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Original Research

Can Scientists Influence Donkey Welfare? Historical Perspective and a Contemporary View

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ABSTRACT

Humans have greatly benefited from their relationship with donkeys. Different roles that donkeys play in high- and low-income countries are two sides of the same coin. Their draft power is indispensable in low-income countries, and by contrast, their milk in Europe is fetching a premium. New productive niches are controversially being explored, for example, donkey meat and skin (ejiao); both are considered premium products and have increased value of donkeys in many developing regions of the world. New advances in human medicine are starting to consider possibilities of donkey serum and heart valves. Scientists and channels that they use to spread their knowledge directly influence public interest and implementation of welfare practices in domestic species, indirectly affecting their survival. The study's aim was to trace historical registry of www.sciencedirect.com directory from 1896 to 2018 to assess trends followed by articles dealing with donkeys. Publications with 22 themes and 114 publications (91 JCR indexed journals) from 56 countries were included. JCR impact index was scored to study influence of publications dealing with donkeys. Chi-square test tested six variables, randomly influenced by the rest. Cramer's V measured strength of association between variables. Statistically significant differences were observed between almost every combination of variables except for year and JCR impact, year and area/topic and country of the corresponding author, and area/topic of submission. JCR impact and journal influences the area of the articles that are published. As some countries are more specialized in certain themes concerning donkey-related sciences, they are more likely to publish.

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1. Introduction

Throughout time the donkey, *Equus asinus*, a member of the Equidae family, has played a pivotal role in civilization, especially in regards to development. According to the Food and Agriculture Organization, in 2002, there were over 44 million donkeys worldwide, 13.3 million mules and hinnies, and 52 million horses. Most of the world's donkey population is located in developing regions of the world. Industrialized nations such as the United States and most of Europe have far fewer donkeys than horses [1]. Owing to

increased interest and popularity of the mule and hinny (reciprocal hybrid cross, a male horse and a female donkey) as trail mounts or show animals, donkeys are once again gaining in popularity in the United States [2]. The donkey's popularity has also grown internationally. This is especially true throughout Africa where the donkey has often replaced oxen due to extended periods of drought, deforestation, and increased human population [3,4]. Despite the valuable contributions donkeys make toward society, particularly in developing areas of the world as well as the growing use of donkeys for production of food products, very little is known about the proper care and management of this species, and their welfare is often neglected [5].

Furthermore, the defining role of donkeys and their relationship with humans is constantly changing. A new and evolving role of donkeys in a production sense is taking off. Donkeys are commonly being used for milk production in Eastern Europe and for skin and meat production in Asia. Defining good welfare and agreeing on what's best for donkey welfare is often not straightforward and there are many viewpoints [5].

Animal welfare/Ethical statement: No animals were harmed in this study. All data was gathered from studies that had received institutional approval from their Animal Care and Use Committees.

Conflict of interest statement: No conflict of interest was present or occurred based on authors commitment to this research.

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The attention provided to species is greatly affected by science. According to www.sciencedirect.com, although donkeys came into the scientific scene in 1896, the interest of scientists in donkeys slowly increased through the years with barely a few articles published (Fig. 1). The scientific relevance of donkeys has remarkably improved through 2017 as a new record has been hit with 57



Fig. 1. Number of papers focused on donkeys from 1880 to present.

articles dealing with different topics involving donkeys or their products. The upcoming year, 2018, is showing promise for an increase in donkey articles with four articles already being accepted into publication at the end of 2017.

The donkey could be considered the most historically derogated one of all times. The advances in different areas related to donkeys and the power that such factors exert, may raise the interest in the species among the scientific community and society. Thus, studying the publications of international authors and their impact factor, we could obtain indirect estimators of the welfare progress achieved by the species.

2. Materials and Methods

To obtain the sample used for this study we accessed the www.sciencedirect.com and typed the word donkey on the regular searching window of the site on December 22, 2017. We exported these data into a .docx file, and we checked every reference on the list registering the name of the journal, its Journal Citation Report Impact, the number of authors, the country of the corresponding author, the year of publication, the topic or area in which each publication could be classified and its doi (Supplementary Table 1). Data collection was carried out from December 22, 2017 to December 28, 2017 to record the most updated articles possible before 2017 ended.

