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The Activity of Lactate and Malate Dehydrogenases in the Blood Serum of Chickens of Various Breeds and Crossbreds

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Summary. Studies on the activity of lactate and malate dehydrogenases in the blood serum of 'Leghorn', 'Greenleg' and 'White Rock' chickens and their crossbreds have shown that:
1. The highest activity of both enzymes occurs in 'Greenleg' chicken, and the lowest in the 'Leghorn' birds.
2. The mean activity of both enzymes in crossbreds was considerably higher than that obtained for the control, purebred birds.
3. The mean activity of both enzymes was higher for crossbreds than for the whole population.

Key words: Chicken - Serum Enzymes - Crossbreds - Physiological Heterosis - Vitality of Crossbreds

Introduction

Many authors - including Lerner (1972) and Pirchner (1972) - who have studied the genetic variability and heredity of traits have drawn attention to the meaning of physiological observations, which might be used for learning about the processes conditioning the phenotype characteristics of animals, and also for finding indicators of the organisms vitality. A knowlege of relationships of this kind might be useful for breeding practice, to predict the production results. This problem has been mentioned by Kołątaj (1973) and Kusznier (1972); Rako and coworkers (1961, 1964) regarded higher productivity to be a result of special traits arising from certain biochemical processes in the organism and proposed the introduction of biochemical selection tests.

In recent years many scientists have devoted themselves to these problems with a view to explaining, in the simplest possible way, the physiological basis of useful traits and the effects of heterosis. Equally important is the question of whether or not those traits are conditioned genetically, i.e. whether they are characteristic for a breed, a type, a line or a family. It seems that the qualitative and quantitative observation of enzymes and other biologically active substances whould be very important in this respect.

For instance, Stutts et al. (1956), examining the level of glutathione in poultry in relation to egg production, found a significant negative correlation. Mannel (1966) found a correlation between the content of glucose and protein in the serum and the weight of 1-day-old nestlings. Rako et al. (1964) demonstrated changes in the activity of alkaline phosphatase connected with egg production. Martin et al. (1966), examining the level of certain enzymes in the brain of the Japanese quail, found considerable activity of dehydrogenases (lactate, malate) and aspartate aminotransferase and a relatively lower activity of aldolase and isocitric dehydrogenase.

Pavel and Svozil (1967, 1968) pointed out the relation between changes in aminotransferase and dehydrogenase activities in the tissues and blood serum and hormonal and chirurgical castration. Chand and Sapra (1973) demonstrated significant differences in cholesterol level in the blood between chickens of the 'Australorp', 'White Cornish' and 'New Hampshire' breeds and their crossbreds.

Buckland (1970), observing high LDH activity in cock semen of the 'Single Comb' meat breed and a relatively low activity of glucose-6-phosphate dehydrogenase, assumed this to be connected with the predominance of anaerobic matabolism in the semen. In turn, Mamazina and Komarova (1969) found a sig-

Table 1. Mean values of LDH and MDH activity in serum of examined birds (I.U.) ± standard error of the mean

Group of Birds	N	LDH	MDH
'Leghorn'	22	108.80±11.82	133.86± 9.33
'Greenleg'	18	165.73±15.81	201.44±19.23
'White Rock'	19	139.36± 7.43	145.21± 7.44
WR × Gl	7	149.05±12.71	197.00±16.88
Gl × WR	21	182.16± 8.64	221.33±13.12
Gl × Lg	13	166.01± 9.58	230.30±20.21
Lg × Gl	11	183.84±13.01	179.18±12.14

Table 2. Statistically significant differences of enzyme activity between examined breeds and crossbreds (Student's t Test)

Examined Groups	LDH	MDH
Lg-Gl	++	++
Lg-WR	+	
WR-Gl		+
Lg-Gl × Lg	++	++
Lg-Lg × Gl	++	++
WR-WR × Gl		++
WR-Gl × WR	++	++

\+ - significant differences
++ - highly significant differences

nificant correlation between the concentration of cock semen and its lactate dehydrogenase activity. Many workers indicate connections between enzymatic activity and pathological conditions - the relationship to be used in veterinary diagnosis.

