**Review**

**Toxoplasma gondii** in Foods: Prevalence, Control, and Safety

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**Abstract:** *Toxoplasma gondii* is an obligate intracellular parasite that causes toxoplasmosis, with approximately one third of the population around the world seropositive. The consumption of contaminated food is the main source of infection. These include meat products with *T. gondii* tissue cysts, and dairy products with tachyzoites. Recently, contamination has been detected in fresh products with oocysts and marine products. Despite the great health problems that are caused by *T. gondii*, currently there are no standardized methods for its detection in the food industry. In this review, we analyze the current detection methods, the prevalence of *T. gondii* in different food products, and the control measures. The main detection methods are bioassays, cell culture, molecular and microscopic techniques, and serological methods, but some of these do not have applicability in the food industry. As a result, emerging techniques are being developed that are aimed at the detection of multiple parasites simultaneously that would make their application more efficient in the industry. Since the prevalence of this parasite is high in many products (meat and milk, marine products, and vegetables), it is necessary to standardize detection methods, as well as implement control measures.

**Keywords:** toxoplasmosis; *Toxoplasma gondii*; control; food; detection

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1. Introduction

Toxoplasmosis is a zoonotic disease that is caused by the obligate intracellular parasitic *Toxoplasma gondii*. This protozoon of the Apicomplexa phyla presents only felines as the definitive host, being the ones where the parasite can complete its life cycle. However, all warm-blooded animals, including mammals and birds, can act as intermediate hosts (Figure 1). In most hosts, *T. gondii* causes a lifelong latent infection in tissues such as skeletal and heart muscle, and the central nervous system, causing the disease. In humans, infection by *T. gondii* is particularly important in pregnant women and immunocompromized people. During pregnancy, the risk of fetal infection increases with gestational stage, increasing as gestation progresses [1]. Neonatal manifestations include hydrocephalus, microcephalus, intracranial calcifications, chorioretinitis, cataracts, convulsions, nystagmus, jaundice, petechiae, anemia, enlarged liver and spleen, prematurity, and severe intrauterine growth restriction [2,3]. Ocular manifestations also appear as chorioretinitis and retinal lesions [4]. In immunocompromized people, the neurological symptoms, such as encephalopathy, meningoencephalitis, cerebral mass lesions, headache, confusion, poor coordination, and seizures are usual [5], with toxoplasmic encephalitis being the most frequent manifestation in HIV patients [6], whereas the disseminated toxoplasmosis is more characteristic of transplant patients [7]. However, not only pregnant women and immunocompromized people may suffer the symptoms of *Toxoplasma* infection. Immunocompetent individuals can develop acute, chronic, and ocular toxoplasmosis. The acute toxoplasmosis is asymptomatic around 80% of individuals [8], and the symptoms in the other 20% includes fever, mononucleosis-like symptoms, with cervical posterior adenopathy, myalgia, and asthemia [9]. Although these symptoms are not relatively serious, the severity of infection...
depends on genotype of the parasite strain. In fact, infections with a highly virulent strain can produce fatal pneumonitis, myocarditis, meningo-encephalitis, and polymyositis [6]. In chronic toxoplasmosis, tachyzoites form bradyzoite cysts intraneuronal which are controlled but not eliminated by the immune system [10]. The immune response in the brain of patients produces brain inflammation, ventricular dilatation, disrupting neuronal structure and connectivity [11,12]. Although the symptoms of chronic toxoplasmosis have not been unraveled, several studies correlated these manifestations with neuropathies [13,14]. Related to ocular toxoplasmosis, it is the primary cause of infectious uveitis, presenting with retinochoroiditis [15].

