

Влияние паразитов *Sarcocystis* крупного рогатого скота на продуктивность животноводства, а также на продовольственную безопасность и питание

Джозеф Рутаганира¹ rutaganirajoseph@yahoo.com
Игорь И. Гламаздин¹ glamazdin@yandex.ru

¹ Московский государственный университет пищевых производств, ул. Талалихина, 33, Москва, 109029, Россия

Аннотация. Коров и быков выращивают в основном для получения молока и мяса. Молоко и мясо крупного рогатого скота играют жизненно важную роль в мировой экономике и способствуют обеспечению продовольственной безопасности и питания. Для большего накопления финансовых доходов, продукты питания, производимые крупным рогатым скотом, включая молоко, масло, йогурт, топленое масло, сыр, нежное мясо, мясные колбасы и т.д., являются источниками финансовых доходов для фермеров и производителей продуктов питания. К сожалению, болезнь саркоцистоза крупного рогатого скота может повлиять на продовольственную безопасность и экономику фермеров, выращивающих крупный рогатый скот, вызывая снижение производства молока, потерю веса и снижение качества мяса, аборт и даже смерть из-за воздействия этих паразитов на крупный рогатый скот. На сегодняшний день известно, что саркоцистоз крупного рогатого скота вызывается шестью видами *Sarcocystis* spp. Каждый из шести видов (*S. cruzi*, *S. hominis*, *S. heydorni*, *S. rommeli*, *S. hirsuta* и *S. bovifelis*) имеет своего собственного дефинитивного хозяина. Два зооноза (*S. hominis* и *S. heydorni*) имеют общего дефинитивного хозяина - человека. Хотя самый распространенный из шести видов крупного рогатого скота, *S. cruzi*, не является зоонозом, он представляет собой финансовое бремя для производителей продуктов питания и может увековечить недоедание и отсутствие продовольственной безопасности. Поэтому для предотвращения распространения спороцист и защиты воды и кормов для скота от заражения *Sarcocystis* spp требуется усиление контроля в области безопасности продуктов питания, пищевой биотехнологии и ветеринарной паразитологии при участии общественности, гражданского общества и частного сектора.

Ключевые слова: паразиты, говяжье мясо, биология *Sarcocystis*, саркоцистоз, крупный рогатый скот, финансовые потери, производителей продуктов, ПЦР-тест.

Cattle *Sarcocystis* Parasites Impact on Cattle Farming Productivity as well as on Food Security and Nutrition

Joseph Rutaganira¹ rutaganirajoseph@yahoo.com
Igor Glamazdin¹ glamazdin@yandex.ru

¹ Moscow State University of Food Production; Talikhina, 33, Moscow, Russia, 109029

Abstract. Cows and Bulls are mainly raised for milk and meat. Cattle Milk and meat play a vital role in the worldwide economies and contribute to food security and nutrition. For greater financial income accumulation, Cattle sourced Food products encompassing milk, butter, yogurt, ghee, cheese, Tenderized meat, meat sausage, etc. are sources of financial income for farmers and food producers. Unfortunately, Cattle Sarcocystosis disease can affect food security, and Cattle farmers' economies by inducing reduced milk production, weight loss and decreased meat quality, abortion, and even death due to the effect these parasites have on Cattle. Cattle Sarcocystosis disease is so far known to be specifically caused by six *Sarcocystis* spp infections in the Cattle. Each of the six (*S. cruzi*, *S. hominis*, *S. heydorni*, *S. rommeli*, *S. hirsuta*, & *S. bovifelis*) has its own different definitive host. The two zoonoses (*S. hominis* & *S. heydorni*) share human as their common definitive host. Though the most prevalent among six bovine species, *S. cruzi*, is not a zoonosis, it is a financial burden to the food producers and it may perpetuate malnutrition and Food insecurity. Therefore, Strengthened Control in Food Safety, Food biotechnology, and the Veterinary parasitological sector with the involvement of the public, civil society, and private sector are required to prevent the spread of sporocysts and protect water and Cattle Feed from *Sarcocystis* spp contamination.

Keywords: parasites, beef meat, *Sarcocystis* biology, sarcocystosis, cattle, financial losses, food manufacturers, PCR test.

Introduction

Cattle are one of the livestock assets that can improve the economic lives of the World's Poorest and are the source of the food that is indispensable for mankind to feed the expanding world population. Farmers, pastoralists, and Cattle sourced Food

producers praise cows and bulls for playing a vital role in food security, nutrition, and financial income generation. Unfortunately, researchers have proven that Cattle Sarcocystosis is a handicap. This disease, which is acquired by ingestion of sporocysts or oocysts in contaminated water and feed,

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affects farmers and food producers by inducing reduced milk production, weight loss and decreased meat quality, abortion, and even death due to the effect Sarcocystis parasites have on Cattle (Hoeve-Bakker et al., 2019). Cattle Sarcocystosis is a disease that is associated with water and feed-borne Sarcocystis spp. infections. Although ingestion of sporocysts is the major mode of transmission for cattle, vertical transmission of *S. cruzi* has been documented in experimental studies (Savini et al., 1997). Such infections have to intensively be prevented to ensure sustainable and safe Cattle sourced food products and solve the issue of Food insecurity that affects Countries in which prevalence of Cattle Sarcocystosis is remarkable.

