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Genetic basis of Abigar and Sheko cattle breed adaptations in the tsetse infested lowlands of Ethiopia: A review

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Abstract

The objective of this review paper was to assess the genetic foundation of the Abigar and Sheko cattle breeds and their adaptations in the tsetse-infested lowlands of Ethiopia. Sheko cattle are more resistant to biting fly attacks and maintain their body condition, unlike Zebu cattle, making them less likely to get the disease. The sheko breed is prized for its milk production, adaptability, and greater trypan tolerance compared to other Ethiopian native cattle groups. Shekos do not typically contract the disease during the trypanosomiasis challenge's primary season, and they do not require regular medication and are able to recover from the endemic unaided. The Abigar cattle breed has been produced and maintained primarily by the Nuer people under pastoral and ago-pastoral production methods, with Gambella Regional State serving as both the breed's origin and primary breeding tract. The breed is also noted for its docile nature, long body length, enormous body size, medium height, and typically long curving horns. The predominant coat colors in the population are white and gray. Abigar cattle have special adaptation features that allow them to thrive, produce, and reproduce in conditions of extreme heat, frequent disease outbreaks, and other difficulties. Such adaptation is crucial for low-input farming methods that can be gradually established using locally adapted livestock breeds that have evolved in tandem with the competing forces of arid and semi-arid habitats. Finally, the genetic foundations of the Abigar and Sheko cattle breeds have stronger behavioral adaptations to tsetse-infested animals in Ethiopian lowland areas. Thus, adaptation traits that include tolerance to biting flies, tolerance to heat stress, resistance to tick and internal parasite infestation, and feeding efficiency in order to better understand the trypan tolerance attribute and some adaptation traits of the Abigar and Sheko cattle breeds, further intervention and conservation should be implemented.

Keywords: Abigar, sheko, adaptation, tsetse flies

Introduction

Ethiopia is known for having a vast variety of animal genetic resources, a significant population of livestock that is primarily of the native genotype, and the adaptation of various ago-ecologies and farming systems. Animal genetic resources offer alternative, high-quality food supplies, are a significant source of money, and provide a means of subsistence for indigenous people living in remote places. They are also essential for preserving their social and cultural ties^[5].

Both humans and animals are susceptible to the parasitic disease trypanosomiasis, which is brought on by single-celled protozoan parasites. African animal trypanosomiasis is the name given to this illness on that continent. The main obstacle to livestock production, particularly in sub-Saharan African countries, is African animal trypanosomiasis. *Trypanosoma Congolese*, *Trypanosoma vivax*, and *Trypanosoma brucei* are the primary causes^[19].

Native cattle play numerous roles in the majority of Ethiopia's rural communities and are an essential component of the bulk of the country's production systems. The Abigar cattle are categorized as "Sanga" among the indigenous genotypes known to exist in Ethiopia. They are mostly found in the Ethiopia-Sudan border region, with a broader extension in Ethiopia covering the Akobo area of Gambella^[3]. The breed has been raised and preserved by the Nuer tribes of Gambella Regional State, and it can be found in the lowlands next to the White Nile in southwest Ethiopia and Sudan^[8].

Due to substantial interbreeding with indigenous indicine and Sanga breeds, the Sheko breed

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of Ethiopia is only found in the southern Bench Maji Zone and the surrounding regions of Keffa and Shaka ^[8]. Sheko cattle are kept in tsetse-infested areas, which probably explains how trypan tolerant they are.

Trypanosoma Congolese, *T. vivax*, and *T. brucei*, or concurrent infection with one or more of these trypanosomes, are the three pathogens that cause the illness complex known as African animal trypanosomiasis. When one or more of the three African animal trypanosomes infect cattle, they can cause a subacute, acute, or chronic disease that frequently results in mortality and is characterized by intermittent fever, anemia, sporadic diarrhea, and rapid loss of condition ^[25].

