EFFECTS OF PORK/YELLOW-FIN TUNA (*THUNNUS ALBACARES*) LEVELS ON THE QUALITY CHARACTERISTICS OF EMULSION TYPE SAUSAGE

Jae-Yun Shim[1], Ji-Hun Choi[2], Yun-Sang Choi[2], Si-Young Kim[2] and Cheon-Jei Kim[2*]

[1]R&D Center, DongWonF&B Co., Ltd., 369-3 Sangdaewon-Dong, Seongnam-Si, 462-120, South Korea

[2]Department of Food Science and Biotechnology of Animal Resources, Konkuk University, 1 Hwayang-Dong, Gwanjin-Gu, Seoul 143-701, South Korea

[*]Corresponding author (phone: +82-2-450-3684; fax: +82-2-444-6695; e-mail: kimcj@konkuk.ac.kr)

Abstract—**this study was carried out to evaluate about the effects of pork and yellow-fin tuna levels on the quality characteristics of emulsion type sausage, and establishment the appropriate percentage of tuna meat is added. The levels of pork lean meat (PLM) and yellow-fin tuna (YFT) were as follows; control (PLM 100%), T1 (PLM 90%, YFT 10%), T2 (PLM 80%, YFT 20%), T3 (PLM 70%, YFT 30%), T4 (PLM 60%, YFT 40%), T5 (PLM 50%, YFT 50%). The pH of batters was significantly decreased with increasing content of tuna meat, this is because pH of the tuna is considered lower than pH of the pork. Water holding capacity also did not show as significant difference until added 30% of tuna meat, while the addition of 40% were significantly lower than control. Cooking loss did not differ significantly. Apparent viscosity did not show as significant difference until added 10 % of tuna meat, while from more than 20% of tuna meat was significantly lower than control. Fat loss and total cooking loss did not show differently the control until added 30% of tuna meat, a higher loss showed when added more than 30%. Hardness was lower than the control when added more than 40% of tuna meat, but there was no significant difference in springiness. In every measurement without juiciness that does not have a difference compared to the control until added 30% of tuna meat. Also with the addition of the tuna appear larger in terms of smell does not seem to affect. These results suggest that the addition of 30% of the tuna meat seems to be not affect on the quality of emulsion type sausage made of pork.**

Index Terms—**Tuna, emulsion-type sausage, yellow-fin, quality characteristics**

I. INTRODUCTION

As the recent westernization of dietary patterns in Korea have also increased, intake of animal foods is a trend. This is causing increased serum cholesterol concentration, hypertension, atherosclerosis, and incidence of cardiovascular disease such as heart disease is increasing. Theory that the food is related with health is accepted widely to the general public, and the interest about functional foods is growing. The research about functional meat products also is progressing actively. In recent years, rice bran dietary fiber (Choi et al., 2010), Kimchi (Lee et al., 2010), mulberry, persimmon (Lee et al., 2002), chitosan (Choi & Chin, 2009), grapefruit (Chin, Kim, & Kim, 2005), green tea powder (Choi, Kwon, An, Park, & Oh, 2003) using a variety of additives have been studied a lot of low-fat sausages. Most of these studies were the addition of dietary fiber, water, non-meat protein, vegetable oil replaced with animal fat. But if fish meat with unsaturated fatty acids instead of pork with saturated fatty acids have replaced, development of new functional meat products, it would be possible.

Tuna is a typical red meat, widely used in domesticmarket in korea meat itself. And in particular, eicosapentaenoeic acid (EPA, C20:5 ω-3) and docosahexaenoic acid (DHA, C22:6 ω-3) contains ω-3 of polyunsaturated fatty acid (PUFA) have a much greater attention is being contained. DHA contained in the human brain frontal lobe grey matter and retina are present in the phospholipids, DHA has unique biological activities associated with the brain and the retina, accordingly, DHA has been found to be effective improved the learning ability and vision care (Gibson, Neumann, & Makrides, 1996). Therefore, functional foods supplemented with DHA in the country is popular even today is the release of a variety of products. In addition, both EPA and DHA decreased serum cholesterol, hypotensive effect, antitumor activity, reduced the incidence of diseases such as heart disease have been reported(Beck, Smith, & Tisdale, 1991; Hwang, Baik, Hwang, & Lee, 1992). Thus PUFA of tuna in the development of functional food has many advantages. DHA and EPA's efficacy in tuna is greater, the development of functional meat products utilizing the tuna that can be superior in terms of nutritional quality can be expected. Using surimi to use the mostly white meat of fish, recent catches of white fish decreased, surimi prices have risen, Therefore, using southerners surimi and tuna meat product manufacturing research is needed. A mixture of animal meat and fish meat products are manufactured in South Korea because it can be, through this research for the development of high-quality meat products seem to be research.

Therefore, this study was carried out to evaluate the effects of pork and yelow-fin tuna levels on the quality characteristics of emulsion type sausage, and establishes the appropriate percentage of tuna meat is added.