2.1. Statistical Analysis

A Kruskal–Wallis H test and a chi-square test were used to analyze whether the results for each of the six variables independently (journal in which the article was published, JCR impact factor, country of origin of corresponding author, number of authors, area or theme, and year) were randomly influenced by the five remaining. Cramer's V was tested to measure the strength of association between each variable using the Crosstabs procedure from SPSS Statistics for Windows, Version 24.0, IBM Corp. (2016).

3. Results

When the word donkey was typed onto the www.sciencedirect.com website searching engine, we obtained 40,365 results. These results can be classified according to the year as continues 2018 (359), 2017 (3,030), 2016 (2,476), 2015 (2,482), 2014 (2,399), 2013 (2,317), 2012 (2,172), 2011 (2,112), 2010 (2,020), 2009 (1,868), and from 2009 to 1895 (19,130). The incidence of publications dealing with donkeys steadily decreases to a very irregular anecdotal level before 2009. The mean in such 114-year period (1895–2009) is 167 articles per year so that we decided to group them. When we classified the documents published according to their article type, we determined that 804 were review articles, 32,713 were research articles, 228 were encyclopedias or encyclopedia entries, and 1,778 were book chapters. About 6,302 were open access articles.

For the first time, we filtered the data to aim towards ruling out articles in which neither the word donkey or any reference to the species, *Equus asinus* appeared. We discarded those articles in which the words jenny, jack, donkey, ass, equid, equine, and their plural forms were not present. This filter was applied on the whole article, checking for whether these words were present, at least in one occasion, and whether they referred to the donkey species or other unrelated homophone terms. This filter reported a list of 526 articles. Of these articles, 494 were research articles, and 32 were divided into the rest of article type categories mentioned previously. The articles came from 56 different origins (according to the location of the corresponding author's affiliation).

We studied the whole historical record of 114 publications (23 books or JCR nonindexed journals and 91 scientific journals indexed in JCR). JCR citations report index was the only index considered. Those articles that had not been indexed in the JCR report were given a value of 0. The whole database used for our study can be

found in [Supplementary Table 1](#). A complete list of the journals that were included in the study and the number of articles published in each is shown in [Supplementary Table 2](#).

The highest JCR impact of an article on donkeys was reached by “Efficient electricity generation from donkey farm wastewater by