Tsetse flies are only found in Ethiopia's southwestern and northwestern areas, which span a 220,000-km² range between longitude 33° and 38° E and latitude 5° and 12° N. At any given moment, around 14 million cattle, an equal number of small ruminants, over 7 million horses, and 1.8 million camels are in danger of getting trypanosomiasis ^[26]. Six trypanosome species have been found in Ethiopia, and the tsetse-transmitted species are the most significant trypanosomes in terms of economic damage to domestic livestock: the trio of *T. Congolese*, *T. vivax*, and *T. brucei* ^[1].

To understand the epidemiology of the disease, trypanosome infections in livestock must be correctly diagnosed. While in the chronic phase of the disease, parasites may appear to be absent from the blood for extended periods of time. However, high parasitemia is usually only visible in early infections. This is caused by trypanosomes' capacity for long-lasting infections, which is linked to the phenomenon of antigenic variation. As parasitemia increases, a rapid antibody response is produced against the antigen types exposed on the surface of the bloodstream trypanosome ^[6].

Sheko cattle are only currently found in a remote region of southwest Ethiopia, primarily in the humid Sheko and Bench districts, where they are kept by small-scale farmers who have bred them for millennia for their inherent resistance to disease, particularly tsetse transmitted trypanosomiasis. These cattle are the final survivors of the original *Bos Taurus* (Hump less shorthorn) cattle that were domesticated in eastern Africa for the first time ^[12].

They are much easier to handle because of their smaller stature, slimmer belly and hindquarters, and shorter or no horns. However, their occasionally combative nature and voracious eating habits, especially during the dry season, were cited as unwanted features that led their keepers to purposefully replace them with smaller breeds with reduced feed consumption ^[20]. In comparison to other cattle breeds in the region, Sheko cattle have greater feed conversion efficiency, lifespan, fertility, and good mothering ability. Fast growth and having larger teats than comparable were also mentioned as beneficial characteristics to increase the Sheko breed's milk production ^[20]. It appears that Sheko cattle were intentionally bred to produce milk ^[18].

Farmers' focus groups in Ethiopia revealed that there are substantial fatality rates whenever livestock are transported from highland areas for plow operations. It is feasible to draw conclusions about the potential adaptation mechanisms, such as physiological or genotypic mechanisms suggesting a condition of trypan tolerance, through which the local breed types have evolved. Another explanation is that the trypanosome agent may have used adaptive processes to increase its drug resistance, making it

less virulent. Sheko, a breed that has interbred heavily with indigenous indicine and Sanga breeds, is only found in the southern section of the Bench Maji Zone, close to the neighboring communities of Keffa and Shaka. Sheko cattle are raised in tsetse-infested an area, which probably explains ^[4]. With the goal of reviewing the genetic basis adaptation of the Abigar and Sheko cattle breed in tsetse-infested lowland areas of Ethiopia, the current review was initiated to highlight the information for researchers, breeders, and smallholder dairy producers.

Characterization of Abigar and Sheko cattle breeds

Characterization of Sheko breeds:

One of the indigenous cattle breeds of Ethiopia, the Sheko, is said to be the final survivor of the original *Bos Taurus* cattle that were perhaps the first domesticated animals in eastern Africa. The breed is prized for its milk production, adaptability, and greater trypan tolerance compared to other Ethiopian native cattle populations. The hump less shorthorn taurine cattle, which were first domesticated in eastern Africa, are said to have been replaced by the Sheko cattle breed. They were initially noted in southern Ethiopia in 1929 and again in 1982. The tiny humps that some Sheko cattle currently exhibit is a hereditary trait from zebu introgression. Due to gradual interbreeding with native Zebu and Sanga (Abigar), the breed is now regarded as endangered, and its population size is 31,000 ^[4].

