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The Relationship between Animal Microbiome and Domestication Syndrome

Zahra Bolooki[1*], Mohammad Reza Jafarzadeh Shirazi [1]

[1]Shiraz University, Faculty of agriculture, Department of Animal Science, Shiraz, Iran

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***Corresponding author:** : Zahra Bolooki, Shiraz University, Faculty of agriculture, Department of Animal Science, Shiraz, Iran. Email: Z.blooki@yahoo.com*

Abstract

Different views about traits in domesticated animals compared to wild species have always been expressed. Factors that are more obvious are always examined earlier and determined their impact. In cases like this (DS), one does not have the ability to respond to all parts of the section in the face of syndromes. Given all the physiological, genetic, and neurological factors present, it is also likely that after the domestication of the microbial flora the body will be nourished and the environment around it and the whole body microbiome will cause changes to the behavior. While most studies of the interaction of the microbiome and the nervous system have demonstrated the role of the microbiome in various behavioral and physiological segments and reactions, in cases seen after the complete elimination of germs in the animal body, the amount the extent of social behavior and the like have been affected. Accordingly, it is likely that the secondary factor contributing to the stabilization of domestication syndrome is the microbiome and it may play a role in controlling the nervous and behavioral systems in domestic animals.

Key Words: Domestication; Syndrome; Microbiome; Animal.

Introduction

Domestication syndrome is caused by several factors. History of domestication dates back to about 15000 BC and the wolves (Canis lupus) were the first domesticated vertebrates; human beings cultivated the ability of dogs (Canis lupus familiaris) to confront predatory animals, to protect their property and to secure their safety [1]. In the present century, biomass of domesticated animal is considerable; the amount for cattle is more than the total wild animal population [2].

Domestication syndrome is a term used for animals that have the same features (Table 1). Initially, Brown et al (2008) used this term for crop plants [3]. It is noteworthy that, animals that can be domesticated must have characteristics such as: 1) variable diet, 2) rapid growth rate, 3) ability to live in a surrounded environment, 4) admirable demeanor for animal, 5) no tendency to violence, and 6) a social hierarchy [4].

Generally, two key preventive factors are associated with animal domestication: weakening human threats and reducing reactions to external stimuli [5,6]. An important factor in selection pressure is applied by humans [7].

Domestication syndrome is a term used for a set of similar traits in domesticated animals; the term was initially used for domesticated crops. The question of how biological inheritance occurs and how animals will produce a domesticated population after domestication, what the origin of each trait is, and what the percentage of transmission in each is remain. There are different theories in this regard, and hypotheses have been put forward by scientists like Mendel and Darwin to find answers to these questions. The biggest gap in the science of the ancestors was the

Table 1: List of traits altered in domesticated mammals

Traits	References
Docility	[8,9]
Reproductive cycles (more frequent estrous cycles)	[8,10,11,12,13]
Smaller brain or cranial capacity and teeth	[8,10,11,14,15]
Neotenous (juvenile) behavior	[6,16,17,18]
Curly tails, Floppy ears, Reduced ears, Shorter muzzles Mouse	[8,12,13,14,15,19,20]
Depigmentation (especially white patches, brown regions)	[8,13,18,19]

lack of knowledge of the genetics and the factors that influence it, but with the development of this science there is still no definitive answer to all the traits related to this syndrome. Darwin (1868)cited two explanations of living conditions and intersectionality in justifying the traits, years later Belyaev et al. (1979) considered living conditions a factor in epigenetic and ultimately genetic change [21]. Trut et al. (2004), pointed to the discussion of single genetic regulatory networks, each of which has disadvantages and does not cover all aspects of the syndrome. Some researchers believe the role of the nervous system and changes from the beginning of pregnancy to adulthood show that altered traits in this syndrome are associated with the rate of neural crest cells migration [22]. Given all the genetic and neural factors available, it is also likely that after the animals are domesticated, the microbial flora of their bodies will undergo

 ***Corresponding author email:** *Z.blooki@yahoo.com*

changes in nutrition and the surrounding environment, leading to changes in the appearance and stability of domestication syndrome [23,24]. With these interpretations, this paper attempts to study the changes that result from differences in microbial flora in animals and to clarify the possible role of fluorobacteria in the persistence of this syndrome.

Selective Pressure

The purpose of domestication in any creature is to determine the traits that will be evident in the future. As a result, the selection pressure is not the same in each creature, and firstly, depending on the organism, the acceptance of the pressure is different, and secondly, the goals that are in line with the choice will also be effective [25].

