubes were dried and weighed (a gram). WHC measurement begined by weighing 0.5 grams of sample (b g) and inserted into the centrifuge tube. Distilled water as much as 7 x weight of sample was added. Sample mixed by vortex and than centrifuge for 5 min at 2000 rpm. Supernatant was decanted and precipitate weighed (c g). WHC calculated by :

$$\%WHC = \frac{(c-a)-b}{b} x100\%$$

a = weight of empty centrifuge tube; b = weight of sample; c = weight of the sample and tube after centrifuged

Texture

Penetrometer was used for texture measurement. 25 gram of dough samples were weighing and formed round and texture measurement done on 5 different points. The results of measurement was expressed as average in mm/sec.

Digital Viscosity Measurement (RVA, New Scientific)

3 gr of sample (dry basis) was added by water and weighing until 25 gr. 15 minutes If not dissolve completely may be repeated until dissolved. Lift the lever RVA, attach cans in place. Termocline program select: collect, then auto for existing programs be set tool. Select the desired method. Select run, auto, select

auto, mode to run, wait until the equipment is ready to operate (press lever down RVA).

Scanning Electron Microscopy (SEM, Chuang and Yeh, 2004)

Samples previously dried by freeze drier to achieve a moisture content of less than 5%. Dried samples sprinkled on the stub and then coated with gold dust. Samples that have been covered with gold included in the machine for SEM observation at a magnification of 2000x.

2.5 Film characterization

Tensile strength and elongation (according to ASTM standards D638-94 in Chang et al, 2000).

Pieces of edible film with a width of 10 mm and a length of 80 mm may be stored in a jar containing silica gel for one day. Then the tensile strength was measured using a Universal Testing Machine (Shimadzu). The size of the specimen can be seen in Figure 3

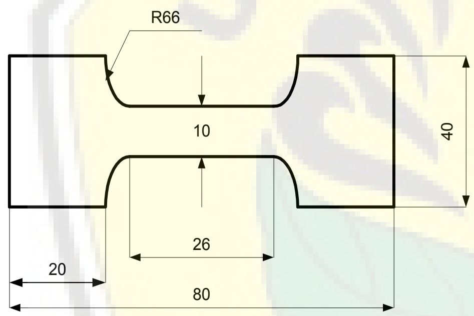

Figure 3. Tensile Test Specimens (according to ASTM D638-94 in Chang et al, 2000).

The tensile strength can be calculated with this formula:

$$\sigma = \frac{F}{A}$$

σ = tensile strength (N / mm 2); F = tensile force (N); A = area of work (mm2).

In accordance with tensile strength procedure, strain measurement was done using Universal Testing Machine. The strain can be formulated:

$$\varepsilon = \frac{\Delta l}{l_0}$$

ε = Strain (%); Δl = length addition (mm); l_0 = Initial length (mm).

Solubility of edible films (Gontard et al., 1992).

Measurement of solubility in water of edible film based on the percentage of initial dry material that dissolves. Pieces of edible film with a size of 2.5 x 5 cm were dried in an oven 105°C for 24 hours, then weighed (a gram). After drying edible film was soaked in 30 ml of distilled water and placed in a container that was covered with plastic and then stored at room temperature for 24 hours. Pick up the resembled pieces and then dried in an oven at 105°C for 24 (b gram). Solubility value is g/g calculated by (a-b)/a or ((a-b)/a) x 100% if the units was % .

3. Result and discussion

3.1 Water Holding Capacity (WHC) of Dough

The results of WHC measurement on dough after mixing with extruder with variation of the SPC : tapioca ratio were ranged between 0.233% - 2.496%. WHC lowest value obtained from SPC: tapioca ratio 0: 100, while the highest WHC values obtained from SPC : tapioca ratio 50:50. The addition of SPC had significant effect on WHC value ($p < 0.05$). The effect of ISP: tapioca ratio on dough WHC values are presented in Figure 4.

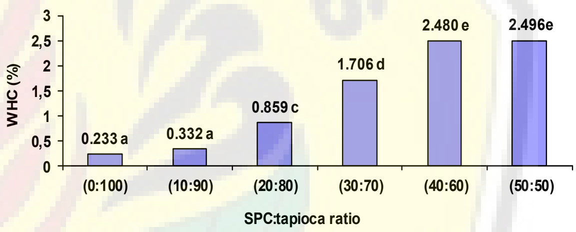

Figure 4. Effect of SPC : tapioca ratio on dough's WHC

Increasing of SPC ratio would increase WHC value (Figure 4). Tendency of SPC protein to bound water higher than tapioca. According to Hansen (1978), increasing tendency of dough to bound water depend on protein content. According to Kinsella (1984), increasing in water absorption due to the addition of protein usually followed exponential function. The amount of water retained by the protein depend on composition of amino, exposed polar groups, conformation and hydrophobicity as well as processing conditions. SPC was one kind of protein that had high water binding capability.

