

## EVALUATION OF BLOOD CONSTITUENTS AS EARLY MARKERS OF PERFORMANCE IN YOUNG BEEF BULLS OF PIEDMONTESE BREED

M. Cicogna<sup>1</sup>, A. Camussi<sup>2</sup>, M. Corti<sup>1</sup>, F. M. Stefanini<sup>2</sup> and Elena Tironi<sup>1</sup>

<sup>1</sup>Istituto di Zootecnia generale, Facoltà di Agraria, via Celoria 2, I-20133 Milano and <sup>2</sup>Cattedra di Genetica agraria, Università degli Studi di Firenze, via S. Bonaventura 13, I-50145 Firenze, Italy.

### SUMMARY

In the framework of the search for new biological variables connected with economic performances of farm animals, 16 blood constituents and 3 production performances were determined on bull calves of the Piedmontese breed. Blood constituent determination was repeated on three blood samples, collected at three-day intervals, at about 2 (milkfed, no. 158) and 5 (ruminant, no. 115) months of age. Descriptive statistics and repeatability of blood constituents are given together with the prediction equations on Market Value Index, Daily Weight Gain and Concentrate Conversion Rate.

### INTRODUCTION

The search for physiological attributes serving for early prediction of economically important traits in immature cattle is now mostly oriented towards the determination of metabolites or hormones or growth factors under specific experimental challenges (fasting, refeeding, intravenous administration of hormones or of secretagogues, etc.) and this particularly for early detection of dairy traits (Woolliams and Løvendhal, 1991). Nevertheless, the determination of blood biochemical variables that are used in clinical diagnosis and which can be cheaply and routinely measured, without the use of radioisotopes, in young bull calves in a Performance Test Station might still be useful for a better physiological understanding of the genetic variability of performances. Particularly so if these blood biochemical variables are considered by a multivariate approach. In fact, with such an approach, blood constituents have shown a better ability to discriminate between beef breeds than somatic or performance traits (Camussi *et al.*, 1990).

In the present work blood constituents were evaluated as early predictors of production performances in a sample of bull calves of the same beef breed.

### MATERIALS AND METHODS

Blood constituents were determined on all the Piedmontese calves entering the Performance Test Station of Carrù (Cuneo) during one whole year, i.e. 12 lots of about 15 subjects each, entering the Station at monthly intervals. The calves were housed in multiple pens and were milkfed, with buckets, until weaning, and thereafter fed hay *ad lib* and a fixed amount of concentrate, supplied by an automatic feeder which also recorded the quantities individually consumed. Blood samples were obtained from the same animals at about 2 (milkfed) and 5 (ruminant) months of age. For each age three samples were collected at three-day intervals, always at the same time in the morning before feeding.

With the aid of an automatic analyser (Multistat III of Instrumentation Laboratory - IL), according to methods previously described (Cicogna *et al.*, 1988), the following metabolites were determined: albumin, cholesterol, creatine, creatinine, glucose, total protein, triglycerides, urea, calcium, inorganic phosphorus; enzymatic activities: alanine aminotransferase (ALT), alkaline phosphatase (AP), aspartate aminotransferase (AST), creatine phosphokinase (CPK), gamma-glutamyltransferase ( $\gamma$ -GT) and lactate dehydrogenase (LDH). Analytical accuracy was systematically checked with a lyophilised human serum (Precinorm U, by Boehringer Mannheim). The creatinine/creatinine ratio was also computed. Data from animals with temporary health problems on the blood sampling day were excluded from statistical analysis. Repeatability of blood constituents determined in milkfed and in ruminant calves was estimated as:

$$R = \sigma_b^2 / (\sigma_b^2 + \sigma_e^2)$$

where:  $\sigma_b^2$  = variance component between subjects, within test lot;  $\sigma_e^2$  = residual component of variance between three measurements repeated on the same subject. The variance between subjects

had to be estimated within test lot because a preliminary analysis had shown, for most blood constituents, statistically significant differences between the 12 test lots. The level of significance for repeatability refers to the ratio: variance between subjects, within test lot / variance between measurements, within subjects.

For each young bull reaching the age of 12 months, the following performance records were considered: Daily Weight Gain, Concentrate Conversion Rate and Market Value Index. This last takes into consideration the conformation for beef production; it is an estimate of the carcass yield and is expressed as the ratio between the mean price per kg live weight assigned to each young bull by three independent appraisers and the mean price recorded in the same week on the Cuneo market for young Piedmontese bulls.

Prediction equations were estimated by multiple regression, backward elimination method, of production performances on blood constituent variables whose repeatability was significant. The analysis was made on the average values of blood constituents determined on three samples collected from the bull calves at both 2 (milkfed stage) and 5 (ruminant stage) months old.

### RESULTS

The descriptive statistics and the repeatability of the blood constituents determined in milkfed and ruminant Piedmontese bull calves are reported in Table 1, whereas their recorded mean production performances are given in Table 2.

Table 1. Blood constituents determined on the same Piedmontese young bulls when 2 (No. 158) and 5 months (No. 115) old.

