Pig Leanness insulin-like Growth Factor 2

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Pig Leanness insulin-like Growth Factor 2 gene status in South Africa

Industry Sector: Pork

Research Focus Area: The relationship between fatness (leanness) and reproduction of the sow

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EXECUTIVE SUMMARY

The association of Insulin Growth Factor 2 gene with the meat and fat quality traits in South African Landrace and Large White pig populations

The Large White and Landrace are the predominant pig breeds used in South African industry. Due to the consumer demands, selection of leaner pigs receive attention in selection programmes. IGF2 is an imprinted gene, paternally expressed with a positive association with an increase in lean yield. The aim of the study was to investigate the effect of the IGF2 gene in the two South African populations with regard to meat and fat quality traits. The first phase of the study was to determine the frequencies of the IGF-2 genotypes in South African pig populations. Frequencies varied from as high as 95% of the G/G genotype in the Duroc to as low as 9% of the A/A genotype in the Large White. IGF2 genotypes were determined to generate sufficient progeny that were finished at a slaughter weight of 100 kg. Carcass, meat and fat quality traits were measured. For the majority of the meat quality traits (pH, water-holding capacity, colour, eye muscle area, drip loss, thiols and thiobarbituric acid reactive substances), the IGF genotype did not differ significantly ($P<0.05$). There was significant genotype effect on warm and cold carcass weights where the A/A genotype has lower weights

compared to the G/G genotype. The pH values varied from 5.8 to 6.10, indicating the absence of pale, soft exudative meat. The G/G genotype displayed differences (P<0.05) with a mean value of 5658mm^2 for eye muscle area where the G allele is associated with more fat. Colour measurements for 24 hours post mortem were nor different between the IGF2 genotypes (P<0.05). The colour measurement from 1 to 7 days post mortem increased across all breed*genotype combinations b* and Chroma measurements. Warner Bratzler shear force displayed differences (P<0.05) for the IGF2 genotype. The G/G genotype displayed more tender pork. Fat free dry matter of belly fat was the only significant measurement with a genotype effect where the A/A genotype had the highest percentage of 9.18%. The G/G genotype had a higher mean value for fat content in muscle compared to backfat in this study. Although not significant in the number of samples tested. Interesting to note that the A/A genotype tended to have more fat in the belly. The IGF2 genotypes were significant for the SFA's (C15:0, C16:0, C17:0 and C20:0) in belly fat where the A/A was higher compared to A/G and G/G genotypes. The double bond index and iodine values were higher in A/A genotypes which is consistent in leaner animals. Results in this study is comparable with other studies showing that IGF2 did not have any negative effect on meat and fat quality traits. This study has highlighted that there is potential for using IGF2 gene as a genetic tool for selection in leaner pigs.

Project Aims

1. To determine the IGF-2 gene status of 500 breeding boars in stud/seed stock herds in South Africa
2. To determine the correlation between MH and IGF2 gene status
3. To offer the test as a service to the South African pig industry
4. * To determine the effects of the IGF2 gene on lean meat content, back fat thickness, fatty acid profile and meat quality pf typical South African pigs

Popular Article

Title for Popular Article

Pig leanness: - Role of Insulin-like growth factor (IGF2) and Malignant Hyperthermia (MH) genes

The challenge is to breed lean pigs with fat characteristics to suit the purposes of their production. For the growing health conscious consumer the production of leaner pigs is necessary and for the production of processed meat such as sausage and bacon a higher % fat carcass is required. There are about 350 commercial pork producers in South Africa, and about 50% of their production is used for processing products. There is on the other hand great scope in South Africa to increase pork production and exploit the consumer purchasing fresh meat.

Producing pork meat mainly free of fat by means of selective pig breeding is on the forefront of genetic research. The IGF2-gene was identified to play an important role in pig muscle growth and was discovered to have potential to assist pig breeders in selection programmes. It was discovered that the effects of the IGF2-gene on muscle mass and leanness are of the same magnitude as that reported for the halothane (MH-gene) but without the undesirable effects (pale, soft and exudative or for short PSE) on meat quality.

IGF2 is an imprinting gene, paternally expressed; i.e. only the allele from the father is expressed in the progeny. The IGF2-gene has an effect on the production of lean meat. Boars tested for IGF2 can be used to either to increase or decrease back fat. Boars with IGF2 +/+ genotypes can be used to increase

lean yield, while those with IGF2 -/- genotype can be used to decrease lean yield. The IGF2-gene can also be used to produce pork with the desired level of leanness from fatter sows.

