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Surimi Preparation from Mechanically Deboned Chicken Meat

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기계발골 계육으로부터 닭고기 수리미의 제조

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ABSTRACT

The mechanically deboned chicken meat(MDCM) has several limits in using for in processed meat products as a main material because of poor color and textural properties, chance of microbial contamination and lipid oxidation. There has been a growing interest all over world in the application of MDCM to the surimi process. The surimi made from MDCM contains a high concentration of myofibrillar protein since this processing involves repeated washing processes with an aqueous solution in order to remove heme pigments, fat and other undesirable substances. The quality of the surimi made from MDCM is affected by various processing factors, such as kinds of wash solution, ion strength, washing cycle, temperature, pH changes, composition, part of muscle, particle size, and rigor state etc. A number of researchers have investigated the effect of the various washing conditions on the properties of surimi gels. A fuller information of all the factors affecting surimi processing and gel formation by heat-induced gelation has not been known yet.

(Key words: chicken surimi, MDCM, washing condition, heat-induced gelation)

INSTRUCTION

In Korea, the spent layer hens and the remaining cuts after separation of cup-up chickens are usually deboned mechanically. The mechanically deboned chicken meat(MDCM) has been used in the production of emulsion type products, or in combination with red and white meat in various muscle-type products. However, it has been found that mechanical deboning alters the lipid and protein composition of the meat, resulting in flavor instability and formation of some undesirable functional characteristics of the meat(Table 1). The MDCM is characterized by its paste-like consistency and high susceptibility to deteriorative changes which occur during storage. The extreme stress and aeration during the process and the compositional nature of the product contribute to its high oxidation potential. Especially poultry meat is composed of relatively high levels of unsaturated fatty acids and low levels of natural tocopherols, resulting in the MDCM remarkably unstable. Stabilizing the color and flavor and defining functional properties have been of fore-

Table 1. Chemical composition of Mechanically deboned chicken meat from various chicken parts(Lee et al., 1994a)

Composition	MDCM(Mechanically deboned chicken meat)				
	Whole carcass	Neck without skin	Upper back and rib	Leg	Carcass without exsanguination
	64.2^{b}	68.6^{a}	61.4^{c}	54.2^{d}	65.6^{b}
Moisture(%)	19.7^{a}	$17.8b^{c}$	16.4^{c}	14.5^{d}	19.0^{ab}
Crude protein(%)	15.0^{c}	12.3^{c}	20.9^{b}	30.1^{a}	14.3^{c}
Fat(%)	1.1	1.3	1.3	1.3	1.1
Total pigment(mg/g)	2.83^{b}	2.93^{b}	1.73^{c}	1.58^{c}	3.83^{a}
Myoglobin(mg/g)	0.26^{b}	0.31^{a}	0.19^{c}	0.17^{c}	0.29^{a}
Collagen(g/100g)	3.30^{b}	2.73^{d}	4.39^{a}	4.88^{a}	3.12^{c}
Hydroxyproline(g/10g)	0.41^{b}	0.34^{d}	0.58^{a}	0.61^{a}	0.39^{c}

$^{a\text{-}d}$Means without a common superscript in the same row significantly($P<0.05$).

most concern(Dawson and Gartner, 1983). Diminishing these problems will encourage and stimulate wider utilization of MDCM.

1. Definition of Surimi

Surimi is a Japanese term for mechanically deboned fish mince that has been refined by water-washing and mixed with cryoprotectants for frozen storage(Figure 1). The objective of the surimi process is to reduce water-soluble proteins, together with enzymes, blood, metal ions, fat, and objectionable flavor components. The washed meat therefore contains a higher concentration of the more functional salt-soluble myofibrillar proteins. The resultant material is not only more functional but also more stable, owing to lower concentrations of enzymes, of heme iron, and also of the sugars that are major substrates for microbial growth(Knight, 1992).

