UTILIZATION OF CARP (*Cyprinus carpio*) AS SURIMI FOR SAUSAGE MANUFACTURING

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Abstract

Carp (*Cyprinus carpio*) is a freshwater fish with high economic value and good farming potential. Carp-based product diversification could be done by using it as food ingredients such as surimi in sausage manufacture. This research was aimed to evaluate sausage produced from carp surimi by varying washing frequency and tapioca filler concentration. Five washing frequencies (1; 2; 3; and 4 times) and three tapioca filler concentrations (2; 3; and 4%) were compared. The study showed 1 time washing frequency gave better surimi physical characteristics (57.40% yield; 73.76% water holding capacity; 26.64% expressible moisture content, 821.92 g.cm gel strength; 54.45% whiteness) and chemical characteristic (78.00% moisture content and 6.34% salt soluble protein) compared to other washing frequencies. Based on the organoleptic test, 2% tapioca was the selected filler concentration. Selected surimi sausage had better physical, chemical and sensori characteristics than commercial sausage. The physical characteristics of the selected sausage were 70.46% water holding capacity; 24.58% expressible moisture content; 78.64% whiteness; 4346.70 g.cm gel strength; 101.23 g hardness; 0.98 g springiness; and 43.96 g chewiness. While the chemical characteristics of that sausage were 75% water; 1.35% ash; 11.51% protein; 4.46% fat; and 7.63% carbohydrate. The sensory scores of the sausage evaluated were color 0.44, aroma 0.60; taste 1.16; and springiness 1.86.

Keywords: *Cyprinus carprio*, surimi, sausage

Pemanfaatan Surimi dari Ikan Mas (Cyprinus carpio) untuk Pembuatan Sosis

Abstrak

Ikan mas (*Cyprinus carpio*) merupakan salah satu jenis ikan air tawar yang memiliki nilai ekonomis tinggi dan berpotensi baik untuk dibudidayakan. Diversifikasi produk berbahan dasar ikan mas dapat dilakukan dengan menjadikannya sebagai bahan baku produk pangan, contohnya surimi untuk pembuatan sosis. Penelitian ini bertujuan membuat sosis dari surimi ikan mas berdasarkan frekuensi pencucian ikan dan konsentrasi *filler* tepung tapioka. Penelitian diawali dengan menentukan frekuensi pencucian (1; 2; 3; dan 4 kali) berdasarkan karakteristik surimi terbaik. Pencucian sebanyak 1 kali menghasilkan karakteristik surimi terbaik dibandingkan frekuensi pencucian lainnya menurut karakteristik fisik (rendemen 57,40%, daya ikat air 73,76%, *expressible moisture content* 26,64%, kekuatan gel 821,92 g.cm, derajat putih 54,45%) dan karakteristik kimia (kadar air 78,00% dan protein larut garam 6,34%). Tahap selanjutnya dilakukan penentuan konsentrasi *filler* tepung tapioka (2; 3; dan 4%) melalui uji organoleptik pada surimi pencucian terpilih. Tepung tapioka 2% merupakan konsentrasi terpilih. Secara keseluruhan (aroma, rasa, rasa pahit, warna, dan kekenyalan), 70 panelis semi terlatih menerima produk ini (5,63 dari skala 7,00). Sosis surimi terpilih memiliki karakteristik fisik (daya ikat air 70,46%, *expressible moisture content* 24,58%, derajat putih 78,64%, kekuatan gel 4346,70 g.cm, *hardness* 101,23 g, *springiness* 0,98 g, dan *chewiness* 43,96 g), karakteristik kimia (air 75%, abu 1,35%, protein 11,51%, lemak 4,46%, karbohidrat (*by difference*) 7,63%), dan karakteristik sensori melalui uji perbandingan pasangan (warna 0,44, aroma 0,60, rasa 1,16, kekenyalan 1,86) lebih baik dibandingkan sosis komersial.

Kata kunci: *Cyprinus carprio*, ikan mas, gel, sosis, surimi

INTRODUCTION

Carp (*Cyprinus carpio*) is one of freshwater fishes which are very popular in Indonesian. Carp processing on industrial scale has not existed until. Thus, one way to broaden carp utilization is to process it into surimi as a basic ingredient for making fish sausage. Amiza and Ain (2012) stated that surimi, also known as wet protein concentrate, can be defined as minced form of fish after deboning, washing, and dewatering. Surimi industry is profitable because it has the ability to be processed as advanced products (Rostini 2013). Surimi usually are made from gurami and stripped mullet *Mugilecephalus*, while carp utilization is still rare.

