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Effect of Giving Insulin and Adrenalin Alternately on Changes in the Level of Blood Glucose in Chickens of Different Breeds

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Summary. Differences in reaction to exogenous insulin and adrenalin were studied among chickens of 'Leghorn', 'White Rock' and 'Rhode Island Red' breeds, using level of blood glucose as indicator of the reaction to hormones. It was found that: 1.) The physiological quantity of glucose in blood in chickens of the three breeds ranged from 157 to 194 mg%. 2.) The reaction of chickens to insulin and adrenalin given alternately, measured by changes of blood glucose, differed according to the breed. The smallest reaction to hormones was in 'Leghorn', the biggest in 'White Rock'. 3.) The chickens of 'Leghorn' and 'Rhode Island Red' breeds, as well as 'Leghorn' and 'White Rock' breeds, differed significantly in maximal glucose level after adrenalin, 4.) The correlation between the normal quantity of blood glucose and the body weight of birds appeared highly significant in cockerels of all three races combined.

Key words: Chickens - Insulin - Adrenalin - Blood Glucose - Physiological Traits

Introduction

The determination of a close relationship between utilitarian and biochemical features would help selection criteria to be more objective and make exact determination possible in early life. Such a relation has been found already e.g. between activity of some enzymes and quantity of total nitrogen in blood and the weight of calves (Miniejev and Kudriaszov 1971).

Many scientists have found interracial differences in enzyme activity, e.g. Guszkiewicz and Dembowski (1971) in cattle, Majewska (1976) in hens, Rako et al. (1964) in hens, Smirnov and Biedmanikaszvili (1969) in pigs, Dembowski (1976) in rabbits, and in level of many metabolites in blood of various species (Ioshi et al. 1963; Kirilov 1968; Kołątaj and Majewska 1973; Weisner et al. 1965; Gondko et al. 1977).

Many workers have examined the level of glucose in connection with utilitarian features and interracial differences. According to Bierus et al. (1968) the quantity of glucose in cattle blood differentiates breeds and represents the intensity of metabolism occuring in the organism. This was verified by Steć (1974), Rattan et al. (1968), Chandler et al. (1968), Pakuliev and Biriukova (1974). These authors concluded that selection for high blood glucose content looks promising because not only does it give a high growth-rate in calves, but also it can protect adult animals from certain metabolic disorders.

For poultry, Kirilov (1968) found that the level of blood sugar was always lower at age 0 to 90 days in crosses of chickens than in pure-bred ones. Kołątaj and Majewska (1973) found that some hen races differed significantly in blood glucose content, but there is no reason to believe that this character is determined by genetic factors.

Rako et al. (1964), investigating the level of blood glucose in 'Leghorn' before and during the laying period, did not find a significant correlation between sugar content and laying capacity. It follows from Mannel's (1966) research that there is a positive correlation between the level of glucose in blood of hens, their age, and the rate of puberty, and a negative correlation with the weight of a one-day-old chickens.

The purpose of the present study was to investigate the range of reaction in chickens of three races to exogenous insulin followed by adrenalin given in vivo. The intention was to find (in connection with studies on the genetic basis of physiological characters of hens) whether the chickens demonstrated significant differences in the rate and range of these reactions, measured by changes in the level of blood glucose.

Table 1. The mean glucose level (mg %) in blood in the cockerels of examined racial groups

Racial group (mean body weight g)	Minutes after insulin injection						Minutes after adrenalin injection										max-min
	n	0	30	60	90	Decrease of glucose level-response to insulin	120	150	180/0	30	60	90	120	150	180	Increase of glucose level-response to adrenalin	
		A			B	(A - B)			C						D	(D - C)	(D - B)
'Leghorn' (1575)	20	165	117	99	94	71	95	102	105	131	142	144	168	169	167	62	73
'Rhode Island Red' (2050)	18	157	119	98	95	62	98	109	108	120	132	148	152	172	192	84	97
'White Rock' (2200)	10	171	101	90	83	88	90	103	101	119	135	156	169	198	198	97	114

A - The normal level of glucose - before insulin injection
B - The period of the biggest decrease of glucose level in relation to the normal level
C - The period after 180 minutes after insulin injection in which adrenalin was injected
D - The period after 180 minutes after adrenalin injection in which the level of glucose was the highest

Corroboration of eventual differences would give reason to believe that the range of the reaction is determined by race, indicating a genetic basis.