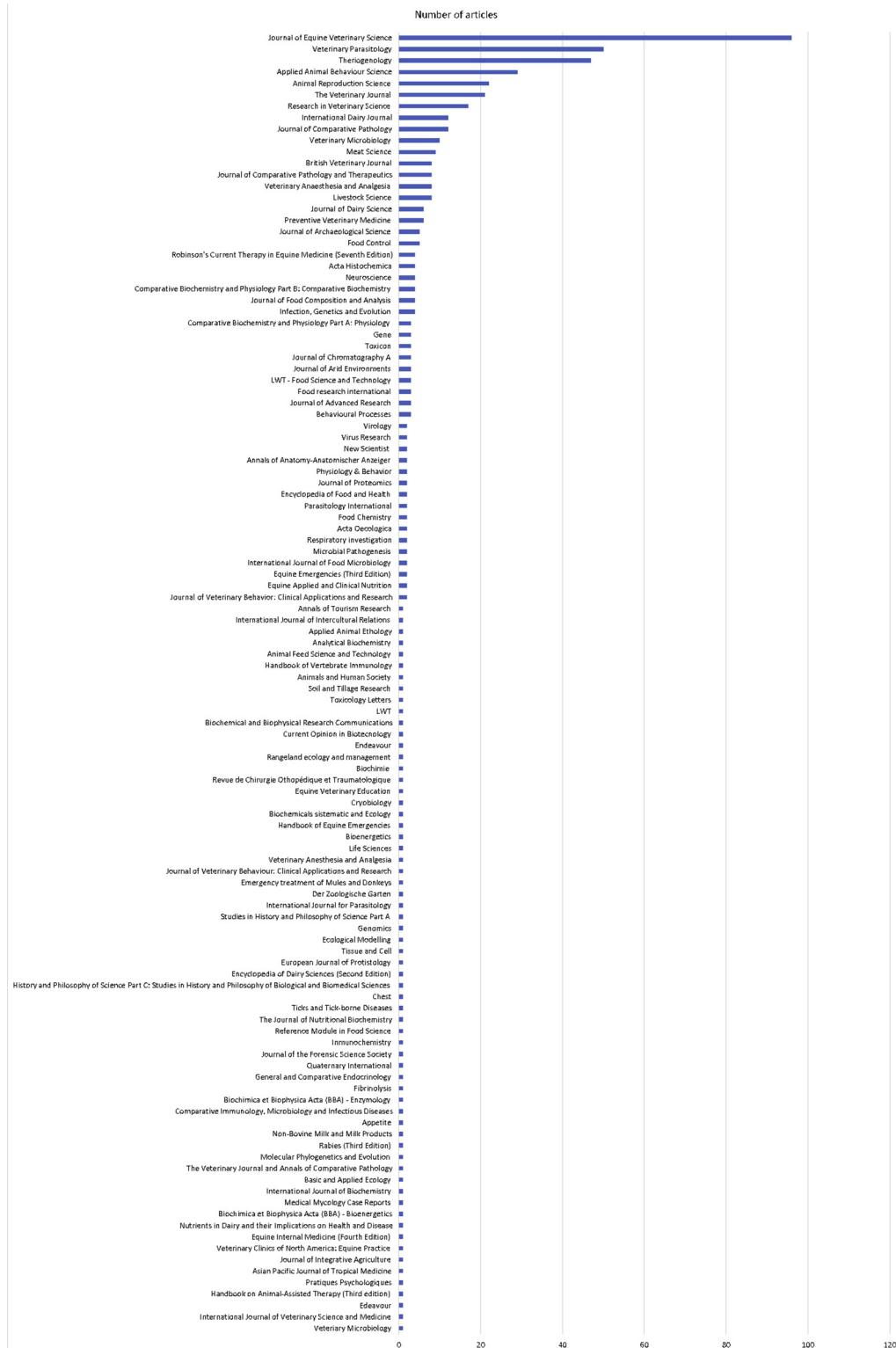


Fig. 2. Number of articles on donkeys found in specific journals.

using microbial fuel cells". The authors Luan Jingfei, Chen Mengjing, and Zou Zhigang from China published it in *Current Opinion in Biotechnology* (<https://doi.org/10.1016/j.copbio.2013.05.224>), and it was classified in the environmental sciences and ecology category. The articles with the lowest JCR score were those published in the *Endeavour* journal, with 0.3022.

In the same way, a complete list of the areas in which the articles were classified, with the mean number of authors per article published can be found in [Supplementary Table 3](#) and [Fig. 2](#). [Fig. 3](#) shows the number of articles published on each area/theme.

A ranking of the different number of articles sorted by the area or topic that they dealt with and considering the country of origin of their corresponding author is shown in [Supplementary Tables 4 and 5](#)

A summary of the frequency of different number of authors per article is shown in [Supplementary Table 6](#).

[Table 1](#) shows a summary of the results of the Kruskal–Wallis H test, statistical significance, and strength (Cramer's V) of each variable on the five variables remaining. Three main themes of uses for donkeys have been defined: donkeys as draft animals, production, and companion. Information focused on welfare and care of donkeys used for these various areas is discussed per topic.

4. Discussion

4.1. Donkeys as Draft Animals

Donkeys are considered by most farmers to be hardier than a horse, can survive on fewer resources, and can adapt to harsher environments. Furthermore, they are highly heat and dehydration tolerant, making them suitable for semiarid climates [6,7]. Most donkeys are not individually fed; rather, they are turned loose to forage on their own. Veterinarians are generally not called in to treat sick or injured donkeys in developing countries unless free veterinary services, such as the Society for the Protection of Animals Abroad are available [8]. Therefore, it is not uncommon to see donkeys working with chronic conditions and little to no pain relief or treatment is available. Other management problems include primitive and ill-fitting harness that is often described as cruel because it causes galling and sores [8,9].

The average life of a working donkey is less than the donkeys in developed countries (10 years compared with the United States, which is 28 years). The longer a donkey lives, the longer the donkey could provide economic opportunities for smallholder farmers [9]. The use of the donkey is a very practical approach to energy-limited transportation and farming in developing countries, but more knowledge on the care of these animals and methods of harnessing and hitching needs to be provided to owners [8,10,11]. Other challenges that working donkeys have traditionally faced involve end of life decisions and how to manage animals that can no longer work. Oftentimes, these animals have been turned loose or a few have been sold or given to zoos for meat for zoo animals. However, a new constraint is now facing working donkeys in South America and many African countries such as Kenya, Ethiopia, Zimbabwe, Mali, Niger, and Nigeria Republic, and that is the loss of working donkeys to the meat and skin industry. The pressure of people selling donkeys that families have depended on for agricultural purposes or domestic chores for a quick return or the loss of donkeys being stolen for meat and skin is creating a lack of working donkeys for some of the world's poorest farmers [12].

