CERTAIN PECULIARITIES OF METABOLISM IN BREEDS OF SHEEP

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In the present work an attempt is made to give the metabolic characteristics of breeds and to determine the changes occurring as a result of cross-breading, i.e., of direct action upon the germ-plasm of the organism.

The metabolic type is formed as a consequence of the organism's hereditary nature, which reflects the circumstances of its phylogenetic development, those of its habitat,and its relation to the external environment. We are trying to achieve a broad, dynamic understanding of metabolic types in terms of biochemistry as well as information on more definite and specific characteristics. To this end the following data are being investigated: a) the chemical composition of organs and tissues — taking into account variations due to the animals' species or breed, the climate, the season of the year, the physiological condition, the age, the kind of feed ration, etc.; b) the metabolic level, i.e., the quantitative nutritional requirement utilized for normal life processes — taking into account their fluctuations — and the intensity, i.e., the efficacy of the metabolic processes in relation to the body mass; c) the metabolic specificity — the transformation of aliment in the course of metabolism by specific biochemical reactions characteristic for the particular species of animals — and the metabolic direction, i.e., the comparative preponderance of one or another form of synthesis of organic matters, such as muscle, fat, milk, wool, etc; d) stability or reactivity — the degree of metabolic changes and their character, due to various influences of environment or to action on the germ plasm, e.g., by cross-breeding — to some extent they determine the adaptive capabilities of the animal; e) the regulation of metabolism — neurohumoral factors, their role in establishing interrelationships of the organism with the external environment, and in changing the metabolism to satisfy the animal's requirements under various conditions of maintenance.

The present data refer only to part of the problems we have tackled.

The peculiarities of metabolism due to breed and the metabolic changes produced by hybridization were studied on various breeds of sheep: 1) the coarse-fleeced Kurdiuchny, large, weighing 60-70 kg , yielding about 2 kg coarse wool; 2) the purebred thin staple Groznensk breed, resembling the Merinos, comparatively small, weighing 40-45 kg, yielding about 6 kg fine wool; 3) cross-breeds, obtained as a result of repeatedly cross-breeding the coarse fleeced ewes with thin staple rams for several generations; in build, appearance and quality of fleece they approach the purebred thin staple sheep; they weigh 50-55 kg and yield 3-4 kg of fine wool. The experiments were conducted at the State Ranch Sarpa, District of Astrakhan.

All the sheep were pastured on the same range; their feeding and care were identical. Some of them were brought from the range to the base camp, where they received only hay and water for 2 weeks preceding the tests.

The most conspicuous breed differences were observed in the general body mass, mainly that of the muscle, and in the quantity of wool; therefore, our principal attention was directed to the determination of the nitrogen and sulfur content of the various tissues. Sulfur was determined by the Benedict-Dennis method; nitrogen by Kjeldahl (semi-micro); protein and serum fractions were determined refractometrically; phosphorus according to Fiske-Subbarow; cholesterol according to Engelhardt and Smirnova.

The blood and tissue investigations were conducted in November, 1952, during a period when the sheep were in top shape; in September 1953 and August, 1954, a short time after weaning the lambs, when the dams had as yet put on insufficient weight following lactation and the summer heat; also during the spring of 1955 on ewes at term or post-partum.

In evaluating the breed peculiarities of blood and tissue composition, it is necessary to take into account the changes due to the season of the year, the fattening condition, etc. In the Kurdiuchny and thin-staple sheep, as well as in those of the Karakul breed [1,2], the hemoglobin, protein, and phosphorus contents of blood are higher in the fall, when the sheep are well fed, than in the summer. Breed peculiarities of the technical composition of the blood have not been elucidated as yet with respect to the above factors (Table 1).

Insignificant breed differences were found in the somewhat greater moisture content of the muscle and skin of the Groznensk sheep and in a higher content of nitrogenous materials in the skin of both groups of fine-fleeced sheep (Table 2).

More obvious differences were discovered upon investigating the sulfur contents.

The sulfur content of the whole blood, erythrocytes and serum was somewhat higher among the thin-staple sheep than among the Kurdiuchny. Higher, also, was their ratio of serum proteins, differeing by greater sulfur content, to globulins (the ratio of the Kurduichny was 2.2:4.2, that of the thin staple was 2.6:4.2). As the amount of protein increases in the blood serum, the sulfur content increases. This is quite natural, since the sulfur in the blood serum is represented almost entirely by protein sulfur: according to our determinations, non-protein sulfur constitutes only 2-6% of the blood serum of sheep. However, the sulfur content rises more slowly than the protein content, so that the unit amount of sulfur in protein becomes less when protein is at a high level (Table 3).