They have a rump that softly slopes. Red dominates the coat's hue and has a glossy aspect. Additionally, they are renowned for having a high milk production rate and traction capacity. It is important to remember that this performance takes place in the warm, muggy surroundings of the native habitat. The Shoa Ghimmira and Sheko regions of southern Ethiopia are home to these short-horned, hump less cattle, which are thought to be trypan tolerant to some extent. They are small and either hump less or only slightly humped. Many of them are polled, and they have little horns. They are either black and white or brown. The cattle in this herd may be the last of the hump less cattle to exist in Eastern Africa ^[22].

Characterization of Abigar breeds

It belongs to the Sanga type, which originated from early emigrations in Ethiopia and extended over south-western Ethiopia and southern Sudan. As a result, these cattle are kept mostly by the Nuer people in the Akobo area of the Gambella region, which is located near the White Nile in the Sudan and nearby lowlands in south-western Ethiopia ⁽⁹⁾. They share characteristics with the nearby Aliab Dinka people of the Sudan, both of whom have kept the real Sanga's huge physique, long horns, and little humps. They have a head with a straight profile, and while their horns can vary in size and shape, they are typically quite long, extend outward and upward, or are oval-shaped. Light-colored coats are the norm ^[2].

The only prominent breed of cow in the area is the Abigar, which significantly contributes to the socio-cultural and economic activities of pastoral and ago-pastoral communities ^[10]. It meets the majority of the region's population's needs for milk and milk products. Given the current high levels of environmental stressors and the intensive management given to the animals, the breed is regarded as productive. Abigar is a breed of indigenous cow that is renowned for its ability to withstand tsetse fly

challenges, high heat load, recurrent flooding, and strong milking and beef production attributes along its breeding tract^[10].

A lack of information about this breed of cattle makes it difficult to determine its current status and to design and implement effective breeding programs and conservation strategies, despite the breed's high importance in sustaining and improving the livelihood of people in the pastoral and ago-pastoral areas of Gambella. It belongs to the Sanga type, which originated from early emigrations in Ethiopia and extended over south-western Ethiopia and southern Sudan. As a result, these cattle are kept mostly by the Nuer people in the Akobo area of the Gambella region, which is located near the White Nile in the Sudan and nearby lowlands in south-western Ethiopia^[9].

Origin and distribution of the Abigar cattle breed

The Abigar cattle are a subspecies of Nuer cattle that are found primarily along the border between Ethiopia and Sudan, with a larger range in Ethiopia spanning the Akobo area of Gambella. They are categorized as "Nilotic Sanga" cattle^[3]. The word "Sanga" is derived from an Ethiopian word that means "bull." This would be evidence that Ethiopia might be regarded as the origin and hub of the spread of Sanga-type breeds, which were developed through crossbreeding between Longhorn, Shorthorn, and Zebu-type cattle beginning before 3000 to 4000 years ago^[17], and the process is still ongoing. Southern Sudan is home to the Abigar cattle along the White Nile (mainly bred by the Nuer, Dinka, and Shilluk tribes)^[3].

The word "Abigar" gets its name from the Abigar people (of the Nuer ethnic group), who truly have a wealth of traditional knowledge and make a significant effort to improve breed management and maintenance. They are known for their traditional management for the breed's continuous usage and improvement, and they consistently prioritize it over other breeds. In fact, livestock producers prefer to refer to the breed as "Nuer breed" or "Anyway breed" by using the ethnic group names of those who predominately raise it because the word "Abigar" is insulting to people throughout the region. However, many literary works utilize and quote the word "Abigar," but it is advised to use the breed names that are already recognized by the locals (such as Nuer breed or anyway breed)^[3].

Adaptability features of the Abigar cattle breed

The Abigar cattle are a sub-type of Nuer cattle that are mostly found in the Ethiopian and Sudanese border regions, with a broader range extending into Ethiopia, covering the Akobo area of Gambella. They are categorized as "Nilotic Sanga" cattle^[3]. The word "Sanga" is derived from an Ethiopian word that means "bull." This would be proof that Sanga-type breeds, which were developed through crossbreeding between Longhorn, Shorthorn, and Zebu-type cattle beginning before 3000 to 4000 years ago, may have originated in Ethiopia and been spread there^[17].