On the basis of the such research, and continuing the previous observations on aldolase (Majewska and Kołątaj 1973), an attempt was made to obtain information on the activity of lactate and malate dehydrogenase. Investigations conducted by Zinkham et al. (1964, 1966) in a similar direction showed that in pigeon's blood the lactate dehydrogenase is controlled genetically. This was confirmed by Sganiesjan et al. (1971) on purebred and crossbred ducks.

No work dealing with this problem and concerning chickens has been found in the literature, so it seems that our investigations may contribute to further clarification of the physiological basis of heterosis, and particularly of the variability between breeds.

Materials and Methods

The observations were carried out on three-month-old chickens maintained under uniform conditions of husbandry and nutrition on an experimental farm at Michrów, in the Institute of Genetics and Animal Breeding of Polish Academy of Sciences.

For the experiment 131 chickens of the following breeds were chosen of random; 'Leghorn', 'Greenleg' and 'White Rock' and crossbreds, WR × Gl, Gl × WR, Lg × GL and Gl × Lg. The breed of the males used for mating is indicated first.

4 ml of blood was drawn from the wing vein, heparin was added and the serum divided into two parts and frozen. During the following 2 weeks the activity of enzymes was determined, only one defreeze being applied.

Lactate dehydrogenase was determined by the method of Wróblewski and La Due (1955), modified by Amelung and Horn (1956) and Haschen (1969) on a Unicam 700 spectrophometer, using a wave length of 340 mm and prepared Fermognost tests.

Malate dehydrogenase was determined by Bergamayer's (1965) method, also on a Unicam 700 spectrophotometer, using a wave length of 340 mm, and prepared Boehringer tests.

The results of the enzymes' activity are presented in international units.

Results and Discussion

The mean level of LDH and MDH activity is presented in Table 1. It can be seen that higher LDH activity among purebred individuals was observed in 'Greenleg' chickens (165.7 I.U.), followed by 'White Rock' (139.4 I.U.) with the lowest in 'Leghorn' (108.8 I.U.). The last value achieves about 60 per cent of that for the 'Greenleg' group.

Interesting results were obtained also for the crossbreds: 'Greenleg' × 'Leghorn' and 'Leghorn' × 'Greenleg' demonstrated respective values of 166.0 and 183.8 I.U., while the 'White Rock' crosses gave 182.1 and 149.0 I.U. (Gl × WR and WR × Gl, respectively).

The mean values for crossbreds of both groups were much higher than the values for purebred birds.

A similar situation was observed for MDH activity. Among purebred birds 'Greenleg' hens demonstrated the highest enzyme activity (201.4 I.U.) and 'Leghorn' hens the lowest activity (133.8 I.U.), with intermediate values being obtained for 'White Rocks' (145.2 I.U.). The 'Greenleg' × 'Leghorn' crossbreds clearly differed depending on the breed of the male - Gl × Lg (230.3 I.U.), Lg × Gl (179.2 I.U.).

The mean value of MDH activity for the crossbreds from both these groups (204.7 I.U.) was higher than the mean from the two purebred groups (167.5 I.U.).