According to Fogaca (2013), washing frequencies is an important factor that could affect texture, color, and smell. Myofibril protein is able to bind water, lipid, and create gel (Nopianti *et al.* 2010). Washing treatment will eliminate lipid and sarcoplasmic protein so that myofibril protein concentration will rise (Chaijan *et al.* 2010). Characteristics of surimi are also affected by myofibril protein solubility, gel formation through cross-linking, fish freshness, heating temperature, and starch (Nopianti *et al.* 2010). According to Singal *et al.* (2013) and Agustin (2015), tapioca addition could increase emulsion viscosity and stability, as well as product characteristic because starch has the ability to bind water and increase formation of lipid emulsion. Agustina (2015) found that tapioca was a suitable filler for sausage due to its ability to produce clear solution, good gel strength, and shiny color in sausage products. This research was aimed to make fish sausage using surimi with various washing frequencies (1; 2; 3; and 4 times) and tapioca concentration (2; 3; and 4%) as filler.

MATERIAL AND METHODS
Research Procedures

Carp was obtained from modern market Garding Serpong. Surimi was prepared according to Wijayanti *et al.* (2012) including deboning, gutting, mincing, washing and squeezing using filter cloth in order to gain filtrate. Washing was conducted with minced fish and water ratio of 1 : 4 at ±5°C (Nopianti *et al.* 2012) with various frequencies (1; 2; 3; and 4 times). In the last step, 0.3% NaCl was added. Surimi was then tested physically and chemically including protein (AOAC 2005) and salt soluble protein (Wijayanti *et al.* 2012) with Kjeldahl method, moisture and yied with oven method, lipid with Soxhlet method (AOAC 2005), expressible moisture content (Rawdkuen and Benjakul 2008), and water holding capacity (WHC) (Nopianti *et al.* 2012). Surimi was eventually processed into kamaboko according to modified method of Nugroho (2011), in which kamaboko making consist of: salt addition (2.5%); boiling (40°C, 20 minutes); further boiling (90°C, 20 minutes); and cold water soaking (5°C, 5 minutes). Kamaboko produced from each washing treatment was evaluated physically, i.e. gel strength (Amiza and Ain 2012) and whiteness (AOAC 2005) with TA-XT plus texture analyzer equipment.

Further analysis was carried out to determine tapioca concentration used in the manufacture of carp sausage. Concentration levels employed were 2; 3; and 4%, in which those three levels were based on research conducted by Nico *et al.* (2014) and Widjanarko *et al.* (2012). The fish sausage processing was started by mixing thoroughly 250 g carp surimi with all remaining ingredients 2% (8 g), 3% (12 g), or 4% (16 g) tapioca, 11 g sunflower seed, 3 g salt, 1 g garlic powder, 1 g pepper, 1 g STPP, and 125 g ice cube (Piotrowicz and Mellado 2015). The mixture was extruded into the casing and then boiled (100°C, 15-20 minutes) to obtain carp sausage. The optimal tapioca concentration was determined using physical evaluation water holding capacity (Nopianti *et al.* 2012), expressible moisture content (Rawdkuen and Benjakul 2008), whiteness (AOAC 2005), gel strength (Amiza and Ain 2012), hardness, springiness, chewiness), chemical (proximate composition), and organoleptic evaluation (Lawless and Leymann 2010) and hedonic (Meilgaard *et al.* 2007) involving 70 semi trained panelist: color, aroma, taste, and springiness. Paired comparison test (Meilgaard *et al.* 2007) was carried out on the sausage with selected tapioca concentration

and commercial fish sausage. Physical and proximate analysis was performed on the commercial sausage product.

RESULTS AND DISCUSSION
Proximate Composition of Carp

Results of proximate composition analysis of was summarized in Table 1. Pratama *et al.* (2013) suggested that the production of surimi used fresh low-fat fish in order to prevent wet textured surimi which could not be processed further. The carp contained 79.55% of water and 16.47% of protein.

Characteristic of Carp Surimi
Yield

Yield was used to reveal the economic value of surimi production. Higher yield means higher economic value to be utilized as raw material for further product processing (Rostini 2013; Shaviklo *et al.* 2012). Table 2 showed that greater washing frequency resulted in lower yield. due to loss of fish components (fish meat weight, sarcoplasmic protein, and fish lipid) (Rostini 2013).