3.2 Texture of Dough

The results of texture measurement on dough after mixing with extruder with variation of SPC : tapioca ratio were ranged between 2,49 – 4,23 mm/second. WHC lowest value obtained from SPC : tapioca ratio 50:50, while the highest WHC values obtained from SPC : tapioca ratio 20:80. The addition of SPC had significant effect on texture value ($p < 0.05$). The effect of ISP: tapioca ratio on dough texture are presented in Figure 4.

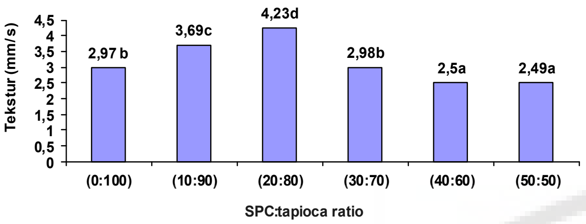

Figure 4. Effect of SPC: tapioca ratio on dough's texture.

Increasing of SPC : tapioca ratio from 0:100 to 20:80 increased texture value. Increasing of SPC : tapioca from 20:80 to 50:50 decreased texture value. Decreasing of texture because of increasing SPC ratio from 40:60 to 50:50 were not significantly different ($p > 0.05$) (Figure 4).

According to Maurice and Stanley (1978) and Sheard et al. (1984) increased protein addition would significantly affected material's rheology. During extrusion, protein would perform network protein-protein that had structure fibers like. According to Noguchi (1989) there were differences in the structure of protein's network that extruded at high moisture content (above 35%) with low moisture content (20-25%). The network performed at low moisture content was not a compact fiber, but a aggregates that was expands and spongy. Extrusion at high moisture content would produce protein-protein network that was compact like fiber. The important thing about the role of water in extrusion were in the formation of protein-protein network structure.

SPC addition less than 20% (SPC : tapioca ratio 20:80) improved value of texture test it means the dough getting softer (Figure 4), This is probably because effect of water absorbtion by carbohydrate. High ratio of carbohydrate could make large amount of water absorb in the carbohydrate matrix and water that was absorbed by protein decreased. This would resulted in formation of soft and spongy protein-protein network.

SPC addition more than 20% (SPC : tapioca ratio 20:80) decreased value of texture test it means the dough getting harder (Figure 4). This is probably due to the amount of water absorbed in protein matrix was sufficient to give the effect of extrusion wit h high moisture content. According to Noguchi (1989), at high moisture content protein-protein network would perform fibers and fibrous like structure that could cause the dough more compact.

3.3 *Rapid Visco Analyser* (RVA) of dough

The results of the RVA analysis on dough's pasting characters in this study could been seen in Table 1 and Figure 5

Tabel 1. RVA analysis on dough of edible film preparing by single screw extruder with SPC : tapioca ratio.

Ratio of ISP : tapioka	*Final viscosity* (cp)	*Peak time* (minute)
0 : 100	1391	4,20
10 : 90	1186	4,33
20 : 80	1182	4,75
30 : 70	1110	4,53
40 : 60	1084	4,67
50 : 50	709	6,60

The result of RVA analysis indicated that increasing of SPC ratio would decrease viscosity and increase peak time value (Table 1). According Sandstedt and Abbott (1961), the character of starch pasting influenced by starch concentration, so in this study increasing of SPC ratio would decreaces starch concentration that would decrease viscosity and increase in peak time. The presence of heat and pressure during extrusion process would denaturate protein and perform protein-protein network, complex structure of protein could decrease viscosity of dough's paste. Lin et al. (2000) reported that the formation of large molecular weight from soy protein during extrusion process could result decreasing of protein solubility.

The greatest reduction in viscosity value was on increased SPC ratio from 40:60 to 50:50 as well as increased in peak time. This was probably due to increase of network protein – protein that formed. Formation of starch paste would be interrupted by formation of protein-protein network.

