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# EFFECTS OF MUSCLE FIBER TYPES ON GEL PROPERTY OF SURIMI-LIKE MATERIALS FROM CHICKEN, PORK AND BEEF

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## Introduction

Muscle fiber type, fiber areas and composition of specific muscles are important factors influencing many of the pre- or post-mortal biochemical processes. There are marked differences in fiber type composition of different muscles, both within and between animals, which may influence meat quality. Myofibrillar protein functionality, particularly gelation, in relation to muscle food quality, has been extensively researched. It has been suggested that the gelation properties of myofibrillar proteins are influenced by the distribution of specific fiber types in the muscles from which myofibrillar proteins are extracted. The literature concerning unfolding, aggregation and gelation of myofibrillar proteins with respect to muscle fiber type, pH and heating conditions has been reviewed by Lesiów and Xiong (2001). It was stressed that under dynamic conditions aggregation plays a major role in producing gel elasticity differences between white and red myofibrillar proteins. While many efforts have been made to elucidate effects of muscle fiber type on processed meat quality, however, there is a little information on gel properties of surimi-like materials (SLM) derived from meat animals such as chicken, pork and beef. An understanding of the characteristics of SLM from meat animals will assist in determining recommendations for how to handle the animal muscles during processing of surimi products.

## Methodology

Fresh chicken, pork and beef were purchased at a local meat market, and the surimi block of Alaskan Pollock (AP) was supported from a commercial company in Korea. All muscle samples were removed external fat tissue, and the lean muscles were diced into approximately 2 cm cubes, and ground through a 4.7 mm diameter orifice with a mincer to manufacture a surimi-like material (SLM). The SLM manufacture procedure was modified to method of Kang et al. (2004). pH of cooked SLM were measured using a pH-meter (MP230, Mettler Toledo, Swiss) and gel strength of cooked SLM was measured with a Sun Rheo Meter (COMPAC-100, Japan). The microstructure changes in muscle and gel of cooked SLM were evaluated using a field emission scanning electron microscope (FE SEM; XL30S, Philips, Netherlands). SDS-PAGE was applied to investigate changes in sarcoplasmic and myofibrillar proteins of muscles. Amino acids composition was determined using an automatic amino acid analyzer (Biochrom 20, Pharmacia, USA).

## Results & Discussion

Results showed that gel strength and hardness of cooked SLM were increased as decrease of pH (Fig. 1). The lower pH in beef-surimi speculated lower moisture, resulted in hard and strong gel strength. Different pH of AP and animal muscles might be related to difference from muscle protein composition and species. Also, the different pH had not effects on only remaining of sarcoplasmic protein in SLM against washing procedure, but also functionality of myofibrillar protein. This result confirmed reports of Lan et al. (1995) who suggested that ultimate pH differences in fish, beef and pork muscles had effects on protein extractability but that on an equal protein basis, gelation properties differed among species.

The differences in thickness and diameter of muscle fibers from chicken breast, *semimembranosus* of porcine and bovine were observed by the SEM micrographs (Fig. 2). Pork had thicker muscle fibers whereas beef had smaller diameter of the muscle fibers. This present was related with gel strength and microstructure of cooked SLM. The differences in the pattern and size of the voids in the SEM micrographs (Fig. 3) indicated much difference in the microstructure for gels by muscle fibers. As decrease of muscle fiber thickness, gel of cooked SLM showed many smaller particles of amorphous proteins that might be related with hard and strong gel structure. The gel from beef muscle showed a structure of coarse aggregates and a rough surface, and had many of smaller conglomerates. These conglomerates seem more interconnected than larger structure particles of others cooked SLM, which may explain the higher strength of the structure. Contrary, the structures of gel from chicken and pork presented larger pockets than beef gel structures in which water may have been held. This feature might be associated with water content and gel strength. Small spaces within the gel network showed the lower water content of cooked SLM derived from beef muscle. This also explains the low expressible fluid of cooked SLM. These results implied that gel texture of SLM was depending upon muscle fiber types from animal species.