This study contributes to the knowledge of the biology of Sarcocystis in the Cattle at the organismal level and shows the role of cattle sarcocystosis in both food insecurity and malnutrition. Finally, it describes how Cattle Farming Productivity and the financial income of farmers and Cattle sourced food producers are affected by the Cattle Sarcocystosis.

Material and methods

During the writing of this article, tools and material that were used to generate information needed for text and numerical data include ScienceDirect., Science Index, National Center for Biotechnology Information (NCBI), Google Scholar, Food and Agriculture Organization of the United Nations Statistics (FAOST).

Results and Discussion

Table 1.

Prevalence of Cattle Sarcocystosis in Europe and Africa based on PCR and Histological Test

County name	Test Results (%)	Performed Test name
Egypt-Africa	90.09%	Histological Test
Egypt-Africa	98.9%	PCR (Polymerase Chain Reaction) Test
Tunisia-Africa	70.6%	PCR-RFLP (PCR-Restricted Fragment Length Polymorphism).
Italy-Europe	78.1%	PCR
Netherlands-Europe	76.9%	PCR
Lithuania-Europe	98.1%	Histological Test
Hungary-Europe	66%	PCR
Belgium-Europe	28%	Histological Test
Germany-Europe	40%	Histological Test
Germany-Europe	67.7%	Conventional PCR Test
Germany-Europe	69.6%	RT-PCR (Real-Time – PCR) Test

From the table and figure of data collected from literature, it is observed that The Cattle Sarcocystosis is the most prevalent in Egypt (Africa) and less prevalent in Hungary (Europe). Belgium and Lithuania don't appear on the figure because these two countries don't have PCR data in the table.

Table 2.

Prevalence of undernourishment as per FAO estimate 2020

Country	Undernourishment Prevalence%
Belgium	2
Egypt	5.4
Germany	<2.5
Hungary	<2.5
Italy	<2.5
Lithuania	<2.5
Tunisia	3
Netherlands	<2.5

From the table, figure, and the map represented by data generated as Prevalence of undernourishment sourced from (Sub-Saharan Africa <https://www.fao.org/faostat/en/#data/FS>, 2020), it is observed that Egypt is the most prevalent country among the considered sample. Egypt has an undernourishment prevalence of 5.4% and all European countries in the sample come with an undernourishment prevalence of <2.5%.

Table 3.

Prevalence of Food Insecurity (%) as per FAO food security indicators 2020

Country	Food Insecurity Prevalence%
Belgium	1.1
Egypt	6.7
Germany	0.7
Hungary	1.4
Italy	1.2
Lithuania	1.7
Tunisia	10.7
Netherlands	1.4

From the table and figure of data generated as food security Indicators sourced from (Sub-Saharan Africa <https://www.fao.org/faostat/en/#data/FS>, 2020), it is observed that Egypt is the second most prevalent country among the 8 sample countries which comes next to Tunisia. Egypt has a food insecurity prevalence of 6.7%. Germany comes with the lowest food insecurity prevalence of 0.7%.

Most African countries grow Cattle with the intention to reduce poverty and alleviate malnutrition. Contrary to the European farmers who grow Cattle on modernized farms at a large scale purposely for a business. For example, in the case of Rwanda, the country has introduced a one-cow per poor family program also referred to as “Girinka” to boost Cattle derived food products’ self-sufficiency in the country. This program is helping poor families increase their crop production by using manure and increasing their financial income and their nutrition at the household level and countrywide as well. The Government of Rwanda started the 'One cow per poor family program' (Girinka) in 2006 as one of the home-grown solutions. (Argent et al., 2014).

This program is also in the line of the Food and Agriculture Organization of the United Nations (FAO) to cope with radical changes to food systems to support human populations (Marco and Smid, 2018) and respond to food security.

Egypt is also an African country that has been well documented in several studies as the most prevalent country in Cattle Sarcocystosis disease with a prevalence of 98.9% based on PCR Test results (Khalifa et al., 2008). This country has a prevalence of 6.7% of severe food insecurity and the prevalence of undernourishment of 5.4% based on FAO estimate 2020 (*Sub-Saharan Africa* <https://www.fao.org/faostat/en/#data/FS>, 2020). Whereas Germany which is European Country, studies show that it is almost less prevalent in Cattle Sarcocystosis with 69.6% (Moré et al., 2014) and at the same time the most less prevalent in the food insecurity with 0.7% and the prevalence of undernourishment of <2.5 in 2020 based on FAO (*Sub-Saharan Africa* <https://www.fao.org/faostat/en/#data/FS>, 2020)

Biology of Sarcocystis in the intermediate host

Sarcocystis spp. are common protozoan parasites with worldwide distribution in carnivores including man as the definitive host and many herbivores including Cattle as intermediate hosts. These parasites infect the skeletal and cardiac muscles (Fayer, 2004).