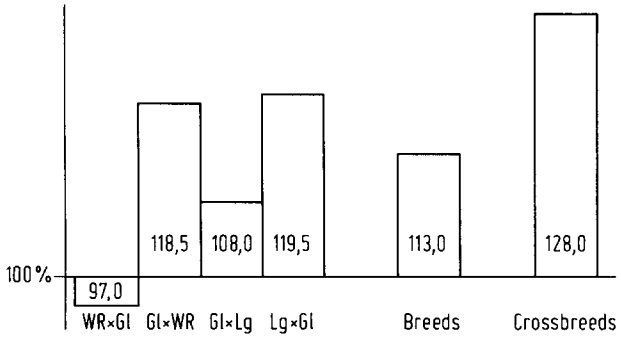

Fig. 1. The variability of LDH- enzyme activity in examined groups

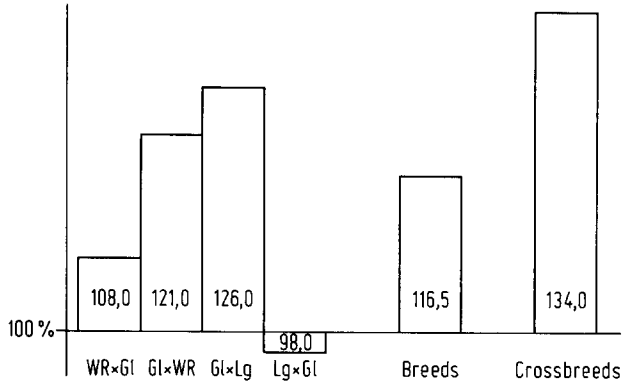

Fig. 2. The variability of MDH- enzyme activity in examined groups

This phenomenon also appeared in 'Greenleg' × 'White Rock' crossbreds where the mean for both the purebred types was 173.3 I.U. while the mean for the crossbred groups was 209.7 I.U.. However, it must be emphasised that the number of birds in the WR × Gl group was one third of that in the Gl × WR group of crossbreds.

The statistical calculations (the "t" test) collected in Table 2 show that significant differences in the LDH activity appeared between the Lg and the Gl and the LG and WR breeds, as well as between both the Gl × Lg groups of crossbreds and the Lg purebred birds. The same applies to the GL × WR crossbreds and the WR purebreds.

The differences in MDH activity were found also between the Lg and Gl and the WR and Gl breeds, and between both the WR crossbred groups and the WR purebred.

Similar differences were also demonstrated between the Lg × GL and Gl × Lg crossbreds and the 'Leghorn' breed.

The diagram of enzyme levels shows the differences obtained as being in favour of crossbreds, both in relation to the mean from the whole examined population and in relation to the control purebred birds.

The results obtained clearly demonstrate the presence of differences between breeds among the birds investigated on one side and crossbreds and purebreds on the other. These indicate the existence of a certain regularity. Majewska (1976) showed that in relation to aldolase and aminotransferase AspAT and ALAT no such phenomenon appeared. 'Greenlegs' demonstrated rather medium values in relation to other breeds.

The results obtained for the crossbreds are unequivocal. They are significantly higher than those for the control birds, higher than the values obtained for the whole population. Similar results were obtained by Dembowski (1976) for the activity of aldolase and aminotransferases in rabbits and by Szwarocka-Priebe (1976) for glutathione reductase activity in chickens.

This seems to indicate a "physiological" heterosis effect which, considered within the framework of the general problem of the known increased vitality of crossbreds, may be connected with their greater productivity and more economic metabolism (Kołątaj 1973). On this basis the authors suggest the need for further observations on the substrate-metabolite relation in the tissues of purebred and crossbred birds. Such investigations may be important in connection with quantitative physiological and biochemical polymorphism in farm animals, and thus, their productivity.

Literature

Amelung, D.; Horn, H.D.: Fermentaktivitäts-Bestimmungen in Serum beim Herzinfarkt. Dtsch. med. Wschr. 81, 1701-1704 (1956)

Bergmayer, H.U.: Methods of enzymatic analyses, p. 757. Weinheim: Verlag Chemie 1965

Buckland, R.B.: Some enzyme activities in chicken spermatozoa, Poultry Sci. 49, 1638-1641 (1970)

Chand, D.; Sapra, K.L.: Egg yolk lipid and cholesterol concentration in Australorp, White Cornish, New Hampshire and their reciprocal crosses. Ind. J. Poultry Sci. 8, 123-130 (1973)

Dembowski, J.: Aktywność aldolazy, fosfatazy alkalicznej i kwaśnej oraz aminotransferazy asparaginowej i alaninowej w osoczu krwi królików różnych ras i mieszańców (doctors thesis)(1976)

Haschen, R.J.: Laktat-Dehydrogenase. In: Emmrich, R.: Arbeitsmethoden der Inneren Medizin und ihr verwandter Gebiete, Bd. V; Klinisch-chemische Labormethoden, 2. Liefg., 196-8, S 106, Fischer: Jena (1969)

Kołątaj, A.: Biologiczne podstawy heterozji P.W.N. Warszawa (1973).