Work is no longer a useful role for donkeys in developed countries. The industrialization process occurring during halfway through the 19th century pushed this species into a background functional secondary position; that is, donkeys were no longer necessary for the purposes they have traditionally been

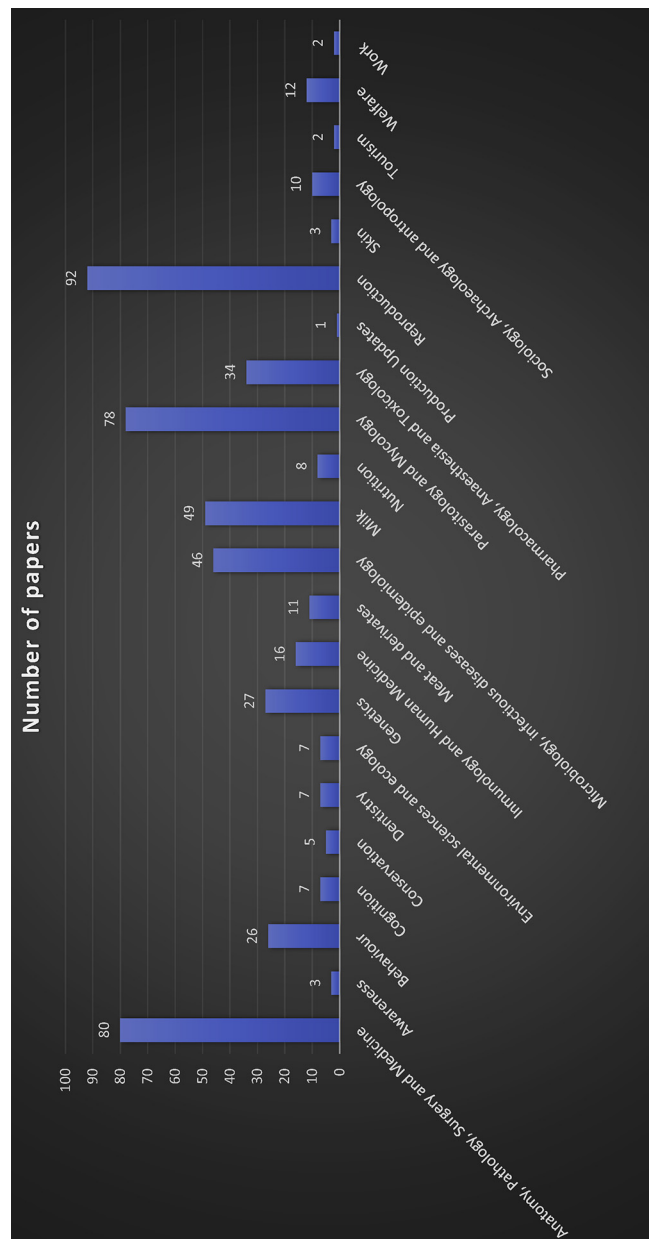


Fig. 3. Number of articles and specific topics related to donkeys that have been published.

used—work and mule production. From a scientific perspective, the fact that most of the journals that are indexed in the JCR ranking are based in high-income countries, may be the main reason why only two references were found concerning the role of donkeys for work, one dating from 1997 (Sweden) and the other from 2015 (Egypt), as shown in [Supplementary Table 1](#). However, this situation changes when we search in local information resources in low-income countries.

4.2. Donkeys as Production Animals

The rapid increase in using donkeys as a source of meat, milk, and skin is creating an interest in the management and requirements of donkeys [13–17]. Donkey dairies are a growing agro-commercial industry in Italy, Turkey, and Serbia. In reality, drinking and using donkey milk is not a new concept. Because donkeys were

Table 1

Summary of the results of the Kruskal–Wallis H test, statistical significance, and strength of each variable on the rest of six variable tested.