Blood constituent	Unit	as milkfed, aged 2 months		as ruminant, aged 5 months	
		Mean $\pm$ SE	Repeatability	Mean $\pm$ SE	Repeatability
Albumin	g/l	31.8 $\pm$ 0.23	0.21***	32.6 $\pm$ 0.19	0.37***
Cholesterol	mmole/l	3.07 $\pm$ 0.08	0.56***	2.53 $\pm$ 0.05	0.79***
Creatine	$\mu$ mole/l	74.6 $\pm$ 2.87	0.54***	89.1 $\pm$ 3.34	0.52***
Creatinine	$\mu$ mole/l	197 $\pm$ 3.41	0.19***	151 $\pm$ 2.9	0.35***
C.inine / C.ine	-	3.45 $\pm$ 0.13	0.37***	2.15 $\pm$ 0.09	0.28***
Glucose	mmole/l	4.21 $\pm$ 0.06	0.39***	4.77 $\pm$ 0.05	0.29***
Total protein	g/l	64.5 $\pm$ 0.5	0.29***	66.6 $\pm$ 0.61	0.02N.S.
Triglycerides	mmole/l	0.22 $\pm$ 0.01	0.28***	0.27 $\pm$ 0.01	0.21**
Urea	mmole/l	5.15 $\pm$ 0.13	0.64***	3.41 $\pm$ 0.07	0.31***
Calcium	mmole/l	2.45 $\pm$ 0.02	0.22***	2.67 $\pm$ 0.01	-0.02N.S.
Inorg. P	mmole/l	2.36 $\pm$ 0.02	0.46***	2.55 $\pm$ 0.03	0.28***
ALT	U/l	14.5 $\pm$ 0.85	0.57***	19.9 $\pm$ 0.49	0.58***
AP	U/l	301 $\pm$ 10.5	0.75***	416 $\pm$ 15.1	0.80***
AST	U/l	70 $\pm$ 2.31	0.58***	72 $\pm$ 1.1	0.54***
CPK	U/l	190 $\pm$ 8.99	0.21***	170 $\pm$ 7.19	0.21***
$\gamma$ GT	U/l	25.1 $\pm$ 0.75	0.87***	18.5 $\pm$ 0.37	0.49***
LDH	U/l	1986 $\pm$ 43.6	0.69***	2067 $\pm$ 32.5	0.48***

N.S. = non significant

\*\* = significant at  $P \leq 0.01$

\*\*\* = significant at  $P \leq 0.001$

Normality assumptions were verified for all the considered variables and no marked deviation was found (data not reported). The comparison between the blood constituents determined at 2 and at 5 months of age (not shown in Table 1 to save space) has shown that only the enzymatic activities of AST and of CPK were not affected by difference of age or feeding system, whereas cholesterol, creatinine, urea and enzymatic activity of  $\gamma$ GT were significantly higher ( $P \leq 0.001$ ) and all other blood constituents lower ( $P \leq 0.001$ ) in milkfed calves.

**Table 2.** Performances recorded on Piedmontese young bulls (No. 112)

Performance	Unit	Mean	±	SE
Market Value Index	-	1.04	±	0.01
Daily Weight Gain	kg/d	1.4	±	0.01
Concentrate Conversion Rate	kg/kg	2.9	±	0.03

All the blood constituents considered, except total protein and calcium in ruminant calves, showed significant repeatability. The repeatability values were generally higher than those previously found with measurements repeated at greater intervals (4-5 repetitions at 2-4 month intervals vs. 3 repetitions at 3 day intervals)(Cicogna *et al.*, 1988).

**Table 3.** Prediction equations of performance variables on the basis of blood constituents determined in young bulls of Piedmontese breed (multiple regression, backward elimination method, with level of significance  $P \leq 0.1$ )

Dependent variables	Market Value Index		Daily Weight Gain		Concentrate Conversion Rate	
	b <sup>1</sup>	Partial R <sup>2</sup>	b <sup>1</sup>	Partial R <sup>2</sup>	b <sup>1</sup>	Partial R <sup>2</sup>
<b>milkfed calves (aged 2 months):</b>						
Intercept	0.9846	-	1.7264	-	2.3127	-
AP	-0.15*	0.04	-	-	-	-
CPK	-	-	0.33 *	0.05	-0.51 °	0.03
γGT	-	-	3.25 °	0.03	-6.38 °	0.03
LDH	-	-	-0.06 °	0.03	0.17*	0.05
Albumin	-	-	-13.2 **	0.06	-	-
Cholesterol	17.8 *	0.04	-	-	-	-
Creatine	-0.5 *	0.04	-	-	-	-
Tot. prot.	2.88*	0.05	-	-	-	-
Urea	11.1 °	0.04	16.8 °	0.03	-42.3 *	0.04
Inorg. P	-65.1 °	0.03	-	-	298 *	0.05
Model R <sup>2</sup>	0.15		0.13		0.14	
<b>ruminants (aged 5 months):</b>						
Intercept	1.1681	-	1.4354	-	2.4928	-
AP	0.092 °	0.03	-	-	-	-
AST	1.27 °	0.03	-	-	-	-
γGT	-	-	13.3 ***	0.11	-31.3 ***	0.14
LDH	-	-	-0.08 *	0.04	0.25 **	0.09
Creatine	-0.85 ***	0.11	-	-	-	-
Glucose	-37.8 *	0.04	-	-	-	-
Triglycerides	-	-	-	-	495 °	0.03
Urea	-	-	-32.8 °	0.03	94.1 **	0.07
Model R <sup>2</sup>	0.18		0.18		0.29	