Kusznier, Ch.F.: Genetyczne i fizjologiczne podstawy zjawiska heterozji. Zjawisko heterozji u zwierząt - Praca zbiorowa, Red. Nauk. 25-55. Wrocław-Warszawa-Kraków-Gdańsk: Wydawnictwo Ossolineum 1972

Lerner, M.J.: Heterozja a przyszłość postępu w hodowli. Zjawisko heterozji u zwierząt - Praca zbiorowa, 141-158 Wrocław-Warszawa-Kraków-Gdańsk: Wydawnictwo Ossolineum 1972

Majewska, H.: Aktywność aldolazy, aminotransferaz: asparaginianowej i alaninowej oraz poziom glukozy w osoczu krwi kur różnych ras i mieszańców (doctor's thesis) (1976)

Majewska, H.; Kołątaj, A.: Obserwacje nad poziomem aldolazy i glukozy w osoczu krwi różnych ras. Praca i materiały zootechniczne 3, 77-80 (1973)

Mannel, K.: A hematological study of the Black Australop in relation to certain economical characteristics. I. Blood glucose. South Afr. J. Agric. Sci. 9, 577-593 (1966)

Mamazina, E.A.; Komarova, V.V.: Studies of some redox enzymes in cock semen. Zap. Leningr selekhoz. Inst. 112, 171-178 (1969)

Martin, K.D.; McFarland, L.Z.; Freedland, R.A.: Normal level of selected enzymes in the brain of *Coturnix*. Poultry Sci. 43, 588-594 (1966)

Pavel, J.; Svozil, B.: Enzimaticka aktivita jaterni a svolove tkane u kohoutu po jajich horminalni nebo chirurgicke kastraci. Acta Univ, agricult a. 15, 633-641 (1967)

Pavel, J.; Svózil, B.: The distribution of lactic dehydrogenase isoenzymes in the blood serum of surgically and hormonally castrated cockerels. Poultry Sci. 47, 91-95 (1968)

Pirchner, F.: Views on the essence of heterosis and the prospects of ulilizing its effects in animal breeding. Zjawisko heterozji u zwierząt - Praca zbiorowa, 5-24. Wrocław-Warsazwa-Kraków-Gdańsk: Wydawnictwo Ossolineum 5-24 (1972)

Rako, A.; Dumanowski, F.; Mikulec, K.: On the relation between the laying capacity and the activity of some enzymes. The level of serum proteins and blood sugar in hens. Poultry Sci. 41, 201-205 (1964)

Rako, A.; Dumanowski, F.; Mikulec, K.: Odnos kolicina ukupne bjelančevina i pojedinih njezinih funkcija te aktivnost krvne lipaze prema zavrsnoj tezini u tovu pilica. Vet archiv 31, 319-323 (1961)

Sganiesjan, S.S.; Krapietian, A.M.; Czilinganjan, A.A.: Sravitielnaja charakteristika isofermientow laktatdehydrogenazy utok i ich gibridow, Ajastani Gienspanakam anties. Bioł. zoiw Armenii 24, 9, 3-12 (1971)

Stutts, E.C.; Briles, W.E.; Kunkel, H.O.: Blood glutathione levels and egg production in inbred lines of chickens. Poultry Sci. 35, 727-728 (1956)

Szwarocka-Priebe, T.: Poziom wolnych grup sulfhydrylowych w wybranych tkankach kur różnych ras i mieszańców (doctor's thesis) (1976)

Wróblewski, F.; La Due, J.K.: Lactice dehydrogenase activity in blood. Proc. Soc. Exp. Biol. 90, 210-213 (1955)

Zinham, W.H.; Blanco, A.; Kupchyk, K.: Lactate dehydrogenase in pigeon testes, genetic control by three loci. Science 144, 1353-1354 (1964)

Zinkham, W.H.; Kupchyk, L.; Blanco, A.; Insensee, H.: A variant of lactate dehydrogenase in somatic tissues of pigeons, physicochemical properties and genetic control. J. exp. Zool. 162, 45-55 (1966

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