In spite of much research, the way insulin acts is not known in detail, but it seems that birds are generally less responsive to exogenous insulin than mammals (Sturkie 1976).

It is understood that adrenalin raises the level of glucose in blood and is one of the more important factors counteracting the hypoglycemic action of insulin. The injection of adrenalin into domestic birds provokes transition hyperglycemia, but the reaction is not very pronounced (Sturkie 1976). Up to now there has been no certainty that hens are less responsive to adrenalin than mammals.

This study also attempted to investigate whether or not any correlation existed between the weight of birds and the level of blood glucose, as well as the range of changes in the blood glucose level reflecting posthormonal reaction.

Materials and Methods

Animals

In the experiment 20 'Leghorn' cockerels weighing 1100 to 2200 g, 18 'Rhode Island Red' cockerels weighing 1500 to 2500 g and 8 hens and 10 cockerels of 'White Rock' breed 1600 to 3000 g in weight were used, all in the age range of 12 to 14 weeks. The birds were from those raised at the farm of the Institute in Jastrzębiec. They were maintained on a standard fodder and were healthy; before blood collection they were starved for 12 hours, although supplied with water.

Animal experiments

Each starved chicken, after the control sample of blood had been taken (agreed time "0"), was given an injection of insulin to the *musculus pectoralis* at the rate of 5 I.U./1 kg body wt. Subsequently, blood samples were taken every 30 minutes for three hours. After that period, when it was assumed that there had been no more changes in blood glucose level, the intramusular injection of adrenalin was given at the rate of 100 μg/1 kg and again for 6 hours the samples of blood were collected every 30 minutes. During the 6 hours 13 blood samples were taken from each chicken. The blood was collected in vivo by pricking the wing vein with a needle.

Determination of glucose

The blood samples were put into an isotonic solution of cupric sulphate, deproteinized with sodium wolframate and centrifuged. Glucose in the plasma was assayed spectrophotometrically by the method of Asatoor-King (King and Wootton 1956). The values were read at λ = 660 nm.

Materials

Swine insulin (*insulinum crystallisatum*) in water solvent and adrenalin-Polfa (*adrenalinum hydrotartaricum;* made by Polish Pharmaceutical Factories POLFA) in physiological salt were used in the experiment.

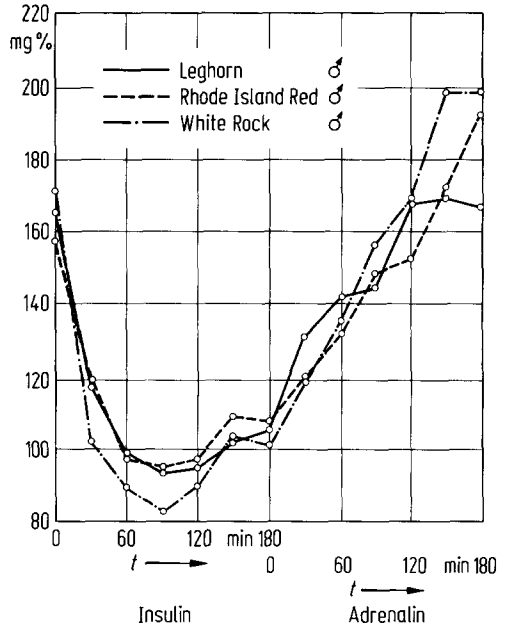

Fig.1. The curves illustrating glucose level changes in blood in examined cockerels

In the experiments carried out contemporaneously some control observations were made, which consisted of watching the changes of blood glucose level in 'Leghorn' cockerels after injecting them with 2 cm^3 of 0,9 % NaCl. The results indicated that the level of glucose fluctuated in the collected blood from 2,8 % to 10,1 % of the initial values.

For testing whether or not the the prospective differentiae would be significant statistically, numerical results were analysed using the two-sample Student t-test between the means.

The experiments were conducted in July.

Results and Discussion

The mean values of blood glucose are presented in Table 1. The data concerning significant differences between groups are shown in Table 2, and the curves illustrating glucose level changes in respective groups are shown in Fig.1.

