A POSSIBLE USE OF BLOOD ANALYSIS IN THE SELECTION OF BEEF ANIMALS WITH SUPERIOR GROWTH POTENTIAL

L'emploi possible de l'analyse du sang dans la sélection des animaux à viande ayant un potentiel supérieur de croissance

Eine Verwertungsmöglichkeit der Blutanalyse bei der Zuckwahl von Fleischrindern mit höheren Wachstumspotenzial

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Introduction

Progeny testing of beef animals generally follows one of two methods: either to keep progeny together under closely controlled husbandry at one centre, or to place progeny at different farms and compare their performance with those of their contemporaries. Theoretically, the latter method is advantageous because it enables bulls to be tested over a large range of environments. Practically, however, it is difficult to control, and factors such as the effect of season and fluctuation in management within farms cannot satisfactorily be taken into account. Keeping progeny together in one environment is preferable from the point of view that the data collected are reliable, but any interactions between genetics and systems of rearing and management cannot be taken into account. Thus there is no guarantee that the «superior bulls» selected on the basis of this type of progeny test will necessarily produce off-spring which will grow well when conditions of feeding and husbandry become less favourable.

As the costs of feed increase the ability to select calves which grow faster under such conditions will become more important. Research at this Institute (Payne, Rowlands, Manston, Dew and Byrne, 1973; Rowlands, Payne, Dew and Manston, 1973, 1974; Kitchenham, Rowlands, Manston and Dew, 1974) has demonstrated that it may be possible to identify such animals from their «metabolic profiles», based on assessments of their blood chemistry. Growth rates of beef animals under certain planes of nutrition have been shown to be related to components of their individual metabolic profiles, but the relationships differ from one environment to another. These inconsistencies in patterns may occur because

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some relationships may only appear when the dietary intake of a particular nutrient is limiting. It has also been shown that concentrations of some blood constituents are under genetic control. This suggests that an assessment of the blood chemistry of bulls may complement progeny and performance tests in the selection of bulls for breeding for particular systems of husbandry. This paper assesses the potential value of the use of blood analysis in a breeding programme, summarising some of the results obtained at this Institute.

Although other blood constituents are included in an individual's metabolic profile, only the following 6 need to be considered here: blood glucose and haemoglobin, serum albumin, inorganic phosphate, sodium and potassium. The methods of chemical analysis have been described by PAYNE, DEW, MANSTON and FAULKS (1970); MANSTON and ROWLANDS (1973).

HERITABILITY

Most of the evidence that blood chemistry is under genetic control has been provided from an experiment involving 231 Hereford × Friesian calves, the progeny of 12 sires, sampled at the Milk Marketing Board Beef Improvement Centre, Warren Farm, Berkshire. Blood samples were taken from each calf on 3 occasions at 9, 10 and 11 weeks of age.

Heritability estimates are shown in Table 1. All blood constituents, except sodium, showed significant relationships to the sire ($P < 0.01$) with estimates for haemoglobin and blood glucose above 0.7. These results, however, are complicated by the fact that the 12 bulls were selected by two panels, 6 by each, for breeding in 2 distinct areas of the country. Eliminating regional differences the heritability estimate for glucose was reduced to 0.18.

TABLE 1

HERITABILITY ESTIMATES OF THE CONCENTRATIONS OF BLOOD CONSTITUENTS, BASED ON 3 SAMPLES AT 9, 10 AND 11 WEEKS OF AGE, AND OF GROWTH RATE FROM 1-12 WEEKS DETERMINED FROM 231 CALVES, THE PROGENY OF 12 SIRES, AT THE M. M. B. BEEF IMPROVEMENT CENTRE, WARREN FARM, BERKSHIRE

	Glucose	Haemo-globin	Potas-sium	Sodium	Inorganic phos-phate	Albumin	Growth rate
Heritability (h^2)...	0.74	0.93	0.40	0.09	0.26	0.28	0.27
S. E.	0.32	0.36	0.23	0.12	0.18	0.19	0.19

Significant sire effects have also been observed at two other farms, where the number of off-spring per sire were smaller — for potassium, at both farms, and glucose, sodium and albumin, each at one farm.