II. MATERIALS AND METHODS

A. Preparation and of sample

Fresh pork (M. *biceps femoris*, M. *semitendinosus*, and M. *semimembranosus*) were purchased from a pilot plant of the Dept. Food Science & Biotechnology of Animal Resources, KonKuk University (Seoul, Korea) at 48 h postmortem. Pork back fat was also collected. All subcutaneous and intermuscular fat and visible connective tissue were removed from the muscles. Yellow-fin tuna (*Thunnus albacares*, 14-15 kg, 70-75 cm length) were purchased from commercial tuna processing plant of DongWon F&B Co., Ltd.(Changwon, Korea). The scale, fin, and bone of tuna were removed. The pH of pork was 5.83±0.02 and pH of yellow-fin tuna was 5.77±0.04. The pork and tuna's lean muscles were initially ground through Ø-8 mm plate and the pork back fat was ground through Ø-8 mm plate using a meat grinder. The compositions of all treatments were as follows; lean meat 60%, back fat 20%, ice 20%, NaCl 1.5%, sodium tripolyphosphate 0.3%. The levels of pork lean meat (PLM) and yellow-fin tuna (YFT) were as follows; control (PLM 100%), T1 (PLM 90%, YFT 10%), T2 (PLM 80%, YFT 20%), T3 (PLM 70%, YFT 30%), T4 (PLM 60%, YFT 40%), T5 (PLM 50%, YFT 50%). The ground pork lean meat and tuna was homogenized for 1 min in a silent cutter (Cutter Nr-963009, Hermann Scharfen GmbH & Co, Postfach, Germany) then chilled in iced water (2 ˚C). NaCl and sodium tripolyphosphate were added to the meat and mixed for 1 min. Finally, pork fat was added in mixture and then mixed for 5 min. The manufactured batter was analyzed.

B. pH and color

The pH values of meat batters were measured in a homogenate prepared with 5 g of sample and distilled water (20 ml) using a pH meter (Model 340, Mettler-Toledo GmbH, Schwerzenbach, Switzerland).

The color of each meat batter was determined using a colorimeter (Minolta Chroma meter CR-210, Minolta Ltd., Osaka, Japan; illuminate C, calibrated with a white plate, L^*=+97.83, a^*=-0.43, b^*=+1.98). Lightness (L^*- value), redness (a^*- value), and yellowness (b^*- value) values were recorded.

C. Water holding capacity and cooking loss

Water holding capacity (WHC) was measured by a modification of the procedure of Grau and Hamm (1953). Briefly, a 300 mg sample of muscle was placed in a filter press device and compressed for 2 min. WHC was calculated from duplicate samples as a ratio of the meat film area to the total area.

Cooking loss was determined by calculating the weight differences before and after cooking.

D. Apparent viscosity and emulsion stability

Meat batter viscosity was measured in triplicate with a rotational viscometer (HAKKE Viscotester® 550, Thermo Electron Corporation, Karlsruhe, Germany) set at 10 rpm.

The meat batters were analyzed for emulsion stability using the method of Bloukas and Honikel (1992) with the following modifications.

E. Texture analysis and sensory evaluation

Texture profile analysis was performed at room temperature with a texture analyzer (TA-XT2*i*, Stable Micro Systems Ltd., Surrey, England).

The sensory evaluations of each patty were evaluated by a 12-member trained panel using 10-point scale (1 = extremely undesirable and 10 = extremely desirable for color; 1 = extremely undesirable and 10 = extremely desirable for flavor; 1 = extremely tough and 10 = extremely tender for tenderness; 1 = extremely dry and 10 = extremely juicy for juiciness; 1 = extremely undesirable, 10 = extremely desirable for overall taste).

F. Statistical analysis

An analysis of variance was performed on all the variables measured using the general linear model (GLM) procedure of the SAS statistical package (1999). Duncan's multiple range test (P<0.05) was used to determine the differences between treatment means.

III. RESULTS AND DISCUSSION

Table 1 is compared on the physicochemical properties of batters manufactured by the levels of pork lean meat and yellow-fin tuna. The pH of batters was significantly decreased with increasing content of tuna meat ($P<0.05$), this is because pH of the tuna is considered lower than pH of the pork. Color of batters did not differ significantly L*-value and b*-value of the treatments, but a*-value did not show as significant difference until added 30% of tuna meat, while the addition of 40% were significantly lower than control ($P<0.05$). Water holding capacity also did not show as significant difference until added 30% of tuna meat ($P>0.05$), while the addition of 40% were significantly lower than control ($P<0.05$). Cooking loss did not differ significantly ($P>0.05$). Table 2 is compared on the apparent viscosity and emulsion stability of batters manufactured by the levels of pork lean meat and yellow-fin tuna. Apparent viscosity did not show as significant difference until added 10 % of tuna meat ($P>0.05$), while from more than 20% of tuna meat were significantly lower than control ($P<0.05$). Fat loss and total cooking loss did not show differently the control until added 30% of tuna meat, a higher loss showed when added more than 30%. Table 3 is measured on the texture analysis of Batters manufactured by the levels of pork lean meat and yellow-fin tuna. Hardness was lower than the control when added more than 40% of tuna meat, but there was no significant difference in springiness. Also cohesiveness, gumminess, chewiness tended to be lower than the control when added tuna meat. Table 4 is compared on the sensory evaluation of batters manufactured by the levels of pork lean meat and yellow-fin tuna. In every measurement without juiciness that does not have a difference compared to the control until added 30% of tuna meat. Also with the addition of the tuna appear larger in terms of smell does not seem to affect.

