4 - 13 EFFECT OF JONIC STRENGTH ON EXTRACTABILITY AND ELECTROPHORETIC PICTURE OF PROTEINS IN A CHICKEN BROILER MUSCLE TISSUE.

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The extractability of proteins,mainly actomyosin of broiler chickens breast and thigh muscles during comminuting and salting was determined.The muscle tissue homogenate prepared using a common salt solutions of ionic strength μ=0,35;0,45 and 0,55 was centrifuged and 3 fractions were obtained, i.e. colloid solution, protein sol and the residue.The increase in actomyosin extractability in the form of colloid solution and protein sol was observed as resulted from the increase in ionic strength.The actomyosin extractability of breast muscles was higher than that of thigh muscles. A remarkable part of thigh muscle actomyosin was found in the fraction of protein colloid solution, whereas actomyosin of breast muscles was determined mainly in protein sol. The electrophoretic analysis indicated various quantitative ratio of myosin to actin as dependent on ionic strengths of salt solutions used for homogenization. The ratio of myosin to actin decreased when the ionic strenght increased.The electrophoretic analysis also showed significant differences in the content of α-actinin in the actomyosin complex of colloid fraction in comparison with actomyosin complex in protein sol.

Introduction

Myofibrillar proteins play an important role in the formation of functional and technological properties of meat /Acton et.al.,1983/.In the solutions of high ionic strength, myofibrillar proteins, mainly myosin and actin, occur as an actomyosin complex.The ratio of myosin to actin in the actomyosin determines a number of functional properties of the proteins /Galluzzo and Reganstein,1978; Acton et.al.,1983/. One of the factors deciding on extractability of actomyosin is the ionic strength. In the processing of comminuted meat products, the ionic strength depends on the amount of sodium chloride and polyphosphates added to the batter.For many years,the studies on the extractability of muscle proteins in NaCl solutions, have been performed /Gillet et al.,1977,van Gord and Wesdorp, 1978/.Such studies are usually conducted under model conditions, being different from those applied in manufacture processing.A complex analysis of protein structures in comminuted meat after adding NaCl was made by Schut and Brouwer /1974,1979/.Apart from colloid solutions of proteins, they also analyzed gel fraction /sol fraction/ resulting from centrifuging of muscle homogenates in NaCl solutions.

In the present study, the effect of ionic strength on actomyosin extractability in the form of colloid solution and protein sol was analyzed.

Material and methods

The material comprised 24 chickens of White Rock breed.Slaughtering, bleeding and muscle preparation were performed under laboratory conditions.Then the muscles were comminuted /separately from breasts and thighs/ in a laboratory mincer.Total time for all the operations did not exceed 15 min.Thereafter comminuted muscles were chopped in a small laboratory chopper with the addition of ice and NaCl solution of three different concentrations /50% in proportion to meat/ which allowed to obtain three values of ionic strength in homogenates : μ =0,35; 0,45 and 0,55, with regard to physiological ionic strength of muscles μ =0,15 /Goll and Robson, 1977/.Separation of protein fractions was obtained by centrifuging