CORRELATIONS WITH GROWTH RATE

Simple correlation coefficients, calculated on an «among calf within sire» basis in the above experiment, are shown in Table 2. Growth rate from 1-12 weeks was

TABLE 2

SIMPLE CORRELATION COEFFICIENTS DESCRIBING THE RELATIONSHIP BETWEEN GROWTH RATE FROM 1-12 WEEKS, BODY WEIGHT AT 6 AND 9 MONTHS AND THE AVERAGE CONCENTRATIONS OF BLOOD CONSTITUENTS IN 231 CALVES AT M. M. B. BEEF IMPROVEMENT CENTRE, WARREN FARM, BERKSHIRE

	Glucose	Haemo-globin	Potas-sium	Sodium	Inorganic phos-phate	Albumin
Growth rate 1-12 weeks	0.46 *	0.24 *	— 0.11 *	0.31 *	0.28	0.38
6 month weight	0.35 *	0.08	0.03	0.34 *	0.31	0.36 *
9 month weight	0.30	0.08	— 0.02	0.30 *	0.32	0.38 *

* These were significant ($P < 0.01$) on a partial correlation basis.

most closely correlated with blood glucose concentration ($r = 0.46$). In a multiple regression analysis the effects of haemoglobin, sodium and potassium were also highly significant ($P < 0.01$). Relating blood concentrations with subsequent body weights at 6 and 9 months, simple correlations persisted for albumin, inorganic phosphate and sodium, but the correlation for blood glucose was reduced by 9 months, and the correlations for haemoglobin and potassium became non-significant (Table 2). On a partial correlation basis only sodium and albumin were significant ($P < 0.01$) at 9 months.

The change in relative importance of glucose and albumin from 12 weeks to 9 months suggests that the albumin concentration in the blood of a young calf may be a better indicator than glucose concentration of its long-term growth potential. A high glucose concentration appears to be at more of an advantage early in life; this has been observed in other environments when animals are reared to grow at moderate rates of about 0.5-0.75 Kg/day, as in this experiment, but not when animals grow at much faster rates.

The correlation between growth rate from 1-12 weeks and haemoglobin concentration probably reflects the ability of calves with high haemoglobin concentrations to grow faster prior to weaning than those with low concentrations. BREMNER and DALGARNO (1973) observed a similar effect in veal calves. The fact that the correlation later became non-significant suggests that the calves with the lower haemoglobin concentrations compensated in growth.

Albumin and potassium are the two constituents for which relationships with growth rate appear to occur most frequently in different environments. Such relationships were found at Meat Livestock Commission Beef Performance Centres at Holme Lacy, Herefordshire and Stoneleigh, Warwickshire. Thirty-three bulls from each centre were sampled on three occasions at 6 weekly intervals from 8 to 11 months of age. Growth rate was correlated with potassium ($P < 0.05$) at Holme Lacy, and with albumin ($P < 0.05$) at Stoneleigh.

SELECTION

It is clear from the Warren Farm experiment that the concentrations of some blood constituents are under genetic control, and these findings are in agreement

with WIENER and FIELD (1971). However, it has yet to be established whether the concentrations in the blood of the calf correlate with those in the blood of its sire. Thus the possible response in growth rate of calves to indirect selection for blood concentrations in the sire cannot be readily estimated from the present results. Blood samples are now being taken from the sires involved in the progeny test, and calculation of genetic correlations between growth rate of calves and blood concentrations of sires may provide an initial estimate of the response that might be achieved by indirect selection.

Tentatively, at this stage of the work, albumin and haemoglobin concentrations appear to offer most promise. Repeatability estimates for these constituents have been found to be high and consistent over long periods of time. Sixty-four Friesian bulls undergoing milk progeny tests were sampled on three occasions between March and October, 1973. Repeatability estimates, eliminating differences between studs, were 65 % and 70 % for albumin and haemoglobin respectively. Albumin concentrations appear to correlate well with long-term growth, but it remains to be seen whether the heritability of this constituent is sufficient to allow a satisfactory prediction of the performance of a bull's off-spring from its own serum albumin concentration. A bull maintaining a high haemoglobin concentration may be suited to sire calves to be grown for veal.