According to Coughlan et al. (2000) and Zaleska et al. (2000), formation of protein-carbohydrate complex would increase functional properties of gel such as viscosity. In this study, viscosity of gel decreased in increasing protein addition. Probably in this study interaction between carbohydrate - protein was not forming new covalent or ionic bonds to form complex.

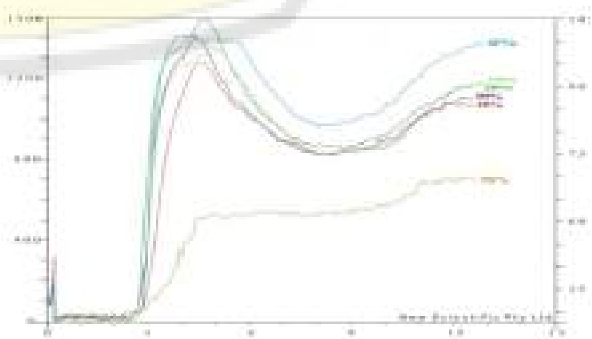

Figure 5. Chart result of RVA analysis of edible film's dough materials with variation of SPC : tapioca ratio after mixing with a single screw extruder.

3.4 Scanning Electron Micrograph (SEM) of dough

Microstructural analysis by SEM performed at 2,000 x magnification presented at Figure 6, Figure 7 and Figure 8.

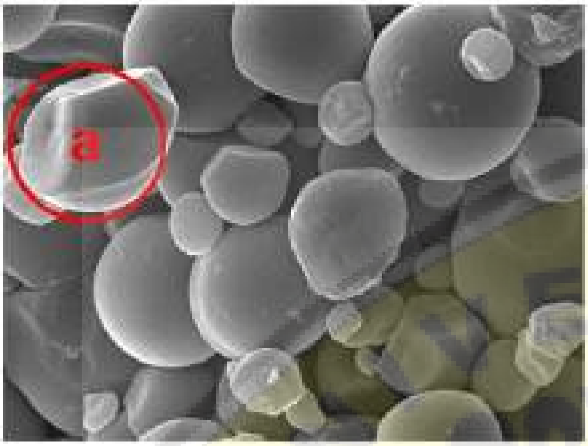

Figure 6. SEM micrographs of edible film's dough at SPC : tapioca ratio 0 : 100 (a = the ruptured starch granules).

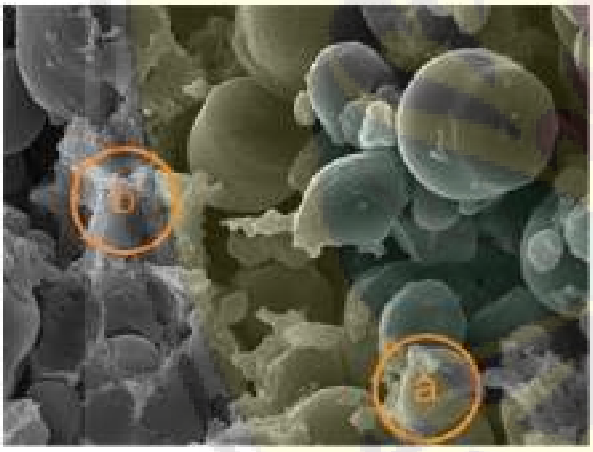

Figure 7. SEM micrographs of edible film's dough at SPC : tapioca ratio 30 : 70 (a = the ruptured starch granules ; b = fiber like protein-protein network).

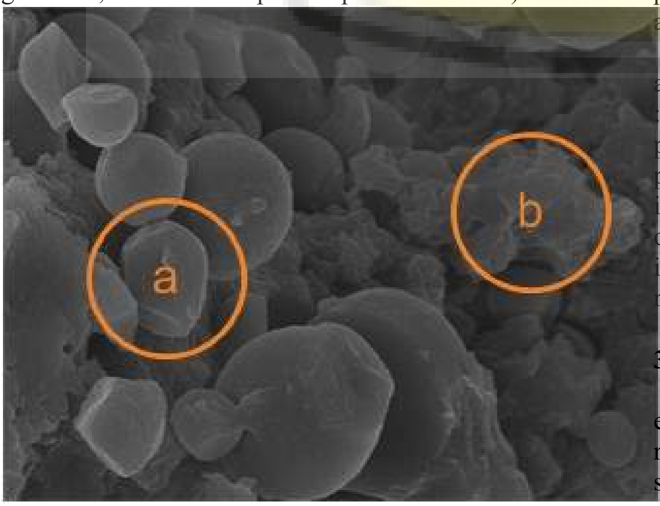

Figure 8. SEM micrographs of edible film's dough at SPC : tapioca ratio 50 : 50 (a = the ruptured starch granules ; b = fiber like protein-protein network)

Figure 6 was a micrograph of edible film's dough with SPC: tapioca ratio at 0 : 100. The image showed existence of intact and ruptured starch granules. Several studies (Molina-Garcia et al., 2007 and Shariffa et al., 2009) showed there were intact and ruptured starch granule after treatment as showed at Figure 6. Granule size in this study was bigger than these studies, it was presumably because the effect of shear stress during extruder mixing. It was showed at figure 6 that starch granule was not melted nor gelatinized.