Because these parasites are threat to the public health, to the Cattle farming productivity, especially to the Cattle derived food production system, and widely to the food security and nutrition, a deep understanding of Cattle Sarcocystis spp biology is essential for any preventive approach and for getting rid of the parasites ingestion routes. The cow acquires infection by ingesting feed and water contaminated with Carnivorous faces containing oocysts or free sporocysts. Then after the ingestion of sporocysts, they pass to the small intestine, and Sporozoites are liberated from sporocysts after breaking sporocyst walls. A complex sexual cycle is initiated. The released sporozoites are motile and can migrate from the Small Intestine to penetrate the extraintestinal and the gut epithelium tissues and mucosa to be developed into schizonts by the first asexual generation called schizogony. Schizonts are formed in vascular endothelial cells, somatic cells, and neuronal cells, depending on the species of Sarcocystis. After a few cycles of schizonts, the schizonts release the second asexual generation called merozoites. The Schizonts release merozoites that enter into skeletal or cardiac muscle after circulation Then. merozoites round up to form unicellular bodies containing a single metrocyte (mother cells which through repeated asexual multiplication, many cells are formed). The small rounded, non-infectious metrocytes increase in size and when they become infectious, they are called

bradyzoites which will later develop mature sarcocysts (Ortega and Pape, 2011) (Kojouri et al., 2011) The encysted stage is called a sarcocyst. A sarcocyst may take two months or more to mature to become infectious to the carnivore host.

Table 4.

Sarcocystis incubation period

S/N	Activity	The Incubation period (Days)
1	Ingestion of Oocysts/free Sporocysts by Cattle	1
2	Release of sporozoites	2
3	Schizonts formation	15–16
4	The release of Merozoites.	27
5	Merozoites round up to form unicellular bodies containing a single metrocyte (mother cells)	27–29
6	Repeated asexual multiplication of metrocyte	29–30
7	Bradyzoite formation	31–59
8	mature Sarcocysts development	≥60

Conclusion

Cattle are infected by the ingestion of water or feed contaminated by sporocysts or oocysts. The mature sarcocysts can only infect the definitive host.

Based on the data analyzed from literature, it is well observed that Cattle sarcocystosis prevalence in each of the 8 countries is closely related to the country's food insecurity and food malnutrition. African countries are the most vulnerable which may indicate that Cattle farming productivity is among the major sources of food and nutrition in Africa. Therefore, the intervention to raise awareness in the general public and particularly among farmers about Cattle Sarcocystis's negative impact on Cattle farming production is needed. However, for about six Sarcocystis spp that are specific to Cattle, regular and daily water and feed control, monitoring, and reporting activities are not sufficient or even not available at all in most African countries. Therefore, more chances for the parasites to be ingested by the Cattle (Dorny et al., 2009a) and consequently the disease will induce *reduced milk production, weight loss and decreased meat quality, abortion*, and even *death* which will result in loss of financial income for Cattle sourced food producers, in malnutrition as well as in food insecurity. Among options for better prevention, monitoring, and control of water and Cattle feed-borne Sarcocystis parasites are preventing and keeping carnivorous animals away from the Cattle'farm. Alternative options are treating, monitoring, and controlling the water to be fed into the cattle especially by using new risk assessment tools, and new technologies such as PCR, Serology, health education, social and economic development (Dorny et al., 2009b). More research and analysis are needed to determine the reason European countries with a high prevalence of cattle Sarcocystosis are not affected much by food insecurity and malnutrition compared to African countries.

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Сведения об авторах

Джозеф Рутаганира аспирант, факультет ветеринарной медицины, Московский государственный университет пищевых производств, ул. Талалихина, 33, Москва, 109029, Россия, rutaganirajoseph@yahoo.com

Игорь И. Гламаздин профессор, факультет ветеринарной медицины, Московский государственный университет пищевых производств, ул. Талалихина, 33, Москва, 109029, Россия, glamazdin@yandex.ru

Information about authors

Joseph Rutaganira postgraduate student, veterinary medicine department, Moscow State University of Food Production, Talalikhina, 33, Moscow, 109029, Russia, rutaganirajoseph@yahoo.com

Igor Glamazdin professor, veterinary medicine department, Moscow State University of Food Production, Talalikhina, 33, Moscow, 109029, Russia, glamazdin@yandex.ru

Contribution

Joseph Rutaganira wrote the manuscript, correct it before filing in editing and is responsible for plagiarism

Igor Glamazdin consultation during the study

Conflict of interest

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