Water holding capacity (WHC)

Water holding capacity is the ability of meat structure to hold water naturally (Walukonis *et al.* 2012). Water holding capacity plays important roles in gel and emulsion formation (Zhou *et al.* 2016). Table 2 demonstrated that greater washing

frequency increased the WHC. According to Brown (2011), washing process affects amino acid composition, in which more washing frequencies increased the gap between myofibril filaments in surimi structure generating hydrophilic protein and trapping more water inside the surimi gel (Brown 2011; Ismail *et al.* 2010; and Sofiana 2012).

Expressible moisture content

Expressible moisture content reflects the ability of the surimi to release water from the sample. Table 2 showed that more washing frequencies improved surimi ability to release water. Washing increase surimi ability to hold water sreducing water release. Water retention in the surimi structure affect the formation of surimi gel. The results of the expressible moisture content analysis were not in accordance with the research conducted by Amiza and Ain (2012) because the weight used to hold surimi is ineffective so the results were biased.

Gel strength

Gel strength was measured by processing it into kamaboko which was stored for 24 hours in the refrigerator. Table 2 indicates that washing frequency increased the gel strength. Santoso *et al.* (2008) noted that gel strength increased when more washing was implemented. The washing process increases the distance between myofibril filaments

Table 2 Phase I research analysis results

Parameter	Result				
	Unit	Washing 1	Washing 2	Washing 3	Washing 4
Physical characteristics					
Yield	%	57.40±2.90	48.76±3.00	37.47±0.87	36.00±2.04
WHC	%	73.76±1.61	74.52±2.20	75.12±5.83	76.19±4.70
Expressible moisture content	%	26.64±1.39	28.07±1.27	30.03±1.70	31.88±1.36
Gel strength	g.cm	821.92±20.49	846.06±5.39	851.05±2.36	862.75±4.77
Whiteness	%	52.45±0.32	52.49±0.17	59.87±3.49	55.14±0.76
Chemical characteristics					
Moisture content	%	78.00±1,14	83.12±0.65	84.16±0.47	89.93±0.13
Salt soluble protein	%	6.34±0,12	5.11±0.50	4.66±0.16	4.07±0.04

Notes: Treatment was not compared between analysis

which results in a hydrophilic protein and a stronger water trap in the gel.

Whiteness Degree

Whiteness degree indicates the surimi quality from color aspect with the value in the range of 0-100. White colour shows good surimi quality. Table 2 reveals that the three time washing produced surimi with better whiteness degree compared to others. According to Ramadhan *et al.* (2014), washing treatment is able to improve surimi whiteness degree. Washing treatment will release away component in the fish so that the whiteness degree of the surimi improves. Bledso *et al.* (2010) noted that fish which needs high amount of sodium bicarbonate (NaHCO$_3$) addition requires washing treatment in order to increase the whiteness degree of surimi.

Moisture content

Moisture content analysis was carried out to determine the amount of water trapped in surimi gel. Table 2 demonstrates that washing process increased moisture content of surimi. Ismail *et al.* (2010) informed that Cl$^-$ in salt used as solvent for myofibril protein will bind to a positive bond increasing the distance between filaments. An increase in the gap will trap and capture water in the surimi network.

Salt soluble protein

Salt soluble protein analysis was directed to determine the myofibril protein contained in surimi. According to Wijayanti *et al.* (2012), myofibril protein makes up 55-60% of total protein, in which other proteins are sarcoplasmic and connective tissue proteins. Salt addition up to 3% was needed in this analysis in order to produce elastic effect from the myofibril protein. Table 2 shows that the increasing frequency of washing reduced the salt soluble protein concentration. According to Wijayanti *et al.* (2012), increasing washing frequency washed myofibril protein away, reducing the salt soluble protein concentration.

Best surimi selection

According to Rostini (2013), Wijayanti *et al.* (2012), and Amiza and Ain (2012), good surimi is characterized by high yield and salt soluble protein, and low expressible moisture content. High yields indicates that more material or ingredients can be further utilized or processed. The presence of salt soluble protein in surimi indicates that high myofibril protein is available to be involved in gel formation of a product. Expressible moisture content value is expected low so that the surimi can hold more water during gel formation. Based on the results of quality analysis and the criteria of good surimi, the product with one washing was considered the best and selected as surimi for further research phase, i.e. carp sausage making. Properties of surimi with one washing frequency were 57.40±2.90% yield, 73.76±1.61% WHC, 26.64±1.39% expressible moisture content, 821.92±20.49 g.cm gel strength, 52.45±0.32% whiteness, 78.00±1.14 whiteness, 6.34±0.12% salt soluble protein.