Basic processing of surimi

The industrialized fish surimi process has been developed in Japan since the 1960s. After the fish was headed, filleted, and deboned, the fish mince was washed two or three times with water and the wash water was strained through large rotary screen. The amount of washing

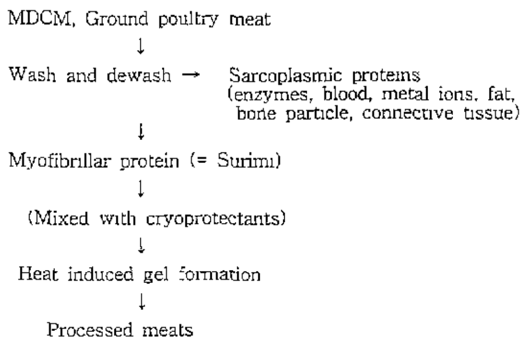

Figure 1. Basic processing of surimi

required at each stage was judged subjectively by the operators. The washed mince then passed through a refiner to remove blade skin fragments. It was known that washing treatment altered the level and composition of fatty acids of meat surimi compared with unwashed meat. For example, McCormick, et al.(1993) reported that washing increased moisture and decreased fat and protein in mutton surimi. Percentage of 14:0, 16:0, 18:0 and 18:1 fatty acids tended to decrease and pecentage of poly unsaturated fatty acids tended to increase with washing.

2. Factors affecting surimi quality by washing methods

The principle of chicken surimi processing is similar to that of fish surimi. Many researchers tried to prepare for animal surimi, mainly chicken surimi from MDCM, with various washing conditions. There are many factors that affect surimi quality according to various processing methods. Lee(1998) reported that chicken surimi was made from MDCM (mechanically deboned chicken meat) under condition of various washing procedures. The effects of washing processing on the thermal gelation, color, functional properties, and microstructure of chicken surimi were investigated. Among the SC(sodium chloride, 0.5%), STPP (sodium polyphosphate, 0.5%) and SBC(sodium bicarbonate, 0.5%) solution, the washed MDCM with STPP was lighter, and less red than other washing treatments(Table 2). But the washed MDCM with SC had higher WHC(water holding capacity) and adhesiveness than the washed MDCM with STPP.

Ball and Montejano(1984) investigated that the various washing solutions including tap water, sodium bicarbonate (pH 8.45) and sodium acetate (pH 5.25) were used to extract pigment from the thigh meat of broilers. The largest amount of pigment was removed by the bicarbonate treatment, with an 88% reduction, and the other treatments removed ca. 70~75% of the pigment. Shahidi et al.(1992) also reported that approximately 75.5% of the total hemoprotein pigments was removed by washing of MDCM with a sodium bicarbonate solution which resulted in the best color improvements in the samples. Dawson et al.(1988) showed that bicarbonate buffer (pH 8.5) was more effective in removing pigment from mechanical deboned chicken than washing with acetate buffer (pH 4.5) or neutral tap water. However, there was no difference in the amount of fat removed from the chicken meat by each of the extractants. The quality of surimi from MDCM washed with tap water, 0.5% sodium bicarbonate, sodium phospahte buffer, or 0.1M sodium chloride were different. These differences were attributed to pH and washing solvent residue in the washed MDCM(Yang and Froning, 1992). Smyth and O'Neill(1997) reported that chicken surimi was prepared from fresh mechanically separated chicken meat using a sodium bicarbonate washing process. The heat-induced gelation properties were assessed under different condition of pH, temperature, heating rate, protein and sodium tripolyphosphate(TPP) concentrations. Surimi gel strength increased after reducing pH from 6.4 to pH 6.0, increasing temperature from 60℃ to 80℃, reducing heating rate from 5℃

Table 2. The effect of washing solutions on the color characteristics of washed MDCM(Lee et al., 1994b)

Treatments	Hunter color value		
	L(Lightness)	a(Redness)	b(Yellowness)
Unwashed	37.9	11.0	11.5
Cooled distilled water	42.2	6.9	12.9
Sodium phosphate(0.04M, pH 8)	50.2	3.3	12.2
Sodium bicarbonate(0.5%, pH 8)	54.9	2.2	12.8

[a-c]Numbers in same column with same superscript not different at $P<0.05$.

/min to 1℃/min, increasing protein concentration from 4%(W/W) to 8%(W/W) or addition of 0.3%(W/W) TPP. Recently, Jiang (1998) tried to use the washing solution with ozonation in minced mackerel. They reported that washing with alkaline phosphate or bicarbonate buffers(>pH 8.0) did not remove the pigments. But gel strength such as the deformation and breaking force increased in alkaline washing solution combined with ozonation.