A somewhat higher, but variable, sulfur content was observed in the muscles of thin-staple sheep. Considerable differences could be expected in the chemical composition of the fleece, which is different in the thin-staple sheep not only in mass, but also in morphological composition, such as the absence of the soft layers of the hair which contains less sulfur than the keratin. According to our data, the minimum sulfur content of the fleece is 2.65%; the maximum is 3.98% in thin-staple breeds and 3.5% in coarse-wool breeds. On the average, a higher sulfur and nitrogen content was found in the fleece of thin-staple sheep (Table 2); the sulfur level of the coarse wool of the Karakul sheep was found to be the same as that of the Kurdiuchny – 3.1%, that of newborn Karakul lambs – 1.9%.

The nitrogen content of the wool, especially that of the thin-staple sheep, sometimes exceeds 16%, and calculating the protein content of the wool fiber (keratin) by means of the coefficient 6.25 sometimes gives values of over 100%. This permits us to consider (without carrying out special analyses) that there are present considerable amounts of nitrogenous compounds other than keratin (non-keratin nitrogen) in the thin wool.

The ratio of sulfur to nitrogen (S/N) in the serum and blood varied in different breeds and groups of sheep; generally it was higher among the thin-staple sheep. This ratio varied in the muscles of the different groups without marked breed peculiarities; in the skin, the sulfur to nitrogen ratio was considerably higher, expecially among the thin-staple sheep; in the wool, it varied within very narrow limits (20-22%), and was also somewhat higher among the thin-staple sheep.

Since the sulfur in the wool is present basically as cystine and methionine, the total amount of sulfur-containing amino acids in coarse-wool sheep was calculated to be approximately 12.3%, of pure-breed thin-staple sheep – 12.85%, and of cross-breed sheep – 13.2%; while the nitrogen combined with this cystine and methionine was calculated to be 1.5-3%, or about 10-5% of the amount usually present in wool.

The chemical composition of the blood, muscles and skin changes noticeably as a result of the living conditions of the sheep (pasture or pen), the season of the year, and the physiological condition. When the sheep were transferred from pasture maintenance to hay, the amount of water, nitrogen, and sulfur in the muscles and skin decreased. Substantial changes arose during pregnancy. There was a marked decrease in the sulfur content of the blood, and especially of the skin. The composition of the skin becomes much more labile: during insufficient or inadequate nutrition while penned or pregnant, the skin loses its nitrogeneous and especially its sulfur-containing amino acids more readily than do the muscles. This attests to its role as a reserve for the metabolic processes of the organism. This lability is more noticeable in the cross-breed sheep (Table 2).

TABLE 1

Composition of the blood in various breeds of sheep

Breed	Weight of sheep (in kg)	Number of experiments	Hemoglobin	Ash	Protein	Nitrogen		Phosphorus	Cholesterol	Total sulfur			S/N		
						Blood	Serum			Serum	Blood	Erythrocytes	Serum protein	Protein	Blood
			In %							In %			In %		
November, 1952															
Kurdiuchny	66	10	10.4	8.0	8.2	–	1.30	5.9	62	–	–	–	–	–	–
Cross-breed	55	10	9.6	8.0	7.6	–	1.20	5.8	72	–	–	–	–	–	–
September, 1953															
Kurdiuchny	59	14	9.0	7.9	7.0	–	1.00	3.9	65	83	109	118	1.19	7.8	–
Cross-breed	51	12	8.8	8.1	7.4	–	1.10	4.6	74	93	108	126	1.26	8.4	–
Groznensk	41	13	9.6	8.0	7.4	–	1.10	4.9	62	86	127	129	1.12	8.0	–
August, 1954															
Kurdiuchny	55	10	8.6	8.4	7.3	2.37	1.04	4.2	67	99	121	149	1.36	9.5	5.2
Cross-breed	47	10	9.0	6.9	6.6	2.33	1.03	4.4	71	104	130	145	1.56	10.0	5.7
Groznensk	43	10	9.1	8.4	7.2	2.45	1.07	4.3	64	107	137	156	1.54	10.0	5.7
April, 1955															
Kurdiuchny	–	10	–	–	7.0	2.49	0.93	–	–	80	88	–	–	8.2	3.3
Cross-breed	–	10	–	–	6.9	2.40	0.97	–	–	71	81	–	–	7.6	3.4
Groznensk	–	10	–	–	7.2	2.42	1.03	–	–	74	90	–	–	7.2	3.8