A commercial test is available to test for the IGF2-gene allowing for knowing if the pig has the gene for leanness or fatness and accurately detects the genetic mutation associated with meat quality. The effects of this gene on lean meat content and back fat thickness of pigs were reported by several studies but we do not know if it has an effect on meat tenderness, juiciness and taste.

Association between IGF2-gene and lean pork

Several international studies have reported the presence of the gene on the distal tip of chromosome 2 (SSC2) in pigs that without question has effects on lean meat content. These studies also confirmed that the QTL (quantitative trait loci) was imprinted and paternally expressed. The effects on muscle mass and fat deposition were major and of the same magnitude as that reported for the halothane gene (ryanodine receptor 1 gene). This single nucleotide mutation adds approximately 3-4% more lean meat to pigs. The link of the mutation with the desired phenotype is 100%, regardless the origin of the pedigree. It allows for the selection of carcass leanness based directly on the functional nucleotide at the DNA level.

Actual breeding trials have shown that the use of IGF2-gene to increase uniformity of pork leanness is not just theoretical. Published trials consistently showed that the pigs from selected boars were leaner and more uniform compared to those from unselected boars. The back fat thickness was reduced by 2.3 mm. Average lean meat percentage, ham percentage and loin percentage increased by 1.98%, 0.31% and 0.43% respectively. The meat quality traits of the offspring from the selected boars and those from unselected boars had the same pH value (5.77 to 5.78 measured after 24 hours), and meat colour (lightness of 44.57 and 43.08 respectively) - all within the optimal range. The investigation concluded that the selection of homozygous terminal sires with the favorable allele at IGF2-gene increased the uniformity and carcass leanness in market pigs without influencing meat quality, in particular the water holding capacity. Water holding capacity is a characteristic affected by the PSE phenomenon.

Malignant Hyperthermia (MH) or Ryanodine receptor (RYR1) and lean pork

The best described example of a gene affecting meat quality in pigs is the well-known halothane (HAL) gene also known as the Malignant Hyperthermia (MH) or Ryanodine receptor (RYR1). Although this gene has the advantage of heavy muscling, it is accompanied by an increased tendency to pale, soft and exudative (PSE) pork, higher stress related mortalities and loss of meat yield, which directly translates into economic losses for the entire pig production chain. This porcine stress syndrome (PSS) was found to cause malignant hyperthermia (MH) when pigs carrying the gene are exposed to conditions causing stress such as high temperatures, transport and handling. The meat is unacceptable to consumers and is also less suitable for further processing because of its low water-holding capacity. Homozygous pigs (nn) are more prone to producing PSE meat than carriers (Nn). A commercial test is also available and a previous Red Meat Research and Development Trust (RMRDT) study on the South African pig population indicated a low frequency of the HAL-gene.

What is the connection between Ryanodine receptor (RYR1) gene and IGF2 gene?

Not much is known at present if there is a connection between the RYR1- and IGF2-genes. One study that aimed to investigate the effect of the IGF2 mutation on biochemical and histo-chemical muscle fibre characteristics in relation to the RYR1 genotype (Nn vs. NN) was found. No effect of either the IGF2 or the RYR1 genotype on muscle fibre type composition was found. In this study, the mutation in the RYR1 did not influence birth weight, average daily gain, lean meat content or average daily lean

meat growth, although an increased percentage of carcass weight and Longissimus muscle cross-sectional area were found in Nn animals. It is clear that information is scarce and that further investigation is necessary to understand the interaction if it exists between the IGF2 mutation and the RYR1 genotype. While the increased leanness due to the RYR1 genotype is connected more with increased muscle mass and better carcass conformation, the IGF2 mutation leads to increased leanness which is associated with reduced fat deposition. The former is thus more involved with carcass weight (carcass yield) and the latter with carcass composition (fat/protein ratio).

It is clear that genetic information can play an important role in breeding programmes to produce animals within purebred or crossbred lines with economic important traits. Future success for the pig industry will require putting the consumer preferences first and to breed for good quality lean pork with less emphasis on carcass yield especially if this means poorer quality product. The initiation of IGF2 testing in South Africa can become a useful tool for South African commercial pork producers and the industry at large to help them achieve this goal.

References available on request

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