It has been reported that the level of ionic strength of sodium chloride(NaCl) affected protein solubility and gel rigidity in surimi. The use of salt(NaCl) as a washing solution affects the extracting myofibrillar protein in Pacific whiting mince. Increased salt concentration from 0.25% to 1% reduced the loss of myofibrillar proteins. High salt (2.0% NaCl) washing resulted in low removal sarcoplasmic proteins and severe loss of myofibrillar proteins(Lin and Park, 1996). Lee(1998) reported that the effect of increasing the ionic strength from 0 to 1% sodium chloride was to reduce the amount of salt soluble protein and meat pigment in the chicken surimi. Textural rigidity by thermally induce gelation was highest in the surimi washed with 0.2~0.5% NaCl solution.

There were no differences in textural properties and color due to number of washes(once, twice, or three times) in gel from washed channel catfish surimi. However, differences in proximate composition, textural properties and Hunter color values were found between gels prepared with washed and unwashed surimi (Kim et al., 1996). In case of chicken surimi from MDCM(Table 3), the gel strength decreased as the number of washing increased, but the lightness value(L*) of color increased (Lee, 1998). The proper washing cycles (numbers) and volume are not found clearly. For example, there is doubt about requirement for large volumes of water during the washing stages. Hastings(1989) examined the influence of the number of the washing stages on the rheological properties of heat-set surimi gels. Gels made from surimi, previously washed three times in water (fish:water ratio 1:3) were soft and flexible; gels from unwashed fresh cod mince were firmer and less elastic, but both gels gave a maximum score on the folding test. A single wash made the gels firmer and slightly more elastic than those from unwashed mince. Sensory assesment of the gels found no differences in firmness between the different washing procedures and a slight difference in elasticity and toughness.

The temperature of washing solution didn't seem to affect surimi quality definitely. According to Lee(1998), consistent effects of different wash temperature(4℃ and 20℃) were not

Table 3. Effect of washing cycle on the textural properties of washed MDCM(Lee, 1998)

Parameter	Washing cycle			
	1	2	3	4
Hardness(g)	189.5± 8.8[b]	216.4± 5.4[a]	212.9± 4.9[a]	205.5± 5.0[ab]
Adhesiveness(g*s)	−190.5±28.1[a]	−168.6±33.3[a]	−141.2±22.0[b]	−97.9± 8.7[c]
Springiness	0.9± 0.03[a]	0.9± 0.04[a]	0.9± 0.04[a]	0.9± 0.03[a]
Chewiness	76.7±13.6[a]	87.1± 4.3[a]	74.9±17.9[a]	74.9±18.0[a]
Cutting strength(g)	123.1±31.3[a]	95.6±17.1[ab]	79.5±16.1[ab]	65.6± 7.4[b]

Means within row with different superscripts are significantly different($P<0.05$).

Table 4. Effect of washing temperature on the color properties of washed MDCM (Lee, 1998)

Temp. (℃)	Processing Steps[1)]	$L^{*2)}$	a^*	b^*	W	C	h^0
4℃	After washing	55.9 ± 0.3^{ab}	14 ± 0.2^{b}	14.2 ± 0.1^{c}	51.6 ± 0.3^{c}	19.9 ± 0.2^{b}	45.5 ± 0.1^{d}
	Salt added	53.2 ± 0.9^{b}	14.9 ± 0.2^{a}	$15.2\ \pm0.19^{a}$	48.5 ± 0.8^{d}	21.3 ± 0.3^{a}	45.5 ± 0.2^{d}
	After cooked	63.0 ± 0.4^{a}	5.1 ± 0.1^{e}	12.59 ± 0.2^{e}	60.6 ± 0.4^{a}	13.6 ± 0.2^{d}	68.0 ± 0.4^{b}
20℃	After washing	55.7 ± 0.9^{ab}	12.5 ± 0.1^{d}	13.9 ± 0.2^{d}	51.9 ± 0.7^{c}	18.7 ± 0.2^{c}	48.0 ± 0.3^{c}
	Salt added	53.2 ± 0.8^{ab}	13.4 ± 0.3^{c}	14.7 ± 0.3^{b}	49.1 ± 0.6^{d}	19.9 ± 0.4^{b}	47.8 ± 0.2^{c}
	After cooked	61.6 ± 0.6^{a}	4.5 ± 0.2^{f}	11.9 ± 0.3^{f}	59.5 ± 0.5^{b}	12.8 ± 0.3^{c}	69.6 ± 0.8^{a}