Abigar cattle have special adaptation features that allow them to thrive, produce, and reproduce in conditions of extreme heat, frequent disease outbreaks, and other difficulties. More than 50% of respondents in Ethiopia claimed that Abigar cattle have a higher level of tolerance or resistance to most stressors than other cattle breeds in the area. This ranges from 63.8% for heat tolerance to 71% for withstanding feed shortages as compared to all other

indigenous cattle breeds currently present in the area. Such adaptation is crucial for minimal input farming methods that can progressively develop within locally adapted cattle breeds due to their simultaneous evolution with all the conflicting stresses in arid and semi-arid settings^[14].

The local population will benefit directly from this in terms of food security, resource conservation, and sustainable use. Abigar cattle have a long body length, a big body size, and a medium height. They also have a straight back and a good heart girth, and they have great body conformation. The horns are typically curved and lyre-shaped, and they extend forward and upward in most cases. The horns are typically curved and lyre-shaped, and they extend forward and upward in most cases. In both sexes, they do feature a straight facial profile, a modest hump, and a sloppy rump. In all of the studied locations, white and gray coat colors are quite prevalent in the population, which could have an association with the

Adaptation Attributes of Sheko Cattle

According to more than two-thirds of the responders, Sheko cattle are somewhat trypan tolerant. According to the purported causes of this trait, Sheko cattle are not bothered by biting flies, and even if they are, the consequences are less severe than with Zebu cattle. Black cooler is uncommon in Sheko cattle, whose coat color is known to draw stinging flies. Simulium frustum, or black biting flies, are also greatly impacted by color, finding dark hues more attractive than pale ones and blue, purple, brown, and black more attractive than white or yellow. This was noted by Agriculture and Agri-Food Canada in 2005. Sheko cattle, which are red and white with red patches, have less allure for biting insects. They also mention Sheko cattle.

Sheko cattle are more resistant to biting fly attacks and maintain their body condition, unlike Zebu cattle, making them less likely to get the disease. Trypan tolerance is easily detected by this ailment. They have tough skin that is difficult for flies' proboscis to penetrate. Sheko do not contract the disease during the trypanosomiasis challenge's major season, and even when they do, they do not require regular medicine and recover from the endemic untreated. It is thought that trypanosomiasis deaths in Sheko cattle are substantially lower than those in Zebu cattle^[24].

Threats to Sheko cattle

Sheko cattle numbers were lower than predicted, according to the information from the current study. It was shown that this decline was worse in places with a high human population density. It is important to note that the Sheko is an extremely endangered breed. Further reductions in the number of Sheko cattle have been caused by the rapidly shifting socioeconomic conditions of farmers, ecological trends such as decreasing pasturelands, uncontrolled crossbreeding with local Zebu cattle, and the loss of interest in the breed by a sizable portion of the community^[26]. It was made clear to the participants that the marginalization of the livestock production system and subsequent threat to Sheko cattle result from the incursion of crop farming to feed the growing population at the expense of pastureland. The cultural preference for growing families and the practice of polygamy, in particular, contribute to the studied area's rapid population expansion by elevating children to status symbols. Additionally, the ever-increasing influx of immigrants who came to the region to work as daily laborers

for the harvest of coffee beans before settling there permanently also contributed to the rise in human population and, consequently, the shrinking amount of grazing pasture. According to [4], the Sheko breed of cow is utilized for a variety of producing tasks (Milk, meat), as well as for services like draught and saving.

Disease resistance and adaptability of the Sheko cattle breed

The Sheko breed has been designated as one of Africa's "Big Five" vintage cows with tremendous potential to create the genetic foundation for long-term survival, according to an ILRI report from 2007. The traits of the breed that relate to disease resistance and adaptation to harsh conditions were also discussed by [7]. These traits may be crucial for ensuring food security for current and future human generations. Sheko cattle, in addition to Ndama cattle, are trypanosomiasis-tolerant cattle strains that enable them to thrive in trypanosomiasis-infested regions of the continent, particularly in wet areas of Ethiopia, the south, and the southwest, where trypanosomiasis coverage exceeds 180,000 to 200,000 km² of arable land. This breed's genetic makeup is similar to that of West African Shorthorn cattle [2].