![Biological cycle of Toxoplasma gondii](image-url)

**Figure 1.** Biological cycle of *Toxoplasma gondii*.

*T. gondii* has a worldwide geographic distribution and an estimated 30% of the population is seropositive [16]. The genetic diversity of *T. gondii* around the world has been elevated, so more than 36 genotypes have been found [17]. The transmission of this parasite in humans may result from the ingestion of tissue cysts in raw or undercooked meat of infected animals, ingestion of raw vegetables, water that is contaminated with *T. gondii* oocysts from cat feces, and by vertical or transplacental transmission [18]. Although, the main route of infection in humans is through ingestion of contaminated food. In fact, it has been described that up to 50% of infections are caused by food transmission using a novel multiplex Polymerase Chain reaction (PCR) assay [19]. A study that was undertaken in school dining rooms of Colombia showed the presence of *T. gondii* in meat, water, cucumber, and guava juice, both inert and living surfaces [20]. In the last years, the concern about this zoonosis and its transmission has been increasing. In 2018, the EFSA recommended a serological screening of livestock to identify positive farms [21]. In the following year, the EFSA report found that food-borne transmission accounts for 40–60% of *T. gondii* infections [22]. The last report indicated positive samples of meat, fish, raw mollusks and shellfish, honey, and potable water, and *Toxoplasma* was included in category III of zoonotic agents to monitor, along with *Campylobacter* or *Yersinia* [23].

However, and despite the great health public problem that it poses, there are currently no specific detection criteria for *T. gondii* in food, and there are no standardized methods
or validation procedures for its detection in the food industry. In fact, different direct and indirect detection techniques exist. Cat and mouse bioassays are the reference direct techniques to analyze the viability of the parasite, but these tests are not commonly used due to the long time that is taken to obtain results, ethical issues, and great costs [18]. The alternative method are cell cultures which are limited in use because of the variability of the results depending the sample [24]. Other serological methods (indirect detection) have been developed such as immunofluorescent assay (IFAT), enzyme-linked immunosorbent assay (ELISA), latex agglutination tests (LAT), modified agglutination test (MAT), and more recently, a luciferase-linked antibody capture assay (LACA) [23,25]. The latest studies of T. gondii detection in food products have used serological techniques to improve the sensibility of these serological tests using different approaches. For example, Suwan et al. (2022) used a recombinant dense granule antigen 7 protein for the detection of parasites in blood samples [26]. In addition to these serological methods, other molecular techniques have been tested. Some protocols of PCR have been described as nested PCR, real-time PCR, loop-mediated isothermal amplification (LAMP), and others. However, the more sensitive and specific diagnostic tools to detect T. gondii are necessary [27], and the studies about their sensitivity and to unify the detection in different food products are essential to control of parasite infection by food consumption. The aim of this review is to delve into the current context of T. gondii infection through food, prevalence of different food products, its detection and control, and future perspectives.

2. Methods for T. gondii Detection in Food Products

Although T. gondii is a high priority foodborne zoonotic pathogen around the world, it is not systematically controlled [28]. At present, there are no specific regulations or ISO standards for the detection of T. gondii in any food matrix [21]. Even so, different methods are available to detect tachyzoites, tissue cysts, and oocysts in food products, including immunological and microscopical methods. These methods have an isolate and concentration stage, later applying direct detection methods to the sample. Molecular assays are used to detect the presence of T. gondii DNA in samples, while information on the viability and infectivity can be obtained by in vivo assays (usually in mice) or by in vitro culture techniques. A summary of these methods with sensitivity and type of food product where these methods have been used are shown in Table 1.

Table 1. The table shows different methods for T. gondii detection, sensitivity of method, and type of food product where this method has been used.

| Detection Method       | Specific Method | Type of Food Product | Detection Range (Sensitivity) | References |
|------------------------|-----------------|----------------------|-------------------------------|------------|
| Animal model bioassay  | Cat             | Milk                 | 25%                           | [29,30]    |
|                        |                 | Meat                 | 100%                          | [31]       |
|                        | Mouse           | Milk                 | 100%                          | [29]       |
|                        |                 | Meat                 | 100% (10 tachyzoites)         | [24]       |
|                        | Fresh products  | Milk                 | 13%                           | [32]       |
|                        | Bivalve mollusks| Meat                 | 2.5%                          | [33]       |
|                        | Water           | Milk                 | 100% (10,000 tachyzoites)     | [24]       |
|                        |                 |                       |                               | [30]       |
| Cell culture           |                 | Meat                 | 100% (10,000 tachyzoites)     | [24]       |
|                        |                 | Milk                 | -                             | [31]       |
| Microscopic method     |                 | Meat                 | -                             |            |
### Table 1. Cont.