1) After washing : washed MDCM with Salt added : added 2% NaCl and mixed at 8000rpm for 2 min.
After cooked : heated MDCM for 30 min after the internal temperature attained at 75℃

2) L^* = Lightness, a^* = Redness, b^*= Yellowness,
W : Whiteness $= 100 - \{(100 - L^*)^2 + a^{*2} + b^{*2}\}^{1/2}$
C : Saturation $= (a^{*2}\ b^{*2})^{1/2}$, h^0 = Hue-angle $= \tan^{-1}(b^*/a^*)$
[abcd] Means within column with different superscripts are significantly different ($P<0.05$).

observed although the color value and gel strength of surimi washed at 20℃ solution was slightly higher than those at 4℃ (Table 4).

Of the various examinations, pH gave the biggest effect on the properties of the chicken surimi. Pigment measured by the color difference meter was more effectively removed by raising the pH value of the washing solution. Chicken surimi washed at pH 6.0 solution gel had the greatest textural rigidity such as hardness, cutting strength, tensile and compress test (Lee, 1998). Hernandez et al. (1986) demonstrated that turkey meat pigments were removed more effectively by raising the pH value of the washing medium. Phosphate buffer at pH 6.4, 6.8, 7.2, and 8.0 was examined for their efficiency of pigment extraction. The pH 8.0 buffer produced the highest-colored turkey meat after washing and pressing to de-water twice.

Therefore, the quality of chicken surimi made from MDCM was affected by processing factors such as washing solution and cycle, pH change, ion strength, and temperature etc. Lee (1998) recommended that the effective washing procedure of surimi from MDCM was to reduce the connective tissue with chopping and filtering (2mm, 1mm and 0.6mm mesh), and to remove meat pigments with 3 washing cycle (5 volume of 0.2~0.5% NaCl, pH 6.0), and to concentrate on myofibrillar protein with centrifuging at 3000rpm for 25 min. However, a fuller information of all the factors affecting surimi yield and composition has not been reported although many workers have investigated the effects of process conditions on the quality properties of surimi gels.

3. Assessing the surimi quality

The quality of surimi can be measured by instrumental analysis and sensory evaluation. Ockerman and Hansen (1988) summarized the properties that have been used or proposed for assessing surimi quality, and these are listed in Table 5.

One of important factors affecting quality of surimi is textural properties, usually called as "gel strength". The level of gel strength

Table 5. Properties used or proposed for grading surimi (Ockerman and Hansen, 1988)

Chemical and visual	
	Moisture level
	pH
	Whiteness-Hunter color meter
	Impurities-black skin and bones
Physical properties	
	Expressible drip-pressed
	Viscosity-in 3 /5% NaCl soution
Gel-forming ability (constant moisture)	
	Gel strength-plunger
	Folding test-crack when folded
	Firmness-sensory
	Chewiness-energy used with repeated compression
	Elasticity-tensile force to break sheet
	Water binding-slope of gel strength versus moisture
Frozen storage	
	Freeze-thaw cycles-pressed fluid

measured by instrumental analysis doesn't have the same results. Table 6 showed that the gel strength was different with pH of extracted solutions. The maximum tensile strength and compress property were pH 7 and pH 6, respectively. The exact method for measuring textural properties including elasticity and firmness of gel needed in the future. In addition to these physical and chemical tests, the lipid oxidation and microbiological status of the surimi should assessed during cold or freezing storage.

4. Protein denaturation by heat

Heat affects the flavor, color, juiciness, and texture of salt soluble protein of surimi. Changes in texture and juiciness are due to thermally driven denaturation (unfolding) and subsequent association of proteins, which emphasize the critical importance of these reactions to the chemistry of muscle foods. As chicken surimi is a kind of extracted production from minced meat to refine meat protein, the understanding of heat-induced gel formation is also critically important.

