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From Plumage to Productivity: Navigating Sex-Linked and Sex-Influenced Traits in Poultry Genetics

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Abstract

The study investigates the application of inheritance patterns of sex-linked and sex-influenced traits in the development of auto-sexing breeds, emphasizing key traits such as plumage color, feather patterns, and feathering rates. Additionally, the economic advantages of utilizing sex-linked dwarfism in broiler breeding were studied, offering a understanding of how this genetic strategy reduces costs without compromising productivity. The sex-influenced traits were studied, focusing particularly on the dynamics of hen feathering and its implications for breeding practices. The comprehensive insights presented in this article contribute to the refinement of poultry breeding strategies, offering potential advancements in the production of healthier and more economically viable flocks.

Introduction:

The inheritance of genetic traits in poultry is a fascinating and complex phenomenon that significantly influences breeding practices in the poultry industry. In chickens, numerous pairs of chromosomes are common to both sexes, with autosomes equally contributed by both the paternal and maternal sides. However, a subset of traits exhibits a unique pattern of inheritance, where certain characteristics are exclusively transmitted from the hen to her male chicks, without being passed on to her female chicks. In contrast, some traits are inherited from the cocks and manifest in both male and female chicks. These traits are aptly termed as sex-linked characters, owing to the fact that the responsible genes are situated on the sex chromosomes. This intriguing aspect of genetic inheritance has been strategically harnessed in poultry breeding practices, particularly in the identification of the sex of day-old chicks through specific mating schemes. The concept of auto-sexing breeds has emerged as a valuable application of sex-linked characters in commercial poultry breeding. This wealth of knowledge not only enhances our understanding of avian genetics but also holds practical implications for the commercial poultry breeding industry, paving the way for more precise and efficient breeding practices.

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Sex-Linked Traits

While numerous poultry traits are inherited equally from both parent birds, sex-linked traits exhibit distinctive patterns of inheritance, residing primarily on the "Z" chromosome. This differential inheritance leads to variations in trait expression between male and female birds.

Auto-Sexing Traits

A groundbreaking application of sex-linked traits lies in the development of auto-sexing breeds. This innovative approach involves specific mating strategies to accurately determine the sex of day-old chicks. Several key auto-sexing traits with practical applications have been identified:

Silver and Golden Plumage: Illustrated by the Light Sussex breed, where silver plumage is attributed to the dominant gene "S" and golden plumage to its recessive gene "s" in Rhode Island Red and New Hampshire. Achieving successful auto-sexing involves ensuring the female line carries the dominant gene (hemizygous), while the male line carries the recessive gene (homozygous).

Phenotype	**Golden Plumage (♂)**	**Silver Plumage (♀)**
Genotype	ss	SW
Gametes	(s) (s)	(S) (W)
F_1 Offspring	Ss	sW
	(All ♂ are silver plumage)	(All ♀ are golden Plumage)

If the male is homozygous dominant for silver plumage and female is recessive than all the progenies will be of silver plumage irrespective of their sex and if the male parent is heterozygous dominant, than half of the offsprings will be of silver plumage and other half will be golden plumage.

Barred and Non-Barred Feathers: The gene for barring (B) dominates over non-barring (b), and this trait is located on the sex chromosomes. Barred males (BB) exhibit wider bars than barred females (BW), providing a distinctive visual feature for sex determination.

Phenotype	**Non-barred (♂)**	**Barred (♀)**
Genotype	bb	BW
Gametes	(b) (b)	(B) (W)
F_1 Offspring	Bb	bW
	(All ♂ are barred and had head spot at day old)	(All ♀ are nonbarred and no headspot)

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Slow and Fast Feathering: The slow feathering gene (K) prevails over fast feathering (k), influencing feather development in breeds such as White Leghorn and White Plymouth Rock. This trait plays a crucial role in controlling feathering patterns, especially in the context of commercial poultry production.

Phenotype	**Fast/Early feathering (♂)**	**Slow/Late feathering (♀)**
Genotype	kk	KW
Gametes	(k) (k)	(K) (W)
F₁ Offspring	Kk	kW
	(All ♂ are slow feathering)	(All ♀ are fast feathering)

All the above sex-linked traits are passed from hen to the male chicks and from cock to its female chicks in F1 generation in a criss-cross manner. Hence, this type of inheritance is also called as criss-cross inheritance.

Sex-Linked Dwarfism in Broiler Breeding:

In the realm of broiler breeding, harnessing the dw gene for sex-linked dwarfism presents significant economic benefits. Female parent stocks carrying this gene exhibit a 40% reduction in body weight, requiring less space and consuming 40% less feed while maintaining optimal hatching egg production. Notably, the offspring from dwarf dam lines exhibit normal size phenotypically, offering a cost-effective breeding strategy for producers.

Phenotype	**Normal (♂)**	**Dwarf (♀)**
Genotype	DwDw	dwW
Gametes	(Dw) (Dw)	(dw) (W)
F₁ Offspring	Dwdw	DwW
	(All ♂ are normal)	(All ♀ are normal)

Sex-Influenced Traits

Diverging from sex-linked traits, sex-influenced traits are situated on autosomes, exhibiting a unique pattern of inheritance. The phenotype expression of a genotype depends on the sex of the bird. A prime example is hen feathering, where the gene for hen feathering (H) dominates over cock feathering (h). Strikingly, all female's express hen feathering regardless of genotype, while males with "HH" and "Hh" genotypes display hen feathering, and those with the "hh" genotype exhibit cock feathering.

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Phenotype	**Cock feathered (♂)**	**Hen feathered (♀)**
Genotype	hh	Hh
Gametes	(h) (h)	(H) (h)
F_1 Offspring	Hh and hh (Hh- ♂ -hen feathered hh- ♂ are cock feathered)	Hh and hh (All ♀ are hen feathered)

Conclusion

In conclusion, the exploration of sex-linked and sex-influenced traits in poultry, as presented in this comprehensive study, sheds light on the intricate patterns of genetic inheritance that significantly impact breeding practices within the poultry industry. The study emphasizes the practical applications of these traits, particularly in the development of auto-sexing breeds and the utilization of sex-linked dwarfism in broiler breeding. The presented knowledge empowers poultry breeders to make informed decisions in selecting and developing breeds with desirable characteristics.

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