| Variable | Parameter | Publication Name | JCR Impact Factor | Country of Corresponding Author | Number of Authors | Area/Topic | Year |
|---------------------------------|------------|------------------|-------------------|---------------------------------|-------------------|---------------|---------------|
| Publication name | χ^2 | Same variable | 525.000 | 167.481 | 225.440 | 257.197 | 231.038 |
| | df | | 112 | 112 | 112 | 112 | 112 |
| | P-value | | <.001*** | <.01** | <.001*** | <.001*** | <.001*** |
| | Cramer's V | | 1.000 | 0.511 | 0.582 | 0.753 | 0.525 |
| JCR impact factor | χ^2 | 55.687 | Same variable | 17.817 | 29.595 | 11.295 | 31.254 |
| | df | 6 | | 6 | 6 | 6 | 6 |
| | P-value | <.001*** | | <.01** | <.001*** | <.001*** | <.001*** |
| | Cramer's V | 1.000 | | 0.432 | 0.540 | 0.686 | 0.451 |
| Country of corresponding author | χ^2 | 79.188 | 95.083 | Same variable | 218.589 | 59.026 | 173.765 |
| | df | 55 | 55 | | 55 | 55 | 55 |
| | P-value | <.05* | <.001*** | | <.001*** | ns | <.001*** |
| | Cramer's V | 0.511 | 0.432 | | 0.328 | 0.352 | 0.436 |
| Number of authors | χ^2 | 23.437 | 48.020 | 52.319 | Same variable | 15.198 | 112.251 |
| | df | 15 | 15 | 15 | | 15 | 15 |
| | P-value | <.05* | <.001*** | <.001*** | | <.05* | <.001*** |
| | Cramer's V | 0.582 | 0.540 | 0.328 | | 0.203 | 0.293 |
| Area/Topic | χ^2 | 134.217 | 125.021 | 53.421 | 61.669 | Same variable | 87.281 |
| | df | 21 | 21 | 21 | 21 | | 21 |
| | P-value | <.001*** | <.001*** | <.001*** | <.001*** | | <.001*** |
| | Cramer's V | 0.753 | 0.686 | 0.352 | 0.203 | | 0.343 |
| Year | χ^2 | 111.335 | 54.152 | 78.129 | 163.585 | 47.047 | Same variable |
| | df | 57 | 57 | 57 | 57 | 57 | |
| | P-value | <.001*** | ns | <.01** | <.001*** | ns | |
| | Cramer's V | 0.525 | 0.451 | 0.436 | 0.293 | 0.343 | |

Abbreviations: df, degrees of freedom; ns, nonsignificant.

Levels of significance are indicated by *, **, and *** for $P < .05$, statistically significant, $P < .01$, very statistically significant, and $P < .001$, highly statistically significant, respectively; $P > .05$, nonsignificant.

domesticated, their milk has been used by many different societies and communities especially in developing countries. Not only human consumption was its main application but also it was used for many medical purposes. The Egyptian Queen of the Nile, Cleopatra, was known to take a daily bath in donkey milk because she thought it kept her skin youthful [18].

Recent medical research has found feeding donkey milk to young infants to be an alternative to feeding milk from other species, against which children may have allergies. The specific allergy is called “cow's milk allergy” [19]. The composition of donkey's milk compared with other mammalian's milk has shown that donkey's milk is the readily available natural milk closest to human milk [18]. Italian researchers have also documented that donkey's milk is the best choice if human milk is not available. The milk is similar to human milk when comparing several key milk components such as lactose, protein, minerals, and omega-3 fatty acids [19–21].

Welfare challenges for donkeys used for dairy production include how to address disease and parasite infestation. Because the product is being used for human consumption, oftentimes, donkeys go unvaccinated and/or dewormed. Many of the dairies are closed herds but run the risk of infectious disease possibly decimating a whole herd. There is very little to no research available looking at residues of medications and vaccines in the milk. So, researchers have begun to focus on how to evaluate healthy lactating donkeys based on body condition scoring systems that account for the neck crest score as well as body condition score [5] and comparing blood chemistry parameters for donkeys in different stages of lactation [18]. Additional studies are comparing body condition with milk production. Biochemical properties have been compared during various stages of lactation, so clinicians can better identify healthy donkeys during lactation [18]. The donkey dairy industry is generating some of the latest internal medicine research focused on donkey health as well as a continued supply of research based on the overall wellbeing of donkeys kept in production systems. In addition, this industry has provided a new use for donkeys and has addressed the preservation efforts of many

once-endangered donkey breeds in Italy. Many of these almost forgotten breeds such as the Ragusana, Amiata, and Martina Franca to list a few have once again found a purpose [5].