In muscle proteins, aggregation processes occur isothermally at temperatures of less than Td(denaturation temperature). The denaturation temperatures of meat proteins during increasing of heating are referred as "transition temperatures", which are the important factors affecting gel formation. The specific transition temperature and rate were depended on pH, muscle type and rigor state. However, muscle type and pH had a greater effect than muscle rigor state on salt soluble protein denaturation (Xiong and Brekke, 1990).

Meat proteins such as myosin and actin exist as filaments physiologically so their native structures are designed for protein-protein interactions. The association of denatured myosin and actomyosin is typically measured by tur-

Table 6. Effect of pH on the tensile and compress properties of washed MDCM(Lee, 1998)

pH	Tensile		Compress	
	Value	Area	Value	Area
5	-108 ± 18^{bc}	395 ± 58^{bc}	633 ± 5^{c}	6329 ± 542^{c}
6	-171 ± 11^{ab}	617 ± 41^{ab}	1056 ± 84^{a}	10562 ± 844^{a}
7	-238 ± 51^{a}	807 ± 144^{a}	781 ± 4^{b}	7814 ± 43^{b}
8	-36 ± 8^{c}	109 ± 25^{c}	156 ± 13^{d}	1560 ± 127^{d}

[abcd] Means within column with different superscripts are significantly different($P<0.05$).

bidity changes during heating. The formation of turbidity(association) was detected prior to gelation.

5. Texture development by thermally induced gelation

The final result of thermally induced unfolding and aggregation of muscle protein is texture development, namely gelation. It is a matrix that provides processed meats with their texture, and water-holding and fat-holding properties. The important textural indicators of surimi quality is elasticity and firmness. In general, two basic requirements for producing gel products must be met. First, the myofibrillar proteins must initially be dissolved in a salt solution. Second, on heating to form a gel the proteins must be denatured in such a way that they form a regular network structure capable of immobilizing the water present in the uncooked surimi(Mackie, 1992).

The general process of rigidity development in myosin gelation begins at 40~50℃, increases to 60℃, then remains relatively constant from 60~70℃. The exact transitions within the 40~70℃ range depend on the myosin from animal. In contrast, the major increase in rigidity development begins in the range of 50~58℃ in the more complex systems such as myofibrils and surimi. This difference reflects the combined transitions of individual proteins, variations in myofibrillar protein stability among species, and the effect of residual myofibrillar structure(Foegeding, 1988). Montejano et al. (1984) reported that surimi gels cooked by heating at 40℃ for 1 hr, then at 90℃ for 15 min, have greater failure shear stress and shear strain values than those cooked at 90℃ for 15 min. This is generally referred to as the "setting phenomenon", especially "swari phenomenon" in Japan. It was well known that the suwari occurs in most of fish surimi at some specific temperature.

For sardine gel, pre-setting was required to achieve acceptable gel quality. Highest gel strength values were found in gels set for 30~60 min at 35℃ prior to heating at 90℃ for 40 min (Alvarez, et al., 1995). Reppond, et al.(1995) reported that, low-temperature setting, or heating at 40℃ prior to cooking at 90℃, resulted in strong gels made from surimi from pacific herring. Thus these textural differences are due to the variation of micro structure produced by heat(Saliba et al., 1987).

6. Factors affecting heat-induced gelation

Salt soluble protein of surimi from MDCM become a texture development owing to heat -induced gelation. Several studies have shown that heat-induce gelation properties of salt soluble protein (myofibrillar protein) during thermal processing are important in the stability and textural aspects of restructured and reformed meat products. There are so many factors affecting gel rigidity from surimi to heating treatment. Lee et al.(1995) reported that the levels of gel strength are different by muscle age. Influences of protein concentrations, pH and thermal treatment on the heat-induced gelation properties of chicken salt soluble protein(SSP) from red(leg) and white(breast) muscle at different growth stages such as 4 weeks, 8 weeks and 24 months were investigated. The heat-induced viscosity showed to increase with increasing the protein concentration and started to increase rapidly in SSP from younger and breast muscles(Figure 2). The least amount of protein needed for forming gel in SSP from younger and breast muscles(Table 7). The heat-induced turbidity increased higher in salt