| Detection Method      | Specific Method | Type of Food Product | Detection Range (Sensitivity) | References |
|-----------------------|-----------------|----------------------|-------------------------------|------------|
| **Molecular methods** |                 |                      |                               |            |
| PCR                   |                 | Meat                 | 47.1% [35]                    |            |
| Fresh products        |                 | 95–100% [36,37]      |                               |            |
| Water                 |                 | 100% [36]            |                               |            |
| Milk                  |                 | 100% [29,38]         |                               |            |
| Cheese                |                 | 100% [29]            |                               |            |
| qPCR                  |                 | Meat                 | 92.3% (limit 0.01 pg) [39,40]|            |
| Fresh products        |                 | 100% (1 oocyst) [41–43]|                           |            |
| Bivalve mollusks      |                 | 100% [44]            |                               |            |
| Water                 |                 | 100% [44]            |                               |            |
| LAMP                  |                 | Lymph nodes          | 85.7% [45]                    |            |
| Mussels               |                 | 5 oocyst/g [46]      |                               |            |
| Fresh products        |                 | 25 oocyst/50 g [47]  |                               |            |
| **Serological methods** |                |                      |                               |            |
| IHA                   |                 | Meat Juice           | 100% (10,000 oocysts) [50]    |            |
| IFAT                  |                 | Meat                 | 97% [51]                      |            |
| MAT                   |                 | Meat Juice           | 96.9% (10,000 oocysts) [50]    |            |
| ELISA                 |                 | Milk                 | - [32]                        |            |
| BBMA                  |                 | Meat                 | 91% [51]                      |            |
|                      |                 | Meat Juice           | 100% (10,000 oocysts) [50]    |            |
|                      |                 | Water                | 100% (1 fg) [48,49]           |            |

1 PCR: Polymerase chain reaction; qPCR: real-time PCR; LAMP: Loop-mediated isothermal amplification; IHA: indirect hemagglutination antibody; IFAT: indirect fluorescent antibody test; MAT: modified agglutination test; ELISA: Enzyme-Linked Immunosorbent Assay; BBMA: bead-based multiplex assay. 2 The column shows the percentage of samples that were positively detected by the method and the quantity of parasites per quantity of food product that was detected if this data is known. The value (-) means that this data is not known.

#### 2.1. Animal Model Bioassay

This method allows the study of the infectivity of the oocysts and tissue bradyzoites of the parasite. For *T. gondii* detection, the cat bioassay works best, followed by the mouse bioassay [31]. In cats, the animals are fed with the test meat or tissue (up to 500 g) to analyze the presence of tissue cysts. A total of three weeks after exposure, the cat feces are tested for the presence of *T. gondii* oocysts, and serum samples may be analyzed to detect specific antibodies against the parasite [54]. The cat bioassay allows the detection of all stages, as tachyzoite, bradyzoite, and oocysts [55]. However, the bioassay in cats is carried out in few laboratories since it is an extremely expensive method and, in addition, the use of animals raises ethical problems [31].

Therefore, mice are the main animal model to evaluate the infectivity of oocysts. In this technique, 50 to 200 g of tissue are digested with acid pepsin or trypsin and a fraction of the sediment is inoculated in mice, generally intraperitoneally or subcutaneously; although mice can also be infected orally with *T. gondii* oocysts [36]. Typically, two to five mice are used per sample, monitored clinically, and when the mouse dies or is euthanized, brain or peritoneal fluid samples are analyzed for the presence of *T. gondii* by microscopy or PCR in addition to detect specific antibodies in serum. Immunosuppressive drugs can be administered to mice to increase the sensibility of the bioassay [34]. The sample size that can be tested is smaller than that which is used for the cat bioassay, as only a fraction of the digest is inoculated. Mouse bioassays are generally less expensive than cat bioassays, but they also present ethical issues [55]. These models have been used to evaluate the presence of infectious...
oocysts in water and shellfish samples [33], and to evaluate the impact of storage time and temperature on oocyst infectivity in raspberries and blueberries [57]. Bioassays are not useful for previously frozen samples as these tests are based on the viability of the parasite so it is not feasible for large-scale screening, and it does not quantify the intensity of infection [58,59]. However, for other types of samples, this method is still one of the most useful for the detection of viable parasites.