Interestingly, Italian articles on donkey milk were the most numerous articles on a specific theme per country for the whole species above all the countries and areas. These articles presented a higher mean number of authors per article that could indirectly inform of the complex nature of this theme, when compared with other themes that required a less participative work (Supplementary Tables 1 and 4).

New advances in human medicine are starting to consider the immunological possibilities of donkey serum and heart valves. Sixteen articles coming from countries such as Japan, the United States, and China, which are highly developed in terms of human medicine research, may open the opportunity to new scientific or therapeutic niches.

A recent area that has increased exponentially is the consumption of donkey meat and skin products in the Asian market place.

This is reflected in the amount of recent articles published on the subject, with a total of 11 articles mainly coming from Italy, Turkey, and Spain (Supplementary Table 1). The baseline price for donkeys has increased dramatically in developing countries leading to large numbers of donkeys once used for draft purposes being sent for slaughter and their products being exported to Asia. The increased demand has impacted the global population of donkeys with outsourcing to many developing countries with large populations of working donkeys. In many countries throughout Africa, donkey slaughterhouses have been set up and have created additional welfare concerns from transportation, zoonotic disease transfer, care in holding facilities, and methods of processing such as humane slaughter with captive bolt versus slaughter in the bush with axes [22]. Biosecurity measures are another area of concern with carcass disposal at the slaughter facilities. Some places have the capacity to process the meat and ship, and others are left with numerous carcasses to dispose of which have been reported ending

up in canals as well as thrown in large pits creating once again biosecurity hazards for people and other livestock and wildlife in the area [12,13,18].

The lack of consistency and knowledge in donkey processing has led to donkeys dying of dehydration, inhumane bush slaughter, as well as an impact on small shareholder farmers who have had donkeys stolen from them and no longer have a draft animal. Reports of donkeys being skinned alive and killed with toxic compounds are all part of the welfare concerns associated with the growing market [17]. Other concern with the processing of skins is transmission of infectious agents such as *Bacillus anthracis* the agent of anthrax and *Clostridium tetani* which causes tetanus. The anaerobic conditions are prime for soilborne infectious agents, and oftentimes, the diseases may be introduced into new areas from the transport of donkeys into new areas [12].

The transportation and movement of donkeys is also increasing the threat of spreading infectious diseases such as glanders, African horse sickness, equine infectious anemia, and equine piroplasmiasis [12,17].

Donkeys are being transported for long distances in many countries in East, South, and West Africa along with several countries in South America such as Brazil [12,18]. During these long hauls, the donkeys are restricted of water, food, veterinary care, and even the ability to stand upright. Researchers have documented donkeys being transported with their legs tethered [22]. The donkeys are tied with three legs bound and placed on top of one another and transported for distances greater than 1,000 km or more than 20 hours [22]. Empirical observation reveals rectal prolapse, severe lameness and lacerations, or even death as the most common issues to be found as a result of the deficient conditions provided to the donkeys on arrival [12,16,17].

Other areas of concern are focused on product quality and safety with some of the products deriving from donkeys that are progressively growing in popularity. There is little knowledge of the cycle, pathology, and symptoms of the toxicological conditions from which donkeys can suffer, and thus, the understanding of the metabolites deriving from such toxicological conditions and the repercussion that they may have on human health becomes a critical point to control.

In places such as Kenya, Egypt, Brazil, and Australia where donkeys graze on flowering plants from the *Indigofera* family, which produces a toxin called indospicine, 3-nitropropionic acid poisoning has been found in meat and skin products [17]. This toxin has been found to kill other livestock such as cows, camels, goats, chickens, or even dogs that have consumed the poisoned products from animals affected have then died [17]. Although developing the clinical apparent symptoms is not compulsory, the toxin is found to accumulate in muscle tissues and causes liver lesions and abortion by limiting arginine and causing a destruction in protein synthesis in equids [17,19]. Lesions characterize by small, nodular, and yellow affected livers associated with jaundice, ascites, elevation of alanine aminotransferase levels in serum, a tendency to bleed, and signs of hepatic encephalopathy.

3-Nitropropionic acid is another toxin commonly found in the *Indigofera* species that are browsed by donkeys. Donkeys are considered to be browsers versus grazers like horses, which made them especially prone to feed on the *Indigofera* poisonous plants. The condition that they develop is called Birdsville horse disease or grove poisoning and gathers numerous reports from the state of Florida in miniature donkeys where the presence of the plant is common [18,22–31]. So, product consistency, source of donkeys, and managing donkeys in intensive production systems is an area of welfare and management that needs additional research.

