

# Characterisation of a glucokinase-like activity in the chicken liver.

## Variations in response to food intake

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Carbohydrates make up the major energy component of poultry diets. Considerable effort has been made to improve the use of carbohydrates from various sources by increasing their digestibility. The mechanisms involved in carbohydrate utilisation following the intestinal phase have, however, not been adequately studied, in particular the process regulating glucose utilisation by the liver. Recent studies in mammals have shown a major role of the hexokinase D isoform (glucokinase, GK) (EC 2.7.1.2) in carbohydrate utilisation by the liver. The presence of glucokinase in avian species has long been a matter of debate as a number of investigators failed to detect glucokinase activity in livers from the chicken and several other avian species (Cardenas *et al* 1998). We recently characterised, in chicken liver, a protein and a partial cDNA showing a high degree of homology with mammalian glucokinase (Berradi *et al* 2003). In this paper we are interested in the functional role of this enzyme as a measure of its enzymatic activity and the variations in level according to the nutritional state of the chickens.

Forty-eight male chickens were randomly allocated to individual cages. Sixteen chickens were fed *ad libitum* from d1 to d38 and thirty two chickens were meal fed (1h per day from d5 to d27 and 2h/d until sacrifice). Illumination was provided for 23 h per day. Chickens were fed a regular, balanced diet based on corn, wheat and soybean meal (11.8 MJ/kg containing ~22% proteins and 37% starch). Water was freely available. On day 38, chickens from the *ad libitum* diet were sacrificed in the fed (group B) and the fasted (24 h, group A) state. Of the 32 birds fed with meal, 8 were sacrificed after a 24 hour fast (group C), 8 were sacrificed after the meal (group D) and the 16 remaining chickens were sacrificed 2h (group E) and 5h (group F) after an oral saccharose load (6 ml/kg BW of a 50 % saccharose solution) given just before the meal. The chickens were killed by cervical dislocation after blood sampling. Tissues were quickly removed, frozen, powdered into liquid nitrogen and stored at - 80°C. Plasma glucose levels were measured using a glucose oxidase method, plasma insulin levels were determined using a radioimmunological method (Simon *et al* 1974). Enzymatic activities were measured according to (Panserat *et al* 2000).

The glucokinase-like activity was significantly higher in fed than in 24h starved chickens whether *ad libitum* or meal fed. Moreover the glucokinase-like activity was stimulated at least for 5 hours when an oral sucrose load was given before the meal. Liver glucokinase-like activity and liver weight /kg BW were positively correlated (R= 0.62; n=48; p<0.0001).

**Table** Body and liver weights, plasma glucose and insulin levels and enzyme activities according to the nutritional state of *ad libitum* or meal fed chicken. The values are means of 8 chickens per group. Within a line, values not sharing a common letter are significantly different at the 0.05 level. (\*\*\*) p<0.0001

Feed intake	Ad libitum		meal			ANOVA		
	A:fasted	B : fed	C : fasted	D : t = 2h	+ saccharose		p	SEM
Groups				E : t=2h	F : t=5h			
Body weight (BW, kg)	2.08c	2.34c	0.76a	0.89a	0.88a	1.10b	***	0.05
Food intake (g/kg BW)	-	94a	-	117b	109ab	122b	***	3
Liver (g)	36.8	52.1	13.9	19.1	25.2	36.0	***	1.4
Liver/BW (g/kg BW)	17.7a	22.3b	18.3a	21.6b	28.7c	32.8d	***	0.8
Plasma glucose (g/L)	2.15a	2.41ac	2.26ac	2.91b	2.85b	2.52c	***	0.09
Plasma insulin(U/ml)	18.5a	18.0a	8.6a	48.1b	63.0bc	70.0c	***	5.9
Proteins (g/g liver)	0.23	0.19	0.18	0.19	0.19	0.16	NS	0.01
<i>Enzyme activities (mU/mg prot)</i>								
GK	0.32a	0.70b	0.88b	0.89bc	1.49d	1.38cd	***	0.13
HK (low Km)	0.24a	0.22a	1.00c	0.29a	0.77bc	0.54ab	***	0.09
GK/ HK	1.61a	3.17bc	1.01a	3.14c	2.01ab	2.87bc	***	0.31

This work shows that a glucokinase-like activity is induced in chicken liver in response to food intake and that this enzyme is sensitive to the quantity and/or the quality of the sugar present in the diet. The significant correlation between liver glucokinase-like activity and liver weight expressed per kg BW suggests that GK plays an important role in liver carbohydrate utilisation and storage in the chicken.

## References

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