Carp Sausages
Organoleptic Characteristic

Carp sausage prepared using surimi with one time washing and various tapioca levels was evaluated organoleptically in terms of aroma, taste, bitterness, color, springiness, and overall acceptability (Table 3). The addition of 2% tapioca tend to produce better fish sausage and is preferred by panelists. Increasing tapioca concentration reduces the aroma acceptability by panelists (p<0.05). According to Wulandari *et al.* (2013), lower level of tapioca addition induced stroner fish smell. Just like the aroma, panelist tend to like the taste of surimi with 2% tapioca. The addition of tapioca also reduces the panelist acceptability for taste parameter (p<0.05). The addition of 3 and 4% starch in carp sausage produced starchy taste product, while 2% addition level of starch resulted in more acceptable sausage organoleptically for panelist (Lestari *et al.* 2011; Singal *et al.* 2013). Tapioca is made of cassava having naturally bitter taste. Sausage prepared with 2% tapioca addition was more acceptable organoleptically because the cassava bitterness was probably masked by the fish (Wulandari *et al.* 2013). Tapioca addition will result in the increment of tapioca amount in the sausage, bringing about the product

Table 3 Organoleptic score of carp sausage

Hedonic	Tapioca concentration		
	2%	3%	4%
Aroma	5.41±1.08[c]	4.87±1.27[b]	4.36±1.48[a]
Taste	5.56±1.04[b]	4.77±1.32[a]	4.59±1.55[a]
Bitterness	5.43±1.25[b]	5.00±1.46[ab]	4.67±1.50[a]
Color	5.23±1.24[a]	4.96±1.06[a]	4.77±1.26[a]
Springiness	5.61±0.95[b]	4.81±1.20[a]	4.66±1.44[a]
Overall	5.63±0.82[c]	5.04±1.06[b]	4.66±1.40[a]

Notes: Treatment was not compared between analysis

acceptability by panellists to decrease (p<0,05).

Tapioca addition did not affect color of carp sausage (p>0.05). Agustina (2015) and Alamsyah (2005) noted that tapioca addition for 2; 3; and 4% did not contribute significantly to the color of end product. The tapioca addition level reduced sausage springiness (p<0.05). Prastini and Simon (2015) revealed that tapioca addition in sausage produced softer product texture. In general, panelists preferred the fish sausage added with 2% tapioca with overall acceptabiity score of 5.63 (slightly like).

Based on the above results of organoleptic evaluation, the addition of 2% tapioca in carp sausage processing produced the best product and that tapioca addition level is recommended to be employed. In order to explore product feasility, the phycochemical characteristics of carp sausage added 2% tapioca was compared with the commercial products.

Physicochemical characteristics of carp sausage and commercial sausage

Sausage characteristics were explored through physical (WHC, expressible moisture content, whiteness, gel strength, hardness, springiness, and chewiness) and chemical (water, ash, protein, and carbohydrate) analyses. All characteristics of carp sausage were compared to that of of commercial product (Table 4). The ability of sausage emulsions to hold water naturally (WHC) was higher than that of commercial sausage (p<0.05). Washing treatment applied to intermediate product makes the gap between

filaments of myofibril open s trapping water in the surimi gel (Purnomo *et al.* 2011; Brown 2011; Ismail *et al.* 2010; Nopianti *et al.* 2012 and Sofiana 2012).

Expressible moisture content of carp sausage was higher compared to that of commercial sausage (p<0.05). According to Amiza and Ain (2012), expressible moisture content can be reduced through washing. Washing can make surimi sausage matrix thighter and keep the water from releasing. Results were not in accordance to the previous research because of the weight used to hold the surimi was not effective.

Whiteness degree of carp sausage was higher than that of commercial sausage. The introduction of washing can remove some fish component (blood and dirts), so the product looks cleaner (Ramadhan *et al.* 2014). Previous study conducted by Poernomo *et al.* (2011) and Singal *et al.* (2013) also produced fish sausage with higher whiteness degree compared to commercial sausage.

