

Sequence and comparative analysis of the chicken genome: A new challenge for poultry breeding and nutrition

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Summary

In December 2004 chicken genome research reached an important landmark with the release and publication of the chicken physical map (Wallis et al., 2004) and genome sequence (International Chicken Genome Sequencing Consortium, 2004). This draft genome sequence is estimated to cover around 90-95 % of the chicken genome containing close to 18,000 identified genes. A comparison between the chicken and mammalian (human, mouse, rat) genomes showed the existence of extensive conservation of synteny between the genomes of these vertebrates. The comparison of the genomes of different species, generally referred to as comparative genomics, is an extremely powerful tool for the analysis of functionally important conserved sequences and genes. Furthermore having the (near) complete gene catalogues of these organisms opens up completely new perspectives for the comparison of similarities and differences with regard to physiology and biology of these different vertebrates. The knowledge of the sequence of 18,000 protein coding chicken genes supplemented with the sequence information of a large collection of cDNAs strongly improved the possibilities for expression profiling using microarrays that represent the complete transcriptome of the chicken.

Together with the chicken genome sequence, also 2.8 million single nucleotide polymorphisms (SNPs) became available, which presents another invaluable resource for genetic analysis in chicken (International Chicken Polymorphism Map Consortium, 2004). Interestingly, the amount of genetic variation observed in chicken is 5 fold higher than that observed in human with an average SNP frequency of 1 SNP every 200 bp. Much of this genetic variation is still present within commercial breeding lines, which is highly relevant for future poultry breeding.

The chicken has now an impressive array of tools and genome resources (table 1) which are highly relevant for a wide range of poultry research areas including poultry breeding and poultry nutrition. In addition, the chicken also represents a powerful model organism for other birds and vertebrates. Although the chicken embryo has always been an important model in developmental biology, the resources that are now available further extends chicken as a model to other areas as well. In particular the high specificity of sequence comparisons between chicken and mammalian sequences is expected to dramatically increase the chicken as a widely used model organism in science.

Chicken Genomics and Nutrition

It is increasingly recognized that nutrition has a strong influence on gene expression. Many dietary constituents such as fatty acids, carbohydrates and vitamins have been shown to directly or indirectly affect genes expression in human and animals [for recent reviews see: Richards (2003); Daniel and Dieck (2004); Kaput and Rodriguez (2004); Debusk et al. (2005)]. Regulation of gene expression by nutrients however, is not only relevant for genes directly involved in the processing of the food but has also been shown to affect genes involved in other physiological processes such as e.g. the immune system (Kidd, 2004). Understanding the complex interplay between nutrients and cellular processes as well as understanding the effect genetic differences have on this in these interactions is of increasing potential not only for human nutrition but for animal nutrition as well.

Furthermore, different genetic variants can also directly affect the behavior of the organism with regard to the effects of the feed. A good example is the occurrence of a fishy taint in

cows milk (Lundén et al. 2002) or chicken eggs (Honkatukia et al. 2005) due to a mutation in the *FMO3* gene coding for the flavin-containing mono-oxygenase3 in some animals. Although nutritional genomics is a relatively new field of research and many of the expectations have yet to be fulfilled, the potential it has with regard to future human and animal nutrition are enormous.

Table 1: Chicken Genomics, Relevant web sites

Database	Web site
Ensembl	http://www.ensembl.org/Gallus_gallus/
Santa Cruz genome browser	http://genome-test.cse.ucsc.edu/cgi-bin/hgGateway?db=gallGal2
NCBI chicken browser	http://www.ncbi.nlm.nih.gov/genome/guide/chicken/
ChickAce, genetic maps and markers	https://acedb.asg.wur.nl/
ChickFPC, physical map	http://www.bioinformatics.nl/gbrowse/cgi-bin/gbrowse/ChickFPC
Chicken comparative map	http://www.animalsciences.nl/cmap/
Chicken SNPs	http://chicken_genomics.org.cn/index.jsp
ChickRHserver, Radiation Hybrid maps	http://chickrh.toulouse.inra.fr/
ArkDB, genetic maps and markers	http://www.thearkdb.org/browser?species=chicken

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