Although there is evidence that concentrations of glucose and potassium analysed in the blood of calves are under genetic control, concentrations of these constituents in the blood of bulls may not be sufficiently repeatable. Repeatability estimates from the experiment involving Friesian bulls were 32 % and 23 % respectively for potassium and glucose. Further, it may be that the glucose concentrations in calves do not correlate with those of their sires, for glucose concentrations are higher in the non-ruminating calf than in the adult animal.

More research is clearly needed before a profile pattern which fits the needs of future beef systems can be determined. The answer may not be simple, for it may be more important to retain flexibility and select animals from a diverse population than to attempt to breed the «ideal» calf.

SUMMARY

The composition of the blood of calves has been shown to be under genetic control. Heritability estimates of 0.9, 0.7, 0.4, 0.3 and 0.3 have been observed for the concentrations of haemoglobin, glucose, potassium, inorganic phosphate and albumin respectively, in the blood or serum of 231 calves, the progeny of 12 sires. Moreover, in various environments higher or lower concentrations of certain blood constituents have been associated with higher growth rates in the calves possessing them. This paper describes results of analyses carried out on blood from bulls and calves living in a number of environments, and discusses their possible use in complementing breeding programmes using progeny or performance testing.

RESUME

La composition du sang des veaux a été démontré d'être sous contrainte génétique. Dans le sang ou sérum de 231 xeaux — descendants de 12 pères — des

estimations d'héritabilité de 0,9; 0,7; 0,4; 0,3 et 0,3 ont été observé pour des concentrations respectives d'hémoglobine de glucose, potassium, phosphate inorganique et d'albumine. En outre, les veaux possédant une croissance accélérée et provenant de divers milieux ont été associé à de hautes ou basses concentrations de certains de leurs elements sanguins. Cet article présente les résultats des analyses du sang provenant de taureaux et de veaux vivant dans différents milieux et discute de leur utilité possible en tant que complément à des programmes d'élevage basés sur les épreuves de descendance et de performance.

ZUSAMMENFASSUNG

Es wurde bewiesen, dass die Zusammensetzung des Blutes von Kälbern unter genetischer Kontrolle steht. Bei Blut oder Serum von 231 Kälbern, die von 12 Vätern stammten, wurden Vererbungsschätzwerte von 0.9, 0.7, 0.4, 0.3 und 0.3 respektive für Hämoglobin, Glukose, Kalium, anorganisches Phosphat und Albumin festgestellt. Ferner wurde beobachtet, dass zwischen den höheren bezw. Niedrigeren Konzentrationen gewisser Blutbestandteile in verschiedenen Umweltsbedingungen und den höheren Wachstumsraten der betreffenden Kälber eine Assoziation bestand. In der vorliegenden Arbeit, werden die Ergebnisse von Blutanalysen bei Bullen und Kälbern in einer Anzahl verschiedener Aufstallungsarten beschrieben und es werden die Möglichkeiten der Auswertung dieser Ergebnisse im Rahmen von Züchtungsprogrammen, welche sich auf Nachkommen — oder Leistungsprüfungen stützen, besprochen.

REFERENCES

BREMNER, I., and DALGARNO, A. C. (1973): *Br. J. Nutr.*, 29, 229.
KITCHENHAM, B. A.; ROWLANDS, G. J.; MANSTON, R., and DEW, S. M. (1974): *Br. Vet. J.* (In press.)
MANSTON, R., and ROWLANDS, G. J. (1973): *J. Dairy Res.*, 40, 85.
PAYNE, J. M.; DEW, S. M.; MANSTON, R., and FAULKS, M. (1970): *Vet. Rec.*, 87, 150.
PAYNE, J. M.; ROWLANDS, G. J.; MANSTON, R.; DEW, S. M., and BYRNE, M. R. (1973): *Proc. Br. Cattle Breed. Club*, 28, 55.
ROWLANDS, G. J.; PAYNE, J. M.; DEW, S. M., and MANSTON, R. (1973): *Vet. Rec.*, 93, 48.
ROWLANDS, G. J.; PAYNE, J. M.; MANSTON, R., and DEW, S. M. (1974): *J. Agric. Sci., Camb.* (In press.)
WIENER, G., and FIELD, A. C. (1971): *Proc. Nutr. Soc.*, 30, 91.