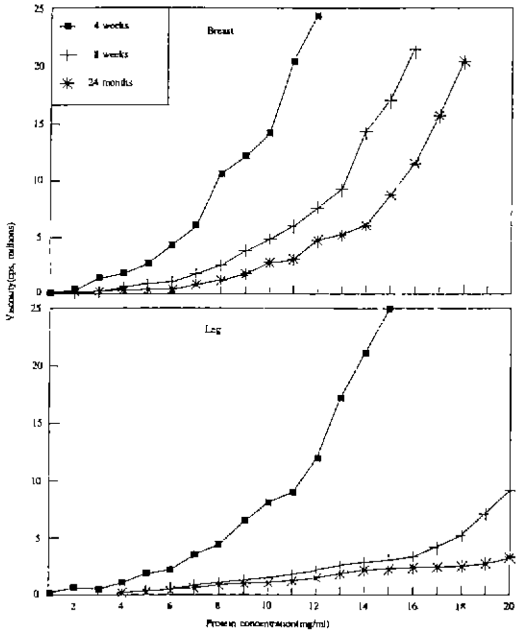

Figure 2. Effect of protein concentration on the gelation of salt soluble protein(1M KCl, pH 7.0) isolated from breast and leg muscles at different growth stages. Run the viscometer at 12 rpm (Lee et al., 1995).

soluble protein extracted from breast meat or young chicken(Table 8).

At a heating rate of 1℃/min, suspensions (pH 6.0, 6.5, 7.0) of isolated SSP were found to start forming gels from 40℃ to 55~60℃ detected by viscosity, and unfolding of peptide structure at 35℃ detected by turbidity. The pH for optimum gelation, indicated by heat-induced viscosity, was 6.0 for breast SSP and 6.5 for leg SSP. Foegeding(1987) also investigated that gels from turkey salt-soluble protein with pH 6.0 and 0.5M NaCl phosphate buffer were stable to centrifugation and had the greatest rigidity.

The SSP from breast muscle had more favorable gelation properties than that from leg muscle. The forming gel also occurred favorably in SSP from younger muscle.

In case of salt soluble protein from spent layer hen, denatured protein (turbidity change) was appeared and then became gelation (viscosity change) during heating. Viscosity of salt soluble protein heated at 65℃ for 30 min began to increase sharply above 7 mg/ml of breast protein concentration, and above 21 mg/ml of leg protein concentration, respectively. Both turbidity and viscosity showed the highest value in cooked protein solution with pH 6.0 and 1% NaCl.

Breast protein of chicken meat had higher viscosity than leg protein during heat-induced gelation. Therefore, breast protein showed lower thermal transition temperature, and better gel formation than leg protein during heating(Lee et al., 1998). These results showed same trends with those of Xiong and Brekke (1989) who also reported that breast myofibril suspensions, for all storage times, contained a greater amounts of salt soluble protein and had better gelation properties than leg myofibril suspensions.

The levels of protein solubility at various temperatures were different by species. In pork and chicken at 45℃, a high level of protein solubility was found. In hake, there was considerable loss of solubility at 45℃(Table 9). These result affected gel formation during heating. It appeared that at low temperatures (40℃-50℃) hake gels were stiffer than chicken and pork gels (due to setting); at higher temperature (60), actomyosin from all three formed gels with similar rheological characteristics(Jimenez-Colmenero et al., 1994). It is not clear that mechanisms of gel formation during heating occurs as like same mechanisms of fish gel.