According to Baud et al. (1999) a large molecule will be broken during extrusion. Meanwhile, Barron et al. (2001) studied that heat treatment and shear forces could result in variety of physical and chemical changes, where the structure starch granules damaged, natural crystals melted and stability of macromolecules disturbed. In this study starch granules was not melted because the screw design and operating conditions was not sufficient to destruct and melt starch crystals.

Figure 7 and Figure 8 were micrographs of edible film's dough with ISP: tapioca ratio at 30:70 and 50:50. It were showed presence of aggregates resembling fibers, which supposedly as protein-protein network. Chiang (2007) studied artificial meat composed from SPC and tapioca produce by extrution, SEM observation showed presence of fiber like structure that was protein-protein network, whereas extrusion operated at temperatures above 130°C and the fibers formed were more compact. The results of this study indicated that although extrusion was operated without heating the fibers still formed due to influence of shear stress.

According to de Mesa et al. (2009) in artificial meat formation, network protein occurs on 15% SPC addition. Li et al. (2010) studied that network protein formed on the addition of SPC 30%. During extrution, shear stress and thermal denaturation resulted in aggregates such as fibers which was composed of proteins crosslinking and interactions between proteins and other components (Sheard et al., 1984)

Figure 6, Figure 7, Figure 8 showed that the amount of starch ruptured increased on inceasing SPC : tapioca ratio from 0 : 100; 30:70 and 50:50. This was presumable because formation of fibers like protein-protein net work which could increase shear forces and increased starch granule degradation. Design and operating conditions of extruder in this study resulted in protein to form fiber like network and resembling rupture of starch granules.

3.5 Tensile Strength of edible film

The results of tensile strength measurement on edible film with variation of SPC : tapioca ratio were ranged between 0,179 Mpa – 0,598 Mpa. Tensile strength lowest value obtained from SPC : tapioca ratio 0:100, while the highest tensile strength values obtained from SPC : tapioca ratio 30:70. The addition of SPC had significant effect on tensile strength value ($p < 0.05$). The effect of SPC : tapioca ratio on edible film tensile strength are presented in Figure 9.

Figure 9 showed that, in general, increasing SPC ratio would increased tensile strength values. Lindriati et al. (2007b), studied effect of protein from Jack bean (*Canavalia Ensiformis*) addition on the matrix of edible film from cornstarch. The results showed that increasing of protein addition would increase tensile strength, but the addition of the protein more than 20% influence on increasing tensile strength was not significantly different ($p < 0.05$). Poeloengasih and Marseno (2003), showed a similar trend in which the tensile strength of edible films from tapioca starch would increase with the addition of winged bean proteins. Coughlan et al. (2004) studied addition of polysaccharides on the edible films from whey protein, the result showed decreasing of tensile strength due to the addition of polysaccharides.

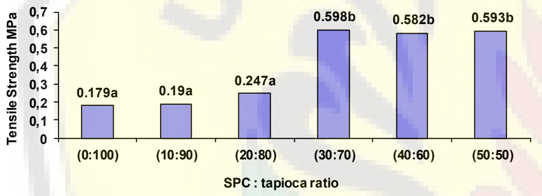

Figure 9. Influence of SPC: tapioca ratio to the value of the tensile strength of edible film.

According to Guilbert and Graille (1994), generally mechanical properties of edible films from protein better than from starch. This is because starch is a homopolymer, whereas the protein has a specific structure composed at least 20 hydrogen bonds from different monomers. This resulted in functional properties of proteins more variable, especially in their ability to form intermolecular bonds. So addition of protein fractions in the matrix of edible film from carbohydrates could increase tensile strength.