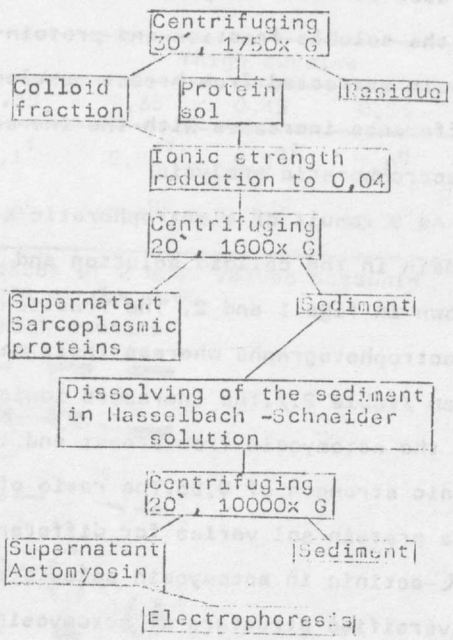


Diagram.Methods of actomyosin separation and purification

1750 x G for 30 min. after adding the NaCl solution of adequate ionic strength in the ratio 1:1 to the homogenate.Further analytical procedure is shown in the diagram.The determination of proteins was made by the biuret method by Gornall et al./1949/.Electrophoresis was made according to Porzio and Pearson /1977/ on 10% polyacrylamide gel in Tris-glicin buffer,pH 8,8 with SDS and urea.A densitometric analysis was made on DM-2 densitometer with an integrator.

Results

Extractability of proteins

Together with the increased ionic strength, the homogenate extractability of chicken breast and thigh muscles decreases, which is due to the decreased extractability of sarcoplasmic proteins, being dominant in the colloid solution.At the same time, extractability of proteins from thigh muscles of ionic strength of 0,55 and 0,35 is higher than that from breast muscles.Other results were obtained from the analysis actomyosin fraction extractability.These results are shown in table 1 as a sum of the amount of actomyosin in the colloid solution and in the protein sol.It was proved that the increased ionic strength increased actomyosin extractability, and especially large amount of actomyosin was extracted from the breast muscles of ionic strength of 0,55. The comparison of the data presented in table 1 allows to conclude that the main part of actomyosin extracted form breast muscles is found in protein sol,whereas actomyosin from thigh muscles is present in the soluble fraction and protein sol in approximate amounts.The amount of actomyosin extracted from breast muscles is higher than that from thigh muscles and the difference increases with the increased ionic strength.

Electrophoretic analysis

As a result of electrophoretic separation, 10 fractions were obtained for actomyosin in the colloid solution and 10 fractions in protein sol.The separations are shown in figs 1 and 2. The fractions of actin and myosin were identified on the electrophotographs whereas their weight ratio was calculated from the densitometric scan /table 2./.The increased ionic strength decreases the ratio of myosin to actin in the actomyosin from breast and thigh muscles and it is remarkably low at the ionic strength of 0,55.The ratio of myosin to actin in the colloid fraction and in the protein sol varies for different values of the ionic strength.The content of α-actinin in actomyosin calculated from the densitometric scans accounts for the diversified structure of actomyosin in both fractions.Actomyosin from the colloid solution is characterized by a considerably higher content of α-actinin in comparison to actomyosin in the protein sol, which at the lower ratio of myosin to actin indicates that the proteins of thin filament pass in a greater extent into the colloid fraction

Table 1. Extractability of chicken muscle proteins.

Type of muscles	Breast muscles			Thigh muscles		
Ionic strenght	0,35	0,45	0,55	0,35	0,45	0,55
Proteins in colloid fraction	$36,3^{b}$	$32,3^{c}$	$25,2^{d}$	$41,9^{a}$	$32,5^{c}$	$31,2^{c}$
Actomyosin in protein sol	$12,0^{c}$	$16,7^{d}$	$42,9^{a}$	$8,1^{e}$	$8,8^{d}$	$9,4^{d}$
Sum of actomyosins in colloid fraction and protein sol	$15,3^{e}$	$23,9^{b}$	$46,4^{a}$	$12,5^{f}$	$17,6^{d}$	$20,2^{c}$

a,b,c,d,e,f - the same letter in the indices of 2 mean values accounts for insignificant difference at $\alpha = 0,05$.

Table 2. Weight ratio of myosin to actin in actomyosin.

