150. **Chemical Studies on Sex Differences of Proteins in Animals and Plants.**


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Generally, the chemical properties of animal proteins are quite different whether they are originated in different kind of animals or even in the same kind of animal, according to the different organs and body tissues, which have special physiological functions. The physiological function of any one organ in the same kind of animal is quite similar and the organ seems to form the same kind of protein. But the sexual products of male and female, which are principally composed of protein, are not the same. In the male, the sperm is composed principally of nucleic acid and strong basic protamin and histon. In the female, the egg is composed principally of cytoplasm which contains acidic vitellin and albumin. Also, casein of milk is acidic and it contains as much monoamino acids in its hydrolytic products as vitellin and ovoalbumin do. On the contrary, the hydrolytic products of basic protamin and histon contain a greater quantity of diamino acids and less of monoamino acids.

Further, from the reports of many workers on the chemical process of sperm formation we know that the process is accomplished in a very short period. In the case of salmon, when the male enters into fresh water to increase its sperm, it takes no food and yet produces a large quantity of nucleoproteid from muscle which contains little nucleoprotein. So, after having finished the formation of sperm, the muscle of its back is decreased markedly, whilst its blood becomes richer in albumose and pepton and its globulin content is doubled. Thus the generating process of purin bases from materials poor in them seems to be similar to the synthesis of imidazol rings as in the case of histidin formation in animal body. In the same way, a new-born animal rapidly generates much nucleoproteid from egg and milk protein which contains a less quantity of purin bases. From the above facts it would seem that muscle and serum-proteins which are the direct source of the formation of sexual
products, should show different physico-chemical properties between male and female. The following experiments were undertaken in order to investigate this point.

(A) Sex Differences of Muscle Proteins.

The muscle formation of animals is influenced by many physiological functions which are observed to be different in male and female. The metabolism of matter in the male is higher than that in the female, as has been measured by Benedict and by many authors who have reported that the female body is always richer in body fat than the male body is. In regard to muscle formation, the amount of fat formed in an animal body greatly influences the nature of the protein. Amino acids which are the components of protein are the amidation products of a fatty acid. If the fat formation is very great consuming the fatty acids, the amidation process results in the more acidic amino acids which would give also a more acidic nature to the muscle proteins. The authors prepared myosin and myogen from muscle by the following process and examined their physico-chemical properties.

A fresh muscle mash was extracted with 0.6% NaCl solution, filtered through a paper pulp and the clear liquid was mixed with 3/4 volume of saturated ammonium sulphate solution. The precipitated myosin was mounted in water, dialysed and precipitated with alcohol, washed with absolute alcohol and ether, dried in a H$_2$SO$_4$ desiccator. The filtrate from myosin was warmed to 51°C and freed from the precipitated residual myosin through filtration; then the filtrate was saturated with ammonium sulphate and myogen was thus precipitated. Myogen was treated as above and dried in a H$_2$SO$_4$ desiccator. The physico-chemical properties were observed as follows by different methods.

(1) In ash and phosphorus contents of myosin and myogen, which are prepared from the muscle of bull, cow, cock, hen, male and female rabbits, the quantities of both constituents are always greater in female than in male specimens. The differences are about 1—27% in ash and about 9—72% in phosphorus.

(2) When the alkaline solution of myosin and myogen prepared from bull, cow, male and female rabbits was titrated with HCl solution to get the maximum point of the surface tension and the turbidity of the solution, the female protein solution needed always a less quantity of acid than that of the male. The quantity of the HCl solution used with female proteins ranged from about 88% to 96% of that used for the male proteins.
(3) The rotatory power of the myosin and myogen alkaline solution was estimated at a definite time after dissolution. The specific rotatory power of female myosin and myogen solution is always lower ranging about 87% to 97% of that of the male proteins.

(4) The total nitrogen and the free amino nitrogen contents of myosin and myogen which were prepared from the muscle of bull, cow, cock, hen, male and female rabbits were estimated by Kjeldahl’s and Sörensen’s methods respectively. The free amino nitrogen content of the female myosin and myogen is always lower, being about 80% to 90% of that of the male.

(5) The amino acids of myosin and myogen were separated and determined by Van Slyke’s advanced method. The contents of arginin and lysin are always found to be greater in the male protein, while that of histidin is superior in the female.

(B) Sex Differences of Serum Proteins.

In connection with the formation of sexual products of male and female, some change of protein nature in blood probably occurs. Smith reported that the fat contents of blood and liver of spiders are greater in the female than in the male. Geyer stated that the female blood of Ocneriadiispar L. contains a green colouring matter which seems to be derived from chlorophyll, while that of the male contains a yellowish xanthophyll. Dewitz observed that the reducing power of the female blood of insects is greater compared with that of the male. Manoiloff and Bernatzki each proposed special reactions to distinguish the difference of sex in blood. For the detection of difference of physico-chemical properties of serum globulin between male and female, the samples were prepared by the following process.

A clear blood serum was diluted with three times its volume of water and saturated with MgSO₄ powder and, after having allowed it to settle over night, it was filtered and washed with saturated MgSO₄ solution. The precipitate was dissolved in water and dialysed for fourteen days and reprecipitated by the addition of alcohol, washed with absolute alcohol and ether, and dried in a H₂SO₄ desiccator.

Just as in the above described results of the analysis of the myosin and myogen of muscle, the following differences of various constituents and physico-chemical properties were observed in male and female serum globulin prepared from bull, cow, man, woman, male and female horses.
(1) The ash and phosphorus contents of female serum globulin are always greater by 3% to 54% than that of male.

(2) In order to obtain the maximum surface tension and turbidity the female protein alkaline solution always required about 87% to 94% of the HCl solution required for the male protein solution.

(3) The specific rotatory power of serum globulin of male is always greater than that of female and the latter is about 90—95% of the former.

(4) The free amino nitrogen of the female serum globulin is always about 77—78% of that of the male.

(5) Among the amino acids of serum protein, the arginin and lysin contents of the male specimens are always greater while the histidin content of the female is always greater.