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HEAT-INDUCED GELATION OF CHICKEN SURIMI

A. SMYTH[1], E. O'NEILL[1], D.J. BUCKLEY[2],
[1]Food Chemistry Department, University College, Cork, Ireland.
[1]Food Technology Department, University College, Cork, Ireland.

When chicken carcasses are boned out, the skeletal frame remains, which has a substantial amount of lean meat adhering to it. This lean meat can be recovered using mechanical deboners and is referred to as mechanically recovered poultry meat (MRPM). MRPM has a high content of fat, heme pigments, connective tissue and ash, which gives it a dark colour and makes it very susceptible to the development of rancid off-flavours. Therefore, the amount of MRPM which can be incorporated into processed poultry products without causing significant changes in quality is limited. The overall objectives of this study were (i) to upgrade MRPM by preparing chicken surimi from it and (ii) to evaluate the functional properties of chicken surimi.

Materials and Methods

MRPM was obtained from a local chicken processing factory and used immediately. Surimi was prepared from MRPM according to a modified procedure of the method outlined by Dawson et al. (1988). MRPM was suspended in three volumes of 0.5% $NaHCO_3$ (pH 8.5, μ = 0.04) at 5°C for 10 min with constant stirring. The suspension was allowed to stand for 10 min and the fat was skimmed off. The suspension was sieved (1.4 mm, 12 mesh) to give solid meat and a slurry (Slurry I). The solid meat, retained in the sieve which contained most of the connective tissue, was suspended in three volumes of 0.5% $NaHCO_3$ pH 7.5 (pH was adjusted using 60% v/v lactic acid). The suspension was stirred for 10 min. The fat was skimmed off and the suspension was sieved (1.4 mm, 12 mesh). The solid meat which was retained in the sieve was discarded and the slurry (Slurry II) was collected. Slurries I and II were combined and centrifuged at 5,000 g for 20 min. The supernatant which contained sarcoplasmic proteins was discarded. The pellet which contains myofibrillar proteins was washed twice with two volumes of deionized water at 4°C for 5 min with constant stirring. The mixture was centrifuged at 5,000 g for 20 min. The pellet, which was a refined preparation of myofibrillar proteins, is referred to as chicken surimi. Surimi was transferred to glass tubes (inner diameter 15 mm) which had been treated with Sigmacote (Sigma Chemical Co. Ltd., Poole, Dorset, England) and air dried. The tubes containing the surimi were centrifuged at 500 g for 10 min to remove dispersed gas and then stoppered to prevent evaporation. The samples were equilibrated in a water bath at 25°C for 30 min and heated to temperatures in the range of 40-90°C at a constant rate of 1.89°C/min. The samples were maintained at the required temperature for 20 min, immediately cooled in ice-water and held at 4°C for 24 h before removal of gels from the tubes for assessment of rheological properties.

The gelling properties of chicken were examined at protein concentrations ranging from 3 to 9% (w/w), at pH ranging from 5.8 to 8.0, at NaCl concentrations ranging from 0-5% (w/w) and at heating temperatures ranging from 40-90°C.

The gels were equilibrated at room temperature for 3 h and then carefully removed from the glass tubes. Selections 15 mm high were cut with a razor edge cutting device. The compressive strength of these sections was determined with a tensile testing machine (Model MK5, J.J. Lloyd Instruments Ltd., Warsash, Southampton, England) using an arrangement similar to that described by Mulvihill and Kinsella (1988). The force (N) required to compress the gels by 70% of their initial height was taken as an index of gel strength.

Results and Discussion

In twelve production trials the yield of chicken surimi obtained was 29-32%. The chicken surimi had a much lower fat, collagen and calcium content than the original MRPM from which it was prepared (Table 1). Moreover, the washing procedure used removed a considerable amount of heme pigments from the MRPM. Thus, the chicken surimi was white in colour and retained this colour on cooking.

Table 1. Composition of MRPM and Chicken Surimi in Twelve Production Trials

	MRPM	Surimi
Protein	11.5-13.3%	8.0-11.1%
Moisture	62.5-64.8%	89.0-92.0%
Fat	20.0-25.1%	0.4-0.6%
Collagen	230-240 mg/100 g	1-3 mg/100 g
Calcium	992-1100 ppm	265-272 ppm
pH	6.7-6.9	7.2-7.25