4.3. Donkeys as Companion and/or Recreational Animals

The largest welfare and management concern for donkeys kept as companion, guard, and/or recreational animals is likely obesity and laminitis. Owing to the donkeys' ability to be an easy keeper and survive off of poor quality forages, many donkeys kept in industrial nations are overweight. Another problem is their stoic nature that makes it challenging for owners to detect pain or signs of colic and laminitis. In addition, many practitioners are now faced with treating donkeys and little to no information is available on some of the most basic health care parameters such as blood biochemistry and hematocrits. Thus, many health chronic conditions may go unnoticed.

One of the most remarkable areas in terms of number of articles published is anatomy, pathology, surgery, and medicine. With 80 articles published worldwide, this may be a sign of the importance to know this species in a deeper way. The more information that we know about the species, the more accurately and approximately, the critical points related to welfare issues, could be addressed as well.

The donkey has provided much interest in terms of scientific curiosity. Unfortunately, little research has been devoted to better understanding their superior ability to adapt and survive in harsh, resource-poor environments until recently. The growing interest of donkey breed preservation and their use as a production animal for human consumption [1] has made it take on a new role that determines the need to adapt to a situation in which they are intensively managed and pushed for food products. How will the requirements and management differ from maintaining donkeys to production animals?

One difference when considering caring for donkeys is their behavior. There are many misconceptions about donkeys that are associated with their seemingly peculiar ways, such as mistaking caution for stubbornness [1,6,27,28]. Some researchers have stated that traditional rules for horse management are detrimental to the donkey [1]. Oftentimes, training or even routine procedures require more patience and effort than when working with a horse [28]. Unfortunately, their behavior has often been misunderstood and in some cases animals may have been treated more harshly than they should have been or pain goes unrecognized due to their stoic nature. In general, most owners have acquired a great sense of patience in dealing with donkeys [32,33]. Donkeys are described to have a “fight” behavior, meaning they will not expend the energy in running away but instead will hold their ground and fight off the predator [33].

Play and socialization are important in domestic donkeys because they establish a social hierarchy as well as aids in development of dominating strategies such as learning to fight, biting in key locations such as the throat latch, and knees [34]. Play and socialization should be considered a compulsory requirement for keeping donkeys as companion animals or in intensified production systems, given their psychology and tendency to suffer from loneliness, when they cannot interact with congeners. Donkeys often seem to become very attached to a mate or another equine [29]. Donkeys have been observed showing signs of depression or distress when their mate is taken away or dies [29]. The sensitivity that has been addressed by other researchers may account for the expected increase in stress experienced by donkeys in intensive production conditions such as those occurring when separating foals for milking. The concern with stress in donkeys is the relationship of stress to hyperlipemia onsets. The articles related to stress were included in the behavior category as in these cases, hyperlipemia among others were the consequences of such stress. Behavior articles reach a number of 26 worldwide from which 20 were from the UK, the United States, and Italy. Cognition deserved

to be treated as a separate category as there are publications that deal with this specific field, although it could have been included in the behavior section. Furthermore, the number of articles in the section made us decide to use a different category for cognition. Italy, the UK, and Spain were the main contributors to the cognition category.

4.4. Management—Body Condition Scoring, Parasites, and Production Systems

Management schemes vary according to location and use of the animal. Donkeys in developing countries are often faced with overwork and poor nutrition but donkeys in industrialized nations are typically exposed to little or no work and abundant sources of nutrients [4]. The use of donkeys in production present new nutritional challenges. Donkeys that are lactating must produce enough milk for the foal as well as for production. The nutritional needs of lactating donkeys have yet to be fully researched and defined. Growing donkeys for meat production is another area of interest in certain regions of the world. Current farming systems in China are looking at growth intervals of 2–3 years in production models and currently feeding donkeys a total mixed ration [35]. However, considering the nutritional efficiency of donkeys, growing young donkeys at such an accelerated rate may present problems such as colic, gastric ulcers, osteochondrosis, and even laminitis. However, production systems in China have evaluated accelerated growth programs in 64 diets in five phases and claimed to improve the average daily gain and shortened the marketing period by 9–10 months. In this sense, the same study would address an increased daily gain for donkeys in such marketing period from 120 g to 250 g, without reporting the incidence of adverse health problems [30].