(<sup>1</sup>) Non standardised coefficients (x 1000, except for intercept)

Significant: ° at  $P \leq 0.1$ ; \* at  $P \leq 0.5$ ; \*\* at  $P \leq 0.01$ ; \*\*\* at  $P \leq 0.001$

In general enzymatic activities, except for CPK whose sensitivity to blood collecting procedures, to stress and even to minimal exercise is wellknown, showed higher repeatability values than metabolites. Particularly high repeatabilities were also found for cholesterol and creatine and, in milkfed calves, for urea. In the case of this last metabolite, the higher mean blood level and the higher repeatability observed in milkfed vs. ruminant calves may be explained by the different feeding and digestion patterns.

The six prediction equations are reported in Table 3. They refer to the three production performances (Market Value Index, Daily Weight Gain and Concentrate Conversion Rate) as estimated from blood constituents determined in 112 pre-pubertal Piedmontese calves: at the milkfed (2 months old) and at the ruminant (5 months old) stage. The predictive ability ranged from 0.13 to 0.29 with, as expected, higher values for the ruminant set.

When determined at the earlier stage (in milkfed. 2 months old calves), more blood constituents enter into the predictive equations, but no one emerges for predictive ability (partial R<sup>2</sup> ranging from 0.03 to 0.06).

On the contrary, in the ruminant set, high predictive abilities emerge for creatine (partial R<sup>2</sup>: 0.11), as regards Market Value Index (i.e. for the index that considers conformation for beef production and estimated carcass yield) and for  $\gamma$ GT, as regards Daily Weight Gain (partial R<sup>2</sup>: 0.11) and Concentrate Conversion Rate (partial R<sup>2</sup>: 0.14).

Serum levels of creatinine, of calcium and enzymatic activity of ALT were never included in the performance prediction equations. The same is true for the creatinine/creatinine ratio which, according to previous papers (Hanset and Michaux, 1985; Cicogna *et al.*, 1988), allowed discrimination between cattle subjects with or without muscular hypertrophy.

### DISCUSSION

It is worth noting that, although with low predictive abilities, the blood constituents included in the equations for Market Value Index are different from those linked with Daily Weight Gain or Concentrate Conversion Rate. Furthermore, all the biochemical variables that appear in the predictive equations for the latter two performances show, as expected, opposite signs for these two performance variables.

In particular, Market Value Index is linked to serum AP activity (associated with osteoblastic activity) and to serum creatine (associated with muscle mass and with energy storage in the muscle), both in milkfed and in young ruminant calves. Daily Weight Gain and Concentrate Conversion Rate are linked to enzymatic activities of  $\gamma$ GT (liver specific enzyme) and of LDH (whose role is still debated), equally in milkfed and in young ruminant calves. The link to the growth and feed efficiency performances of serum urea level is affected by the different feeding regimes in the two physiological stages and thus has opposite signs in milkfed and in young ruminant calves.

Our results confirm previous bivariate associations of performance with creatine and  $\gamma$ GT (Cicogna *et al.*, 1988) and with AP and LDH (Bittante *et al.*, 1987). The latter authors reported medium-high heritabilities for AP (0.61) and LDH (0.39) in young Italian Simmental bulls.

Finally, the blood constituents considered do not seem very promising as juvenile predictors, but may be of interest in the broader context of understanding the physiological attributes of genetically high merit sires.

### ACKNOWLEDGEMENTS

The authors wish to thank the Associazione Nazionale Allevatori Bovini Razza Piemontese (Carrù, Italy) for providing blood samples and performance data of the young bulls studied. Research supported by the Italian Ministry of University and Scientific Research (60%, 1989).

### REFERENCES

- BITTANTE G., BUTTAZZONI L., SPANGHERO M. and ALEANDRI R. (1987) Proc. EAAP Seminar Study Comm. on Cattle Production and Animal Genetics, Pudoc, Wageningen, 146-149.  
CAMUSSI A., CICOGNA M., CORTI M. and GREPPI G.F. (1990) J. Anim. Breed. Genet., 107: 204-209.  
CICOGNA M., CORTI M., GREPPI G., CAMUSSI A. (1988) Zoot. e Nutr. Anim., 14: 315-324.  
HANSET R., MICHAUX C. (1985) 36<sup>th</sup> Ann. Meet. EAAP, Session IV, Kallithea (typescript).  
WOOLLIAMS J.A. and LØVENDHAL P. (1991) Livest. Prod. Sci., 29: 1-16.