Myosin ratio in myofibrillar proteins was lower in SLM from beef than those from AP, chicken and pork (Fig. 4). The myosin ratio was increased as decrease of red muscle fiber ratio, i.e. beef>pork>chicken>AP. This data suggested that the myosin ratio in SLM depended on muscle fiber types in raw muscles, resulted in gel forming ability and texture of cooked SLM. Result was agree with report of Xiong (1997) that myofibrillar proteins play the most critical role during meat processing as they are responsible for cohesive structure and the firm texture of meat products. Also, gel-forming ability differences among animal species were observed by Lan et al. (1995) and Park et al. (1996). The differences in gel texture may be related to pH of raw muscle, protein extractability and gelation, and to gel forming differences in the various myosin isoforms present. Amino acid composition analysis showed significantly ($p<0.05$) lower proline ratio of hydrophobic amino acids in pork compared with chicken and beef (Table 1). It was postulated that a three-dimensional network was established during heating process through linkages in the tail portion of the myosin molecule via hydrophobic interactions. Therefore, the structure of gel from pork presented larger pockets in which water may have been held might be due to the higher proline ratio compared with chicken or beef.

## Conclusions

The lower pH of SLM from beef muscle was related with hard and strong gel strength of cooked SLM. Chicken and pork muscles showed thicker myofibrils and larger diameter of fibers, and formed larger particles of amorphous protein in cooked SLM. Gel-forming ability and texture of cooked SLM were affected by myosin ratio in myofibrillar proteins. Ratio of myosin heavy chain was lower in SLM of beef, resulted in many of smaller conglomerates in gel and harder texture of surimi.