2.2. Cell Culture

Despite the fact that molecular techniques are very specific and sensitive, they only detect parasite DNA, regardless of whether it is viable. A solution to this problem is the detection of *T. gondii* by isolation in cell culture. The test sample is brought into contact with culture of different cell lines. If the parasite is present in the sample and it is viable, the culture cells will become infected, causing the tachyzoites to multiply, which can be observed with an inverted microscope after 3–10 days [60]. Cell cultures can be used as an alternative to bioassays in animals since the cost is lower and solves the ethical problem that is posed by bioassays [61]. Even so, it should be taken into account that cell cultures require perfect observation of the samples to avoid contamination and that they are less sensitive than the bioassay for detecting the parasite viability [62]. Moreover, it must be considered that to detect hazards in food or food outbreaks, faster results must be obtained so that contaminated food can be recalled. Another possibility would be the diagnostic use of methods based on tissue culture, although this is limited. Artificially digested meal or sediment homogenates have been tested with varying success rates. In a study with milk samples from different species of cattle based on tissue culture with Vero cells, positive samples to *T. gondii* could be detected [30].

2.3. Microscopic Methods

Oocysts, tachyzoites, or tissue cysts of *T. gondii* cannot be detected by gross inspection but can be identified by microscopy. In fact, microscopic methods are used for the detection of oocysts in fresh products and shellfish. Parasites are visible using nonspecific stains such as Giemsa or hematoxylin and eosin, but the use of specific stains with fluorescence-conjugated enzymes or antibodies allows them to be differentiated from other structures or apicomplexan parasites and increases the sensitivity [63]. The main disadvantage of microscopy as a detection technique is the appearance of false negatives. This is due to the small sample size that can be examined. In this way, not finding parasites in the examined sample is possible, even though there is contamination in other areas of the sample.

2.4. Molecular Methods

The polymerase chain reaction (PCR) is based on the in vitro amplification of specific DNA sequences. For these sequences, the DNA that is present in the analyzed samples is extracted, and several amplification cycles are carried out. The presence of parasite-specific DNA in the sample is visualized by agarose gel electrophoresis. If the sample contains the target DNA, a specific band is observed in the gel [35].

There are different targets that are available for the detection of *T. gondii* by PCR. The most common are the B1 fragment, which is repeated 35 times in the parasite genome, and a region of 529 bp that is repeated 200–300 times [64]. However, commercial DNA isolation methods are usually designed for 25 mg of sample, but tissue cysts are rare and, therefore, the chance of detecting *T. gondii* in such a small sample is low. To allow analysis of large samples and to increase the detection sensitivity, methods that are based on artificial digestion, homogenization and isolation on Percoll gradients, and sequence-based magnetic capture have been described [63]. This allows the sample to be concentrated and more tissue can be analyzed. In addition, this simulates the conditions of our body when digesting food. The sample is incubated for one hour at 27 °C with hydrochloric acid, pepsin, and sodium chloride, which causes the rupture of the tissue cyst walls of *T. gondii* and the release of bradyzoites [65].
Quantitative PCR (qPCR) is a variant of conventional PCR, which allows the detection of the parasite DNA concentration in the analyzed sample with elevated sensitivity, precision, and speed than conventional PCR, in addition to not requiring the use of gels. For the detection of *T. gondii* by qPCR the most widely used fluorophores are SYBR Green and TaqMan probes [39,66]. The SYBR Green fluorophore has higher sensitivity, but is more likely to bind non-specifically, whereas TaqMan probes have high specificity, but less sensitivity and, therefore, cannot detect low concentrations of parasite DNA [67]. The PCR method has been improved by fine-tunning multiplex PCR for the detection of different organisms simultaneously. More recently, Temesgen et al. (2019) developed and evaluated a new multiplex qPCR for the simultaneous detection of different parasites, including *T. gondii*, in berry fruits [41]. The results showed that it is a highly specific, precise, and robust method, which has potential application in food analysis laboratories. Shapiro et al. (2019) developed a multiplex PCR for the simultaneous detection of parasites, including *T. gondii*, in spinach. This method was found to be more sensitive than traditional qPCR [19].