The normal blood glucose level fluctuated on average from 157 to 194 mg % in chickens of the examined races. The results were similar, taking into consideration the considerable divergence in the papers, to those obtained by other authors (Balsch et al. 1973; Ewy 1969; Sturkie 1976).

In all groups, the minimal level of glucose occurred 90 minutes after insulin injection; the level of sugar then increased very slowly until 150 minutes after the insulin injection. This shape of the glucose curve conforms to the experiments conducted with sheep (Skubis 1969), with rabbits (Lacey cf. Krzymowski 1973) and with hens (Sturkie 1976). The most distinct reaction to insulin was in 'White Rock' cockerels - the level of glucose was at its highest at the beginning of the experiment and after 90 minutes it was at the lowest point. The quantity of glucose decreased from 171 mg % to 83 mg %, i.e. 88 mg %. In 'Leghorn' cockerels the level of flucose went down during that period 71 mg % (from 165 mg % to 94 mg %) and in 'Rhode Island Red' cockerels 62 mg % (from 157 mg % to 95 mg %).

So the smallest reaction to insulin after 90 minutes following injection was in cockeres of 'Rhode Island Red' and of 'Leghorn' (the level of glucose decreased 39,5 % and 43 % of the initial value respectively), and the most intense reaction was in 'White Rock' cockerels (the level decreased 51,5 % from the initial quantity of glucose).

Between 150 and 180 minutes after insulin application no changes were observed; during those 30 minutes the level of blood glucose within each race was stable - allowing adrenalin to be injected.

After the adrenalin injection the quantity of glucose in blood plasma began to rise uniformly and attained a maximum three hours after hormone injection.

The largest quantity of glucose after adrenalin - 198 mg % - was observed in 'White Rock' cockerels. They also reacted to adrenalin with the largest absolute augmentation of glucose level, amounting to 97 mg % (from 101 mg % to 198 mg %). The smallest rise in quantity of glucose, amounting to 62 mg % (from 105 mg % to 167 mg %), occurred in 'Leghorns' and the intermediate one - 84 mg % (108 mg % to 192 mg %) - in 'Rhode Island Red' cockerels. So the augmentation of the level in relation to the value of glucose at the moment of injection of adrenalin totalled, in relative values: in 'Leghorn' breed - 59 %, in 'Rhode Island Red' breed - 77,7 %, in 'White Rock' breed - 96 %.

As can be seen in Table 2, statistically significant differences within normal values of glucose were found only in the 'White Rock' breed, between hens and cockerels. Such differences were not found among the racial groups of cockerels.

Table 2. The data about the significance of differences in glucose level in blood in examined groups of cockerels

Racial group	A The normal blood glucose level	B The minimal blood glucose level (90 minutes after insulin injection)	C The level of blood glucose at the moment of adrenalin injection	D The maximal blood glucose level (180 minutes after adrenalin injection	The difference between the maximal and minimal level of blood glucose
	mg %	mg %	mg %	mg %	mg %
'Leghorn'♂	165	94	105	167	73
'Rhode Island Red'♂	157	95	108	192	97
'White Rock'♂	171	83	101	198	114
'White Rock'♀	194	65	101	218	154

The mean values differing statistically significantly (at 5 % level of significance) are connected by lines.

Similar differences (and the lack of them) appeared when the values of glucose at the peak of "depression" (90 minutes after insulin acted) were compared.

The injection of adrenalin made it possible to obtain statistically significant differences at the moment of maximal glucose level between the 'Leghorn' and 'Rhode Island Red' cockerels and between the birds of 'Leghorn' and 'White Rock' breeds.

The absolute difference between the maximal and minimal level of glucose, after the injection of adrenalin and previous insulin injection, was highest in 'White Rock' cockerels, the intermediate in 'Rhode Island Red' birds, and least in 'Leghorns'. Thus it appeared also in relative differences, viz. in 'White Rock' birds 66,7 %, in 'Rhode Island Red' birds 61,8 % and in 'Leghorns' 44,2 %. When such comparisons were made within the 'White Rock' breed, statistically significant differences were observed between hens and cockerels.

The correlation between the normal quantity of glucose of blood plasma and the body weight of birds appeared highly significant in cockerels of all three races combined. The correlation coefficient r_{xy} was 0,782 and was highly significant. ($t_{0,01} = 2,678 < t_{emp.} = 8,514$).

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