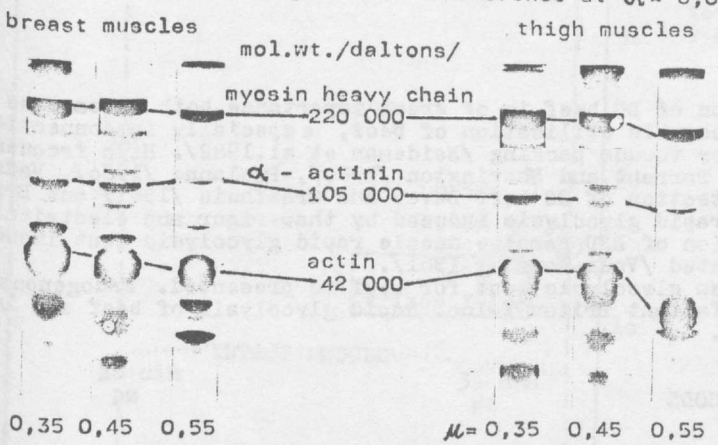
Type of muscles	Breast muscles			Thigh muscles		
Ionic strenght	0,35	0,45	0,55	0,35	0,45	0,55
Actomyosin in protein sol	$0,89^{bc}$	$0,92^{b}$	$0,66^{de}$	$1,16^{a}$	$0,83^{c}$	$0,70^{d}$
Actomyosin in colloid fraction	$0,93^{b}$	$0,88^{bc}$	$0,55^{f}$	$0,91^{bc}$	$0,74^{d}$	$0,64^{e}$

a,b,c,d,e,f - the same letter in the indices of 2 mean values accounts for insignificant difference at $\alpha = 0,05$.

Table 3. Percentage of α- actinin in actomyosin

Type of muscles	Breast muscles			Thigh muscles		
Ionic strenght	0,35	0,45	0,55	0,35	0,45	0,55
Actomyosin in protein sol	$6,8^{de}$	$6,5^{de}$	$4,1^{f}$	$5,2^{ef}$	$5,3^{ef}$	$7,0^{d}$
Actomyosin in colloid fraction	$14,1^{a}$	$14,3^{a}$	$10,0^{c}$	$10,4^{bc}$	$12,2^{b}$	$15,7^{a}$

a,b,c,d,e,f - the same letter in the indices of 2 mean values accounts for insignificant difference at $\alpha = 0,05$.



Figures 1 and 2. Electrophoresis of protein sol actomyosin.

References

Acton J.C.,Ziegler G.R. and Burge D.L. 1983: Functionality of muscle constituents in the processing of comminuted meat products.CRS Crit.Rev. Food Sci.Nutr. 18,99.

Galluzzo S.J. and Regenstein J.M. 1978: Role of chicken breast muscle proteins in meat emulsion formation: natural actomyosin, contracted and uncontracted myofibrils J.Food Sci. 43,1766.

Gillet T.A.,Meiburg D.E.,Brown C.L. and Simon S.1977: Parameters affecting meat protein extraction and interpretation of model system data for meat emulsion formation. J.Food Sci. 42,1606.

Goll D.E. and Robson R.M. 1977: Muscle proteins in Food Proteins,AVI Westport, Connecticut.

Gornall A.G.,Bardawill C.T. and David M.M. 1949: Determination of serum proteins by means of the biuret reaction.J.Biol. Chem. 177, 751.

van Oord A.H.A. and Wesdorp J.J. 1978: Solubility of meat proteins interdependence of pH, sodium chloride, phyrophosphate and intrinsic properties of the muscle. Proceed. 24th Europ.Meet. Meat Res. Workers. D 12.

Porzio M.A. and Pearson A.M. 1977: Improved resolution of myofibrillar proteins with sodium dodecyl sulfatepolyacrylamide gel electrophoresis.Biochim.Biophys. Acta. 490,27.

Schut J. and Brouwer F. 1974: The influence of the presence of fat on the water-binding properties of meat proteins.Proceed. 20th Europ. Meet. Meat Res.Workers.136

Schut J.,Visser F.M. and Brouwer F. 1979: Microscopical observations during heating of meat protein fractions and emulsions stabilized by these.Proceed. 25 th Europ. Meat. Meat Res.Work[illegible]