[21] Found that trypanosomiasis had infected more than 20% of Ethiopia's landmass in the west and southwest. This number may even be greater when the northwestern and pocket portions of Ethiopia's south and southeast are taken into account. Aside from its use in trypanosomiasis-infested areas due to its trypan tolerance, molecular characterization of the Sheko breed reveals that it has high genetic diversity and a number of distinct alleles that may be important for the breed's future conservation [7]. This fact emphasizes how important it is to raise trypan tolerant Sheko cattle and develop improvement and conservation plans for this unusually adaptable breed. The breed's molecularly and clinically demonstrated trypan tolerance should be used in either a transgenic technique or a breeding program to increase the productivity of livestock-based farming systems and arable farming systems by providing draft power to tsetse-infested areas in addition to the direct benefits from their products like milk and meat. The preservation of regional breeds that are adapted to the local environment, like the trypan tolerant Sheko cattle breed, is crucial. Traditional or local breeds are firmly regarded as giving the best opportunities to adapt production systems to drastically changing environmental conditions [12].

Treatment and Control of Abigar and Sheko Trypanosomiasis

Between the two world wars, sodium antimony tartrate was historically the only somewhat effective treatment for African cattle trypanosomiasis. However, it required intravenous administration due to the tissue irritation caused by its injection, and a full recovery was only, at most, possible with repeated treatments. With the introduction of synthetic insecticides in the 1940s, control spread quickly. Large-scale tsetse eradication was made possible by the selective spraying of the flora that serves as the flies' food source and later the aerial application of insecticides [23].

With varied degrees of effectiveness, a variety of techniques have been used to control flies. First, pesticides like synthetic pyrethroids that are sprayed or poured directly over the animal show great potential; insecticide foot baths

are also being studied. Second, the sterile male method (SIT), which has the potential to be useful because females only mate once throughout their lifetimes but requires expensive production facilities and can only be used at the end of an eradication campaign when the density of residual flies is very low, Thirdly, pheromone baited tsetse traps are used to attract and capture tsetse flies. These traps are easy to operate, inexpensive, non-polluting, and well-liked by local communities [25].

Conclusion and Recommendation

The objective of this review paper was to assess the genetic foundation of the Abigar and Sheko cow breeds in tsetse-infested lowland areas of Ethiopia. Sheko cattle are more resistant to biting fly attacks and maintain their body condition, unlike Zebu cattle, making them less likely to get the disease. One of the indigenous cattle breeds of Ethiopia, the Sheko, is said to be the final survivor of the original *Bos Taurus* cattle that were perhaps the first domesticated animals in eastern Africa. Due to its desired qualities for milk production, meat production, and the possibility for draft production. The breed is particularly known for its calm personality. Long Abigar cattle have special adaptation features that allow them to thrive, produce, and reproduce in conditions of extreme heat, frequent disease outbreaks, and other difficulties. Such adaptation is crucial for low-input farming methods that can be gradually established using locally adapted livestock breeds that have evolved in tandem with the competing forces of arid and semi-arid habitats. It can be said that the genetic foundation of the Abira and Sheko cattle breeds has better adapted behavior in Ethiopia's tsetse-infested lowlands. The trypan tolerance trait and several adaptation features of Abigar and Sheko cattle, such as tolerance to biting flies, tolerance to heat stress, resistance to tick and internal parasite infestation, and eating, should therefore be further explored through research. Therefore, further intervention and conservation of the Abigar and Sheko cattle breeds should be implemented by all stakeholder groups and policymakers in the lowlands of Ethiopia.

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