Genetic Base

The main gap in Charles Darwin's theory of evolution, as presented in the first edition of "The Origin of Species" was the lack of theory of inheritance. In this edition, Darwin does not write anything about the operation of biological inheritance [26]. Several decades before there was any science of genetics, his information relied more on data disclosed by farmers and herbalists. Following Darwin's suggestion that the source of changes in domesticated animals is ultimately the low-invasive "living conditions" created for domesticated animals, Belyaev (1979) believed that reducing stress levels in living animals in a protected artificial environment lead to numerous changes in hormone responses and these patterns reset gene expression. In the current terms, he suggested that the initial changes were epigenetic, but over time the genetic changes were fixed [21]. Trut et al. (2004) recently suggested that there is a Genetic Regulatory Network (GRN) based on DS traits and this syndrome is due to changes in relatively "high" regulators, leading to impaired downstream gene regulation involved in the development of different types of tissue being affected in DS [22]. These changes in high-current regulators can be either constant (germ-line transmissibility) or actual (genetic) mutations. In essence, this explanation can account for the variety of features displayed on the DS.

Nervous system

Wilkins et al.'s (2014) hypothesis is based on the assumption that the development of diverse traits characteristic of the domestic syndrome is closely related to NCC and can be readily understood in relation to adrenal size and function in this animal, which are also effectively implicated in physiology of fear and stress responses are essential. Adrenal function and decreased levels of stress hormones are well known in domesticated species [27]. Accordingly, Wilkins et al. (2014) hypothesized that early selection for domestication leads to a decrease in neural-crest cells related to behavioral control, and that this function of the nervous system has been established as an unselected byproduct. The marked changes in pigments, jaws, teeth, ears, etc. that are exhibited in domestic syndrome are due to the mild defect in the migration of these cells during embryonic life compared to wild species; Table 2 show that some genes have roles on NCC migration [27].

Table 2: Some genes related to NCC migration

Gene Name	References
SOX gene family	[28,29,30,31,32,33]
Wnt	[34]
Bmp	[35]
Pax	[36]
Dlx	[37]
Snail	[38]
AP-2	[39]

Behavior Changes

Such a decrease in acute fear and long-term stress is a prerequisite for successful breeding in captivity [9, 40]. Like the study of Trut et al (2009)., the basis of the tameness mechanism is traced to the reduction in size and function of the adrenal glands, which play a central role in the physiology of both fear and stress response. Decreased adrenal gland activity and stress hormone levels are well documented in experimental domestication species [13]. So, in this case, there is a need to focus on HPA axis in the domestication process. Researchers intent to tame is actually a process based on the HPA axis interactions process and the 5 hydroxytryptophan system (5HT). Some of the most important parts of the brain that play a key role in mood control are the hippocampus, amygdala, and the cingulate or singular limbic region in general. These regions are sensitive to glucocorticoids and are internalized by serotonergic projections [41]. If stress decreases as a result of cortisol levels, serotonin levels rise. Conversely, an increase in serotonin levels results in a decrease in cortisol levels. Lower cortisol and higher serotonin levels in the brain increase social behaviors, adolescent social behavior, and learning ability while decreasing aggressive behavior. Therefore, changes in HPAaxis and 5HTsystem interactions are of particular importance in relation to stress and domestication processes in animals [42].

Microbiome

One of the main beliefs about the symbiosis of microbes and animals is that they choose their host and it is not related to probabilities [23]. It is notable that mostly microbes weight in some species is heavier than their brains and absolutely, they have DNA and it is observed in the different situations that it can affect the physiology [43, 44]. Furthermore, predigestion is one of gut microbiome duties which scientists have found could lead to dysphoria on the dietary decision for their hosts [45]. We live in a microbial world. The germs colonize the intestine and the outer surface of the animal as well as some reproductive organs. Some animals even have specialized organs that have selected groups of microbes. In general, despite the dispersal of microbes, the relationship between animals and microbes is not random [23].

Given the relative proportion of microbes and microbial genes in the animal body as well as the fidelity of these relationships in the animal generation, researchers have referred to these groups as "holobiont" and suggest that holobionts are valid units of choice in animal evolution [46, 47]. This idea is known as the hologram model of evolution [47, 48, 49]. This change has the potential to definition to us as evolutionary changes, often as changes in gene frequency over time. Brucker & Bordenstein (2013), for example, argue that we should think of the evolution of animals as a change over time in the frequency of genes in the nucleus, in organelles and in microbial coexistence [50]. Thereupon the animal will be housed in a specific environment for domestication, according to which the nutrition of the environment will change and such will eventually affect the body's microbial flora [23,24]. Scientists have argued in recent years that the microbiome in all living organisms plays a major role in the physiology and control of different systems of the body and is capable of causing genetic and neurological changes, so that it may be argued there are microbial differences with their wild species that justify the different traits created in domesticated animals [6,51,52,53].

Conclusion

One can say so, possibly, one of the effective factors that can play a role in domestication syndrome is the microbial flora in the creatures' body. Microbial flora is be capable of affecting different parts and systems of the body based on the said roles. Domesticated animals experience similar conditions and factors in the domestication process that create the same microbial flora in each species. And by natural selection and adapted to their environment, compatible microbes have also been able to affect their state of host.

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