Tensile strength increased significantly ($p < 0,05$) when the ratio of SPC : tapioca increased 20 : 80 to 30:70. This is supported by the data of dough texture measurements (Figure 4, where a significant decrease ($p < 0.05$) of texture value when the ratio of SPC : tapioca increased from 20:80 to 30:70. This was probably due to the formation of protein network at 30% SPC addition, the amount of water absorbed by protein was sufficient to give effect of extrusion with high moisture content. According to Noguchi (1989) that could produce fibers like protein-protein network that resuled in a more compact dough.

3.6 Elongation of edible film

The results of elongation measurement on edible film with variation of SPC : tapioca ratio were ranged between 22,756% - 157,247%. Lowest value of elongation obtained from SPC : tapioca 50:50 and highest elongation value obtained from SPC : tapioca ratio 0:100. The addition of SPC had significant effect on tensile strength value ($p < 0.05$). The effect of SPC : tapioca ratio on edible film

SPC addition on edible film base material could reduce elongation value (Figure 10), which means decreasing elasticity. Lindriati et al (2007b) showed similar result where addition of protein from Cannavalia Ensiformis to the matrix of edible film from maizena decreased elongation. Research of Poeloengasih and Marseno (2003), also showed a similar trend, where the addition of protein fractions decreased elongation of edible film from tapioca starch.

The addition of protein fractions in the matrix of starch edible film could increase number of intramolecular hydrogen bonds. This could reduce the ability of the plasticizer in reducing the strength of hydrogen bonds. According to Choi and Han (2001), plasticizers can infiltrate between intramolecular hydrogen bonds thereby increasing the distance between adjacent chains which can reduce the strength of hydrogen bonds and can ultimately enhance the flexibility and extensibility of edible film. In addition, during mixing with extruder, protein formed network that likely fibers due to shear and heat generated, when dough was molded by compression molder protein-protein network would strengthen edible film matrix but make the film less elastic.

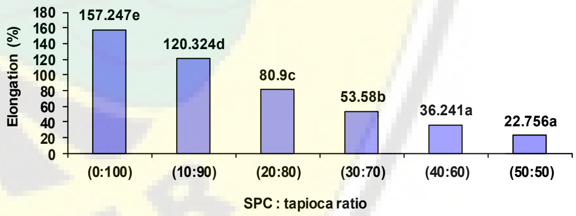

Figure 10. Influence of SPC : tapioca ratio to elongation of edible film.

3.7 Solubility Edible Films

The results of solubility measurement on edible film with variation of SPC : tapioca ratio were ranged between 22,756% - 157,247%. Lowest value of elongation obtained from SPC : tapioca 50:50 and highest elongation value obtained from SPC : tapioca ratio 0:100. The addition of SPC had significant effect on solubility value ($p < 0.05$). The effect of SPC : tapioca ratio on edible film solubility presented on figure 11.

Generally, increasing SPC ratio would decrease solubility value. This was probably due to formation of fibers like protein-protein network. Jeunink and Cheftel (1979) and Noguchi et al. (1989), conducted a study on artificial meat with ISP addition, where solubility of artificial meat decreased when compared to the basic material because of formation of protein - protein network presence by heat and shear forces. Lin et al. (2000) reported the formation of large molecular weight of soy protein during extrusion process could resulted in decreased of protein solubility.

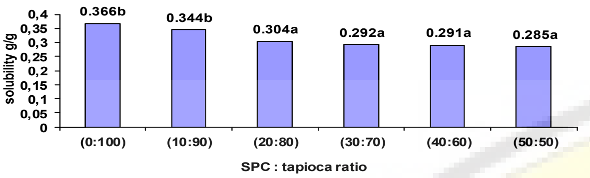

Figure 11. Influence SPC : tapioca ratio to solubility value of edible film

4. Conclusion

Ratio of SPC : tapioca on edible film affect the value of WHC and texture of dough as well as affect on tensile strength, elongation and solubility of edible film. Increasing SPC ratio would increase WHC of dough and edible film's tensile strength but decrease elongation and solubility. At the SPC ratio from 0:100 to 20:80 texture would increase but would decrease when SPC ratio increased from 30:70 to 50:50. The result of RVA analysis indicated that increasing of SPC ratio would decrease viscosity and increase peak time value. The observation of SEM micrographs showed that the changes that occur in the presence of shear forces caused by the screw i study resulted in protein to form fiber like network and resembling rupture of starch granules.

Ratio of SPC : tapioca that produced edible film with the highest tensile strength (0.598 MPa), elongation (53.580%) and lowest solubility (0.292) was 30:70. Combination of single screw extruder as mixing unit and compression molding as molder unit could be applied in edible film production.

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