Table 1. Comparison on physicochemical properties of batter with various contents of yellow-fin tuna

Traits	Pork ham/yellow-fin tuna level					
	100/0	90/10	80/20	70/30	60/40	50/50
pH	6.00±0.01^{A}	5.97±0.01^{B}	5.95±0.01^{BC}	5.95±0.01^{BC}	5.93±0.03^{CD}	5.91±0.02^{D}
CIE L*-value	74.92±3.21	74.18±3.79	75.19±4.43	74.57±3.69	73.75±3.80	72.53±4.32
CIE a*-value	11.75±1.34^{A}	11.85±0.69^{A}	11.46±1.04^{A}	11.25±0.91^{AB}	10.53±0.75^{BC}	10.43±0.55^{C}
CIE b*-value	11.99±1.43	12.05±0.60	11.87±1.49	11.35±1.38	11.85±1.07	11.43±0.94
WHC (%)	98.31±0.62^{A}	97.87±0.66^{A}	97.63±0.44^{A}	96.72±1.08^{A}	92.83±1.76^{B}	88.10±1.48^{C}
Cooking loss (%)	12.86±2.55	14.87±3.71	14.77±4.44	14.31±4.62	15.70±4.64	16.76±4.21

Table 2. Comparison on apparent viscosity and emulsion stability of emulsion type sausage with various contents of yellow-fin tuna

Traits	Pork ham/yellow-fin tuna level					
	100/0	90/10	80/20	70/30	60/40	50/50
AV (Pa·S)	95.95±3.69^{A}	92.75±3.65^{AB}	86.99±4.19^{B}	87.42±3.60^{B}	71.48±7.20^{C}	66.35±7.08^{C}
Emulsion stability						
Fat loss (%)	1.27±0.12^{C}	1.33±0.10^{BC}	1.35±0.12^{BC}	1.45±0.12^{BC}	1.56±0.17^{AB}	1.73±0.15^{A}
Total CL (%)	7.38±0.74^{B}	7.71±0.65^{B}	8.21±0.95^{B}	8.31±0.77^{B}	10.54±0.81^{A}	11.22±1.01^{A}

AV: apparent viscosity; CL: cooking loss

Table 3. Comparison on textural properties of emulsion type sausage with various contents of yellow-fin tuna

Traits	Pork ham/yellow-fin tuna level					
	100/0	90/10	80/20	70/30	60/40	50/50
Hardness (kg)	0.56±0.07^{A}	0.53±0.05^{A}	0.53±0.04^{A}	0.52±0.07^{A}	0.47±0.05^{B}	0.41±0.04^{C}
Springiness	0.93±0.02	0.92±0.03	0.93±0.03	0.93±0.02	0.93±0.03	0.91±0.05
Cohesiveness	0.62±0.06^{A}	0.57±0.04^{B}	0.62±0.06^{A}	0.58±0.04^{B}	0.58±0.04^{B}	0.57±0.02^{B}
Gumminess (kg)	0.35±0.07^{A}	0.30±0.04^{BC}	0.33±0.03^{AB}	0.30±0.04^{BC}	0.27±0.03^{C}	0.24±0.03^{D}
Chewiness (kg)	0.32± 0.06^{A}	0.28±0.04^{BC}	0.31±0.03^{AB}	0.28±0.04^{BC}	0.26±0.03^{C}	0.22±0.03^{D}

Table 4. Comparison on sensorial properties of emulsion type sausage with various contents of yellow-fin tuna

Traits	Pork ham/yellow-fin tuna level					
	100/0	90/10	80/20	70/30	60/40	50/50
Color	8.50±0.53^{A}	8.50±0.76^{A}	8.38±0.52^{A}	8.00±0.53^{AB}	7.38±0.52^{B}	7.38±0.74^{B}
Flavor	8.25±0.46^{A}	8.38±0.52^{A}	8.25±0.46^{A}	8.13±0.64^{A}	7.50±0.53^{B}	7.50±0.53^{B}
Tenderness	7.75±0.71^{B}	8.25±0.46^{AB}	8.13±0.35^{AB}	8.63±0.52^{A}	8.38±0.92^{AB}	8.63±0.92^{A}
Juiciness	8.13±0.83	8.38±0.74	8.38±0.52	8.50±0.76	7.88±0.83	7.63±0.92
Overall acceptability	8.38±0.74^{A}	8.38±0.74^{A}	8.13±0.35^{A}	8.50±0.53^{A}	7.44±0.50^{B}	7.38±0.92^{B}

IV. CONCLUSION

These results suggest that the addition of 30% of the tuna meat seems to be not affect on the quality of emulsion type sausage made of pork.

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