Results of compression tests on surimi gels indicated that as protein concentration increased from 3 to 9% (w/w), gel strength increased (Fig. 1). Protein concentration is considered an important determinant of the strength of muscle protein gels (O'Neill et al., 1993). The positive effect of increasing protein concentrations on gel strength is attributed to an increased number of interaction sites and increased cross-links between polypeptide chains on heating (Lee and Rha, 1979). The compressive strength of chicken

surimi gels (6% w/w) was greatest at pH 5.8-6.0 and decreased progressively as pH was increased to 7.2. No significant differences were observed in gel strength between pH 7.2 and 8.0 (Fig. 2). Since the thermal stability and the apparent heat of activation for protein-protein association (Ziegler and Acton, 1984) are greatly reduced as the pH is lowered towards the isoelectric point of actomyosin (pH ~ 5.3), it is not surprising that chicken surimi gels exhibited higher compressive strength at low pH values. As the pH is increased away from the isoelectric point increased intermolecular repulsion between protein molecules occurs and results in the formation of a loose gel network with low compressive strength. Gels formed at pH 5.8 and 6.0 had a coarse heterogenous appearance and exhibited considerable syneresis on compression. O'Neill et al. (1994) made similar observations on the appearance of rabbit actomyosin gels formed at pH 5.5. In subsequent experiments chicken surimi was adjusted to pH 6.2 before heating.
When no salt was added chicken surimi had very weak gelling properties (Fig. 3). However, in the presence of 0.5-5% (w/w) NaCl strong gels were formed. Heating temperature had a marked effect on the strength of the chicken surimi gels (Fig. 4). Little structure formation occurred at 40°C. Increasing the heating temperature to 60°C increased gel strength. There was no significant differences in gel strength when heating temperatures of 60-80°C were used. Several workers have shown that the extent of protein-protein interactions of actomyosin increases as temperature increases (Acton and Dick, 1982). Since gel strength may be considered as one manifestation of the degree of intermolecular crosslinking, it is not surprising that the compressive strength of the gels increased with increasing temperature.

Conclusions

Chicken surimi which has a white colour and contains low levels of collagen, heme pigments, calcium and fat may be prepared from MRPM. Chicken surimi has excellent gelling properties which are influenced by protein concentration, heating temperature and pH. Thus, chicken surimi has the potential to act as a binder in processed poultry products.

References

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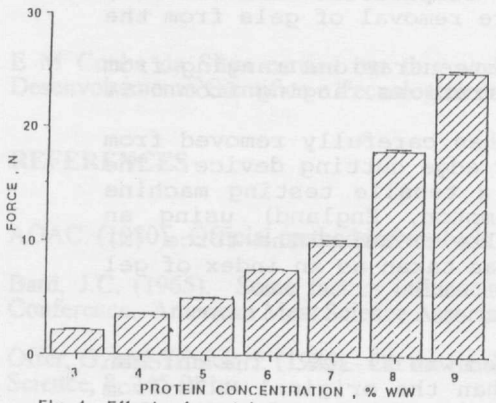

Fig 1. Effect of protein concentration on gel strength

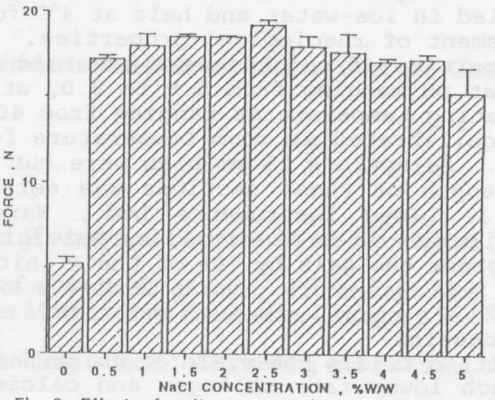

Fig 3. Effect of salt concentration on gel strength

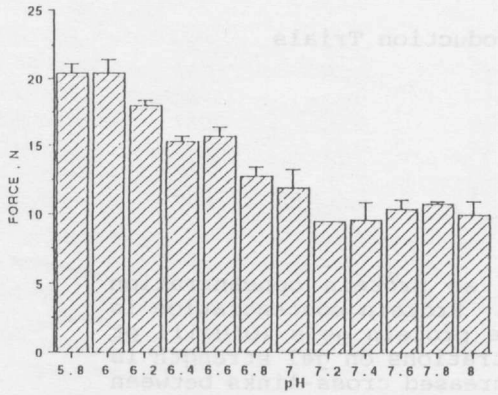

Fig 2. Effect of pH on gel strength

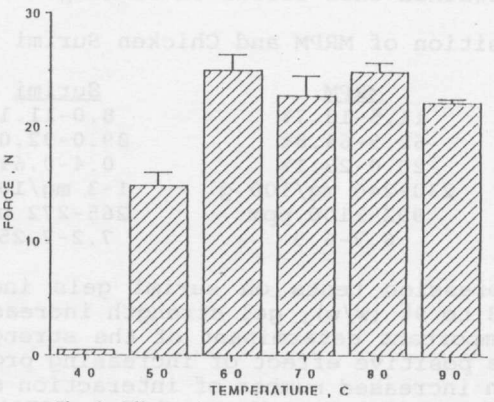

Fig 4. Effect of temperature on gel strength