Gel strength of carp sausage was higher than that of commercial sausage (p<0.05). Gel strength increased due to washing treatment, because the gap between myofibril filaments will open so that it is hydrophilic and stronger to hold water in the gel (Santoso *et al.* 2008).

Hardness of carp sausage was lower than that of commercial sausage (p<0.05). Washing process in surimi prior to sausage production probably reduced hardness through increasing WHC and gel strength of sausage. Carp sausage obtained would keep more water in gel matrix yielding softer final texture than the commercial sausage.

Table 4 Characteristic comparison between selected carp sausage and commercial sausage

Parameters	Carp Sausage	Commercial Sausage	Catfish Surimi Sausage*
Physical characteristics			
Water holding capacity (%)	70.46±0.23[b]	54.61±0.24[a]	79.36
Expressible moisture content (%)	24.58±1.58[b]	13.02±0.25[a]	-
Whiteness (%)	78.64±0.85[b]	64.64±0.48[a]	72.67
Gel strength (g.cm)	4346.70±256.71[b]	3269.91±123.80[a]	4220.55
Hardness (g)	101.23±9.50[a]	103.49±1.95[b]	-
Springiness (g)	0.98±0.01[b]	0.78±0.01[a]	-
Chewiness (g)	43.96±2.03[a]	65.09±4.20[b]	-
Chemical characteristics			
Moisturer content	75.05±1.18[b]	55.00±0.20[a]	70.14
Ash content	1.35±0.02[a]	1.56±0.07[a]	-
Protein content	11.51±0.59[b]	6.49±0.08[a]	10.27
Lipid content	4.46±0.24[a]	13.65±0.08[b]	-
Carbohydrate content	7.63±0.33[a]	23.30±0.43[b]	-

Notes: *Physical characteristic analysis by Poernomo *et al.* (2011)

The springiness score of carp sausage was higher than that of commercial sausage (p<0.05). Agustina (2015) and Santoso *et al.* (2008) revealed that surimi sausage made from washed intermediate ingredients would be able to hold water better resulting in higher springiness score.

Carp sausage showed lower chewiness score compared to commercial sausage (p<0.05). Chewiness is the ability of food products to return to their original form after being pressed. Carp sausage matrix could not produce the same chewiness as commercial sausages, although the carp sausage gel structure had better WHC, gel strength, and springiness compared to commercial sausage. According to Agustina (2015), chewiness score should correspond to hardness because the gel structure formed by polypeptide protein and amylopectin polysaccharide were able to resist the probe's pressure making the elasticity lower than the commercial sausage. In the end, surimi sausage produced was harder (not elastic enough) compared to commercial sausage.

Carp sausage had higher moisture and protein content compared to commercial sausage (p<0.05). Washing process made more water trapped in the gel matrix (Pratama *et al.* 2013). Poernomo *et al.* (2011) also noted higher moisture content in catfish sausage than commercial sausage. The moisture content of carp sausage in this study exceeded maximum level according to Indonesia National Standard (SNI) for sausage, i.e. 67.7% (BSN 1995). Likewise, protein content of carp sausage was also higher compared to commercial sausage (p<0.05), but the value was lower than the minimum protein level for sausage of SNI, i.e.13%. Poemomo *et al.* (2011) also revealed the same result. According to Widjanarko *et al.* (2012), commercial sausages wereprocessed using ingredients other than fish as filler and fish substitutes resulting in sausage with lower protein content.

Organoleptic characteristic of carp sausage and commercial sausage

Organoleptical evaluation using paired comparison test was conducted with hedonic parameter of color, aroma, taste, and springiness. Semi trained panelists evaluated carp sausage based on reference (R), i.e. commercial sausage. The evaluation revealed that the score for each organoleptic parameter

was color 0.44, aroma 0.60, taste 1.16, and springiness 1.86. The above results indicated that carp sausage was organoleptically better thsn commercial sausage.

CONCLUSIONS

The washing process affected the characteristics of carp surimi as the basic ingredients of carp surimi sausages The use of binder concentration played an important role to produce physical characteristics (water holding capacity, expressible moisture content, gel strength, hardness, springiness, and chewiness) chemical (moisture, ash, protein, lipid, carbohydrate), and organoleptic (aroma, taste, bitter taste, color, chewiness, and organelptik as a whole acceptance) carp surimi sausage.

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