A major problem in the United States is obesity in donkeys. These animals become extremely obese due to overfeeding, yet their owners may be feeding far less amounts than to a horse of the same size [4]. These animals are also predisposed to developing fatty liver or hyperlipemia [4]. Laminitis often occurs in all four feet of donkeys and sometimes only in the rear [29]. Often a donkey will not show signs of colic until it has passed the point of survival due to their high level of pain tolerance before exhibiting behavioral signs [23]. It is assumed that donkeys that go off feed for several days may be suffering from colic, hyperlipemia, or hyperlipidemia [28,29].

In general, donkeys are considered to be more resistant to disease such as African sleeping sickness and have less laminitis issues, or these conditions exist more frequently than we know without diagnosis. These animals can live longer (average 27 years) than a horse if properly maintained [4]. Donkeys are subject to hosting lungworms and sarcoid tumors [28,29]. However, the new demands placed on donkeys for milk, meat, and skin production may change how donkeys are fed [5,30].

Other considerations for monitoring the nutritional status of donkeys as a welfare indicator include body condition scoring systems. A scale of 1–5 along with using a fatty neck scoring system and dental scores can be most effective in determining the overall nutritional status and welfare. However, those scoring the indicators must be properly trained in scoring [5]. Another factor that can decrease body condition scores is parasite infestation [36]. Donkeys commonly harbor lungworms and are targets for cutaneous habronemiasis. External parasites such as biting and sucking lice are commonly seen in donkeys kept in large groups and/or inside stables [37].

Parasitology is the third category to gather the greatest amount of articles published. The origins for such articles were Algeria, Belgium, Brazil, Burkina Faso, China, Czech Republic, Denmark,

Egypt, Ethiopia, Gambia, Germany, India, Ireland, Israel, Italy, Jordan, Kenya, Malawi, Morocco, Nigeria, Pakistan, South Africa, Spain, Sudan, the Netherlands, Tunisia, Turkey, the UK, the United States, and Zimbabwe. The contribution of English parasitology articles with their works on low-income countries was also remarkable. Reproduction is the category for which the highest number of articles was published. Italy and Spain come into scene as the reference countries for donkey reproduction, with 92 articles presented in high-impact journals as seen in [Supplementary Table 1](#).

4.5. What Can Scientists Do About Donkey Welfare?

As it could have been expected, our results report areas/themes are highly statistically conditioned by the publication. This may stem from the fact that we are studying specialized journals dealing with limited scopes. JCR impact factor provides scientific relevancy to the articles published among others, so that, such area-journal interdependence may affect JCR factor as well. However, there are trends depending on the year that make one area be more prevalent than others as it happens in donkey milk or meat in recent years. In the same way, the fact that research groups tend to specialize in one theme makes such areas also be determined by the country that works on them ([Table 1](#)).

5. Conclusion

Changing peoples' attitudes toward donkeys is a major problem in terms of how they are treated and managed [38] from being used as a companion, draft, or production animal [4,10,12], but scientists have the ability to do it through their work. While public attitudes to animal welfare are likely to be influential in determining the use of farm animals by society, science has a critical role in supporting governments' decisions, on behalf of the community, on farm animal use and the conditions and compromises to accomplish [39]. The donkey is often associated with poverty and thought of as a poor man's beast. Owing to their low monetary value, donkeys, until recently, have largely been ignored by scientists, extension workers, and farmers in terms of how to properly manage and care for them [4]. Pearson et al. (1999) states that overcoming donkey prejudices offers a challenge to all involved with donkeys [4]. However, the increased interest in donkeys as production animals as well as donkeys as recreational animals has increased the demand for knowledge. In general, we can assume that most challenges that plague donkeys are similar and include the following: nutrition, lack of treatment from owners, overworked or underworked, ill-fitting tack and equipment for both working and recreational donkeys, ability to display natural behavior, and little scientific knowledge on the donkey as a production animal and its requirements [4–6,10]. If donkeys are properly managed, they have the potential to increase economic opportunities for those they serve across the world. However, more research and educational tools are needed on how to properly care for, feed, manage, to meet the production requirements for donkeys in both developing and industrialized countries. Proof of this is the greatly increasing number of articles being published in relevant journal collections for the scientific community.

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Supplementary Data

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