## References


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## Tables and Figures

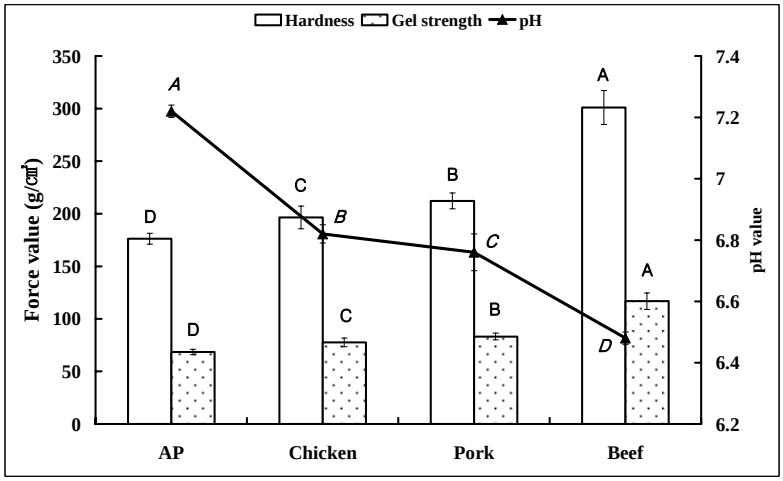
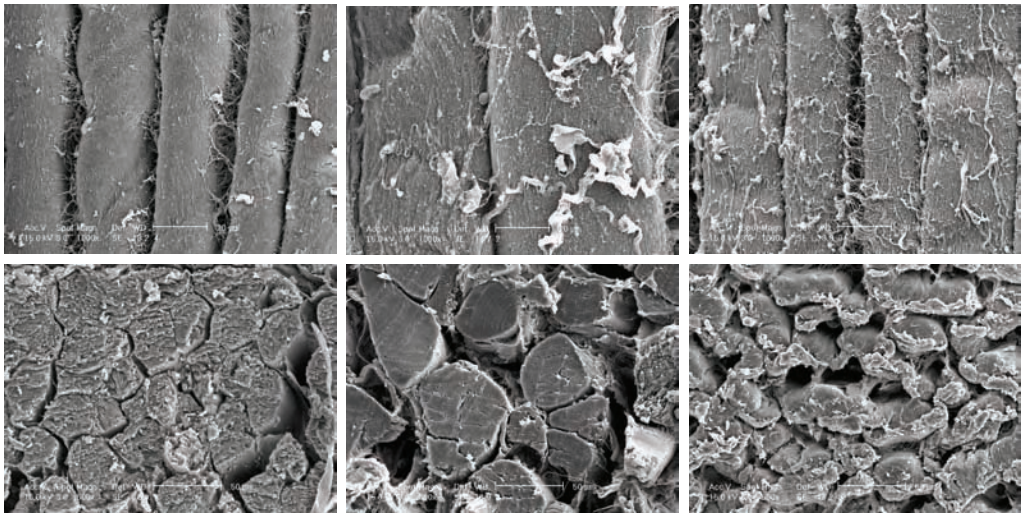
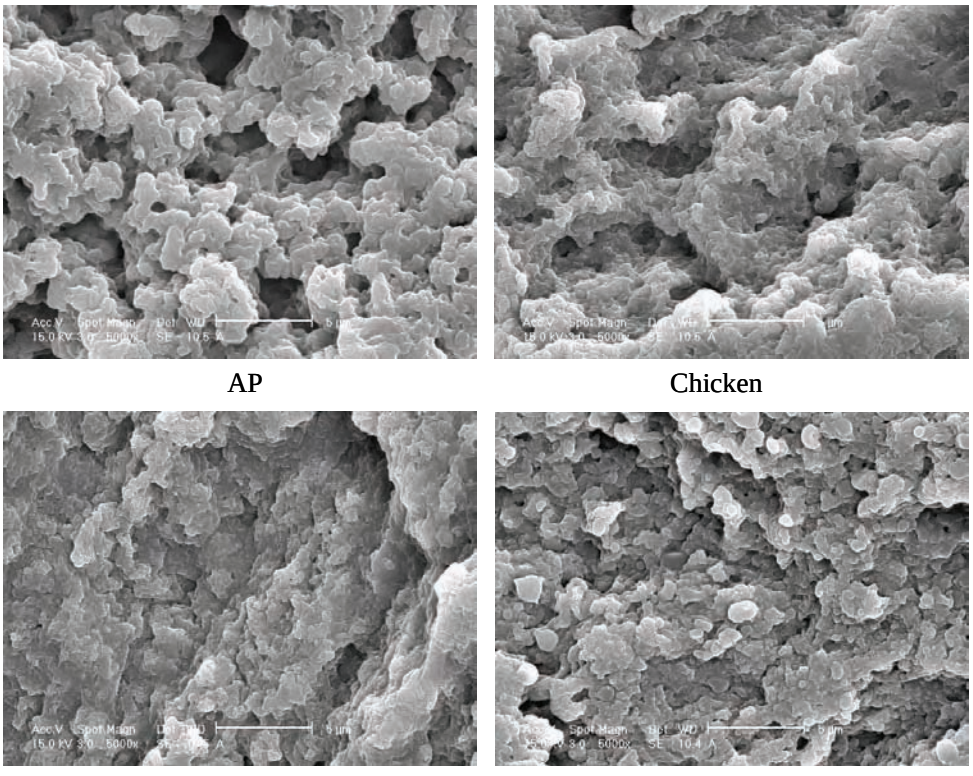



**Figure 1. pH and texture measurements of surimi-like materials from Alaska Pollack (AP), chicken, pork and beef. $^{A-D}$Means±S.D with different superscripts within a variable differ ($p<0.05$).**