Table 7. Least protein concentration of salt soluble protein for heat-induced gel forming(Lee et al., 1995)

Protein conc.(mg/ml)	4 weeks		8 weeks		24 months	
	Breast	Leg	Breast	Leg	Breast	Leg
1	−	−	−	−	−	−
2	2/5*	−	−	−	−	−
3	3/5	1/5	−	−	−	−
4	5/5	3/5	2/5	−	−	−
5	+	5/5	4/5	−	−	−
6	+	+	5/5	−	−	−
7	+	+	+	−	−	−
10	+	+	+	2/5	1/5	−
11	+	+	+	3/5	2/5	−
12	+	+	+	5/5	4/5	−
13	+	+	+	+	5/5	−
14	+	+	+	+	+	2/5
15	+	+	+	+	+	4/5
16	+	+	+	+	+	5/5
17	+	+	+	+	+	+

*Number of gel formed/Number of sample

Table 8. Turbidity of salt soluble protein(Lee et al., 1995)

Ages	Parts	Turbidity (O.D.660nm)	
		2(mg/ml)	4(mg/ml)
4 weeks	Breast	1.40	2.09
	Leg	1.35	1.95
8 weeks	Breast	1.20	1.82
	Leg	1.09	1.72
24 month	Breast	1.11	1.77
	Leg	1.08	1.67 ·

*Salt soluble protein solution(1M KCl, pH 7.0)

a-dMean values with different superscript within the same column are significantly ($P<0.05$).

Table 9. Relationship of solubility of actomyosin of pork, chicken and hake to temperature((Jimenez-Colmenero et al., 1994)

Temp (℃)	Pork	Chicken	Hake
45	94.9^{a1}	69.8^{b1}	35.4^{c1}
60	24.3^{a2}	31.4^{a2}	33.5^{a1}
70	25.1^{a2}	34.3^{a2}	29.4^{a1}

Different letters(superscripts) in the same row and different numbers (superscripts) in the same column indicate significant differences($P<0.05$).

CONCLUSION

The spent layer meat and remaining of cup-up chickens can be processed into mechanically deboned chicken meat(MDCM). The MDCM has several limits in using for in processed meat products as a main material because of poor color and textural properties, chance of microbial contamination and lipid oxidation. There has been a growing interest all over world in the application of MDCM to the surimi process. The surimi made from MDCM contains a high concentration of myofibrillar protein since this processing involves repeated washing processes with an aqueous solution in order to remove heme pigments, fat and other undesirable substances. The quality of the surimi made from

MDCM is affected by various processing factors, such as kinds of wash solution, ion strength, washing cycle, temperature, pH changes, composition, part of muscle, particle size, and rigor state etc. A number of researchers have investigated the effect of the various washing conditions on the properties of surimi gels. A fuller information of all the factors affecting surimi processing and gel formation by heat-induced gelation has not been known yet. As the physicochemical properties and composition of MDCM are different from those of fish mince, new technology of surimi preparation is required for the industrialization in Korea.

적 요

노계육이나 분할하고 남은 육계잡육으로부터 기계발골계육을 생산하고 있다. 기계발골계육은 혈액, 지방, 뼈조각, 각종 인대와 건 등이 들어있기 때문에 이것을 주원료로 육가공 제품을 생산하면 쉽게 변색되고 지방산화와 미생물 오염이 빠르며 조직감이 나빠진다. 따라서 가공적성에 방해되는 각종물질을 수세하여 제거하고 정제된 근원섬유 단백질만 회수하는 수리미(*surimi*) 제조에 관한 기술을 응용하고 있다. 원래 수리미는 일본에서 시작된 어류에서 살코기만 수세하여 정제한 "어육단백질 회수육"을 말하는데 기계발골계육에서도 기본 원리를 이용하고 있다. 그러나 어육과 축육의 이화학적, 조직학적 육특성이 다르기 때문에 수리미 제조조건에서도 차이가 난다. 기계발골계육으로부터 제조된 계육 수리미의 품질은 용액의 종류와 이온강도, 수세횟수, 온도, pH, 원료의 조성과 부위, 강직상태, 세절육의 입자크기 등에 따라 달라진다. 제조된 축육 수리미에 열을 가하여 겔(gel)을 형성하는데 있어서 열특성이 축종별로 다르고 어육단백질과도 다르다고 보고되고 있다. 아직 기계발골계육을 이용한 수리미 제조방법과 추출한 계육단백질에 열을 가해 얻어지는 겔형성에 관한 정보가 미흡한 실정이어서 계속적인 연구가 진행되고 있다. 우리나라에서도 기계발골계육으로 정제한 수리미 생산의 산업화가 요구된다고 하겠다.

(색인 : 닭고기 수리마, 기계발골계육, 수세조건, 겔형성)

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