TABLE 2

Composition of the tissues in various breeds of sheep and its changes under different conditions of maintenance and feeding

Breed	Number of experiments	Ash (in %)		Nitrogen (in %)			Sulfur (in %)			S/N (in %)		
		Muscles	Skin	Muscles	Skin	Wool	Muscles	Skin	Wool	Muscles	Skin	Wool
Pastured												
Kurdiuchny	5	23.3	22.7	11.8	10.9	15.26	918	1 090	3.12	7.8	10.0	20.6
Cross-breed	5	23.9	22.8	13.7	12.4	15.99	950	1 512	3.57	7.1	12.3	22.2
Groznensk	5	22.2	21.1	13.3	12.4	16.31	920	1 430	3.47	7.0	11.6	21.1
Average		23.1	22.2	12.9	11.9		929	1 344		7.3	11.3	
Penned												
Kurdiuchny	4	24.8	27.3	13.2	9.5	—	718	675	—	5.76	7.1	—
Cross-breed	4	24.7	27.1	12.9	10.0	—	806	745	—	7.21	7.7	—
Groznensk	4	24.6	24.9	12.2	10.0	—	870	1 000	—	6.96	10.0	—
Average		24.7	26.4	12.8	9.8	—	731	807	—	6.6	8.3	—
Changes during transfer from pasture maintenance to pen (in %)												
Kurdiuchny	—	94	83	90	115	—	128	162	—	136	140	—
Cross-breed	—	97	84	106	124	—	118	203	—	99	160	—
Groznensk	—	90	85	109	124	—	106	143	—	100	116	—
Average		94	84	105	121	—	117	167	—	111	139	—
Pastured (Spring)												
Kurdiuchny	3	—	28.1	—	11.0	—	—	451	—	—	4.1	—
Cross-breed	3	—	26.1	—	11.8	—	—	581	—	—	4.9	—
Groznensk	3	—	28.3	—	11.5	—	—	616	—	—	5.3	—
Average			27.5		11.4			550			4.7	

TABLE 3

Sulfur content of blood and serum at different protein and hemoglobin levels

Breed	Protein (in %)	Hemoglobin (in %)	Total sulfur		
			Serum (in %)	Blood (in %)	Serum protein (in %)
1953					
Kurdiuchny	6,6	8,4	81	110	1,26
	7,7	9,5	85	103	1,10
Cross-breed		6,7		92	
	6,8	8,4	89	105	1,30
	7,6	9,8	95	114	1,25
Groznensk	7,4	8,6	85	122	1,14
	8,4	10,1	87	121	1,03
1954					
Kurdiuchny	6,3	8,3	92	117	1,45
	7,3	9,0	101	119	1,38
	8,9	10,2	107	127	1,20
Cross-breed	6,1	8,6	100	122	1,64
	6,7	9,3	107	132	1,61
		9,9		134	
Groznensk	6,8	8,2	110	143	1,62
	7,2	9,8	110	140	1,52
		10,6		143	

The results of these experiments show the presence of breed peculiarities in the chemical composition of the blood and tissues of sheep: higher amounts of sulfur in the blood serum, in the serum protein, in the whole blood, in the muscles, skin, and wool were found in the breeds of sheep producing larger amounts of wool. In cross-breeds, which were obtained as a result of repeated cross-breeding of coarse-fleeced ewes with thin-staple rams and which produce larger amounts of fine wool than the maternal breed, the composition of the blood and muscles was the same as that of pure-breed thin-staple sheep.

Marked changes in the composition of the blood and tissues were found with respect to nitrogen and, expecially, sulfur content, depending on the season of the year, the nutritional conditions, and the physiological state. Great lability of the composition of the skin was established, allowing discussion of its role as a reserve for the metabolism not only of water and nitrogenous compounds, but also of sulfur-containing substances. The lability of the tissue composition was more noticeable among the cross-breed sheep.

LITERATURE CITED

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