Chicken Pork Beef

**Figure 2. SEM photographs of muscle fiber thickness (*upper*) and diameter (*lower*) from chicken, pork and beef.**



AP Chicken

Pork Beef

**Figure 3. The microstructures of cooked surimi-like materials from Alaska Pollack (AP), chicken, pork and beef.**

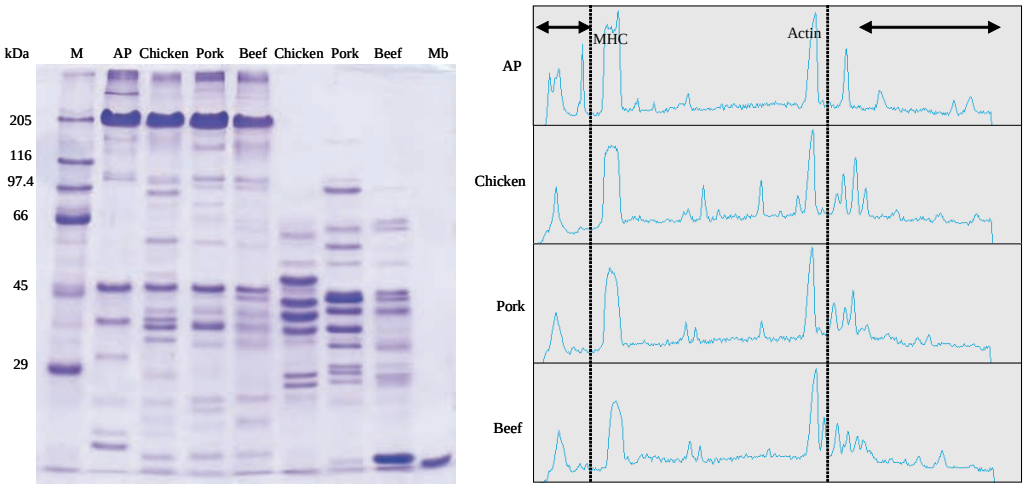



**Figure 4. SDS-PAGE patterns (*left*) and band intensity (*right*) of myofibrillar and sarcoplasmic protein from chicken breast, *semimembranosus* muscle porcine and bovine. The myofibrillar (lanes 2-5) and sarcoplasmic (lanes 6-8) protein fractions (left), which were defined as the sediment and supernatant after the first water-washing and centrifugation of the water-washed pork from chicken breast, SM of pork and beef. M and Mb denote protein molecular mass standards and horse myoglobin, respectively. AP; Alaska Pollock, MHC; myosin heavy chain.**

Table 1. Amino acid composition of surimi-like materials from chicken, pork and beef

| Amino acids | Chicken | Pork | Beef |
|---|---|---|---|
| Aspartic acid | 9.57±0.12 | 9.84±0.47 | 9.58±0.18 |
| *Threonine | 5.27±0.05 | 5.30±0.03 | 5.31±0.05 |
| Serine | 4.53±0.25 | 4.37±0.09 | 4.46±0.15 |
| Glutamic acid | 15.07±0.38 | 15.15±0.60 | 15.14±0.60 |
| **Proline** | 4.61±0.11$^{A}$ | 3.83±0.52$^{B}$ | 4.51±0.32$^{AB}$ |
| Glycine | 3.97±0.06$^{AB}$ | 3.90±0.05$^{B}$ | 4.03±0.03$^{A}$ |
| **Alanine** | 5.97±0.17 | 5.89±0.08 | 6.00±0.12 |
| Cysteine | 0.55±0.12 | 0.57±0.06 | 0.58±0.04 |
| ***Valine** | 5.19±0.28 | 5.53±0.16 | 5.26±0.15 |
| ***Methionine** | 3.05±0.09$^{A}$ | 2.84±0.07$^{B}$ | 2.79±0.08$^{B}$ |
| ***Isoleucine** | 5.30±0.36 | 5.48±0.06 | 5.48±0.04 |
| ***Leucine** | 8.85±0.17 | 9.08±0.16 | 8.79±0.10 |
| Tyrosine | 4.32±0.03 | 4.18±0.29 | 4.23±0.04 |
| ***Phenylalanine** | 4.55±0.11 | 4.52±0.23 | 4.57±0.03 |
| **Histidine* | 2.87±0.10$^{A}$ | 2.74±0.07$^{AB}$ | 2.71±0.04$^{B}$ |
| **Lysine* | 8.91±0.23 | 9.33±0.48 | 9.02±0.14 |
| **Arginine* | 7.42±0.21 | 7.45±0.16 | 7.54±0.06 |
| Total | 100 | 100 | 100 |
| *Basic amino acids* | 19.20±0.35 | 19.52±0.36 | 19.28±0.22 |
| **Hydrophobic amino acids** | 37.53±0.46 | 37.17±0.71 | 37.40±0.23 |

$^{A,B}$Means±S.D with different superscripts within row differ ($p<0.05$).
$^{*}$Essential amino acids.