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Breeding Effects on Quality Beef Traits and their Applications in Animal Genetics

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Description

The science of breeding in beef cattle has undergone significant advancements over the past few decades, particularly with respect to enhancing desirable traits that affect the quality of beef. From traditional selection methods to advanced genomic tools, breeders have focused on traits such as marbling, tenderness, growth rate and feed efficiency. These traits are not only important for economic reasons but also critical to consumer satisfaction, animal welfare and environmental sustainability.

Beef traits affected by breeding

Breeding programs in beef cattle target several key traits that influence the quality of the beef produced. These traits include marbling, tenderness and growth rate and feed efficiency, among others [1]. Each of these characteristics has a genetic component, meaning that they can be selected for and improved over generations through targeted breeding strategies [2].

Marbling refers to the intramuscular fat content found in beef and it is one of the most important indicators of meat quality, particularly in high-end beef markets. Marbled beef tends to be juicier, more flavorful and tenderer than leaner cuts. The degree of marbling is influenced by both environmental factors (such as diet and management) and genetic factors. Research has shown that specific genes, such as the Thyro-Globulin (TG) gene, are associated with increased marbling in beef cattle [3].

Breeding programs focused on improving marbling have successfully utilized genomic selection to identify animals with favorable alleles for intramuscular fat deposition. By identifying genetic markers linked to marbling and selecting sires and dams that carry these markers, breeders have been able to improve the marbling potential of their herds [4]. Over time, this selective pressure has led to substantial gains in marbling, particularly in breeds such as the Angus, which is renowned for its highly marbled beef [5].

Tenderness is another critical trait that significantly influences consumer satisfaction with beef products. It is affected by several factors, including muscle fiber structure, connective tissue content and the activity of enzymes involved in muscle breakdown post-mortem [6]. One of the key genetic contributors to tenderness is the calpain gene, which encodes an enzyme responsible for breaking down muscle fibers after slaughter. Variations in the calpain gene have been linked to differences in tenderness across cattle breeds [7].

Selective breeding for tenderness has made significant strides with the help of genetic testing and marker-assisted selection. Breeders can now identify animals that possess favorable versions of the calpain gene, allowing them to breed for more tender beef. Additionally, research into the calpastatin gene, which inhibits calpain activity, has provided further insights into how to manipulate the genetic architecture of tenderness in cattle [8].

Growth rate and carcass weight are economically important traits that influence the profitability of beef production. Faster-growing animals with higher carcass weights are more efficient in terms of feed conversion and offer greater returns to producers. These traits are highly heritable, meaning that genetic selection can rapidly improve them over successive generations [9].

Feed efficiency or the ability of an animal to convert feed into body mass, is another critical trait that has garnered attention in recent breeding programs. Improving feed efficiency not only reduces production costs but also has significant environmental benefits, as more efficient animals produce less methane and require fewer resources to reach market weight. One key genetic factor in feed efficiency is the Residual Feed Intake (RFI), which measures the difference between an animal's actual feed intake and its expected intake based on growth and body size.

Genomic selection has been used to identify genetic markers associated with lower RFI, allowing breeders to select animals that are more feed-efficient. This has led to the development of herds that require less feed to achieve the same growth rates, which is beneficial for both producers and the environment [10].

Animal genetics in breeding for quality traits

Advancements in animal genetics have revolutionized the breeding of beef cattle, providing breeders with tools that were unimaginable just a few decades ago. Genomic selection, Marker-Assisted Selection (MAS) and whole-genome sequencing are among the most impactful technologies that have transformed the way breeders select for desirable traits.

Genomic selection involves using DNA markers spread across the entire genome to estimate the genetic potential of an animal for various traits. This method allows breeders to make more informed decisions about which animals to breed, based on their genetic makeup rather than just their physical appearance or pedigree. Genomic selection has been particularly effective in improving traits with moderate to high heritability, such as marbling, tenderness and growth rate.

One of the key advantages of genomic selection is that it allows breeders to select animals at a younger age, reducing the generation interval and accelerating genetic progress. By genotyping calves shortly after birth, breeders can identify the animals with the best genetic potential for quality traits and prioritize them in breeding programs. This has led to faster and more efficient improvements in beef quality across the industry.

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