Loop-mediated isothermal amplification (LAMP) enables DNA amplification with high sensitivity and specificity, efficiency, and speed [68]. It is a technique that uses a DNA polymerase with chain displacement activity, with four to six primers that are designed to recognize six to eight different regions of the target DNA, which allows the amplification specificity of LAMP to be very high. Up to 109 copies can be amplified in less than one hour under isothermal conditions (63–65 °C) [69]. These conditions facilitate the process, so a simple incubator is sufficient to amplify the DNA, which allows the use of this technique under field conditions. DNA amplification can be detected by visual inspection of the turbidity or fluorescence of the sample, or by real-time turbidimeter [68]. Therefore, it does not require gel electrophoresis, which reduces the test time and allows this technique to be a fast and accurate molecular method for the detection of *T. gondii*. For the detection of oocysts in fresh products, an adaptation of the LAMP technique has been developed. This new technique includes a chromatographic detection system with a lateral flow test strip that allows to accelerate the visualization of the results [47]. In 2013, the LAMP technique with reverse transcriptase (RT-LAMP) was developed for the detection of *T. gondii* in meat samples. The results suggest that RT-LAMP is a simple and reliable tool to detect meats that are contaminated with *T. gondii* [70]. LAMP seems to be an alternative to most expensive molecular methods with similar sensitivity, with a low detection limit of five oocysts per gram of tissue, and five oocyst per milliliter of hemolymph in bivalves [46].

These molecular techniques detected the DNA of the parasite, and genotyping is possible with them. However, different available genotyping methodologies have been irregularly applied in different geographic areas and over different matrices [71]. The main drawback of these molecular techniques is that it only allows the DNA of the parasite to be detected, but the viability of *T. gondii* is unknown. So, other methods are required to establish whether the detected DNA belongs to viable parasites [31]. Until now, one molecular method for viability detection has been developed. Propidium monoazide-based qPCR (PMA-qPCR) has been positively evaluated [72], and its ability to detect viable parasites in leafy greens has been demonstrated recently [43].

2.5. Serological Methods

Serological methods are indirect methods that are intended to confirm infection with *T. gondii* in animals and humans, but they have been adapted for testing meat and meat juices. Generally, they serve as a first screening to detect seropositive animals, in which later the infection will be confirmed in the tissue samples through a bioassay. However, these methods can also be used to detect infection in meat juice samples, for example [73]. The serological methods that are used to detect antibodies against *T. gondii* in serum or meat juice are indirect hemagglutination antibody (IHA), the latex agglutination test (LAT), indirect fluorescent antibody test (IFAT), modified agglutination test (MAT), Western blot, and ELISA, with MAT, IFAT, and ELISA being the most used and validated methods [74]. All these techniques detect immunoglobulins (Ig) G and M in serum or tissue fluid. The
MAT technique is more sensible than other agglutination methods, but it is not useful for slaughterhouse use, as it requires a large number of intact tachyzoites [56]. The ELISA technique has been shown to be more sensitive and efficient than MAT for the detection of antibodies to T. gondii [75,76]. The serological methods are quick and easy to perform, but they have certain limitations. The sensitivity and specificity can vary, and the results do not always correlate with bioassay results [73].

2.6. New Methods of Detection

The traditional methods of detection have limitations and there are no standardized protocols for their application in the food industry. For this reason, new detection methods are being developed for T. gondii that improve the efficiency and reproducibility. In fresh products in particular, oocyst detection methods are scarce. In the last years, different authors have been developed methods for their detection. Lalonde and Gajadhar (2016) developed real-time PCR methods for the identification of protozoan oocysts in vegetables and fruits [76]. Slana et al. (2021) exhaustively described the different molecular methods for the detection of T. gondii in fresh products [77]. In bivalve mollusks, alternative detection molecular methods have been proven. Concretely, the Q3 lab-on-chip real time-PCR platform, a miniaturized platform, has been checked for the detection of T. gondii and other protozoan, with better results for Toxoplasma than other molecular approaches [78].

The DNA extraction using the bead-beating method has been demonstrated a rapid and simple method for detection in bivalves, but it is not valid for quantification [79]. The determination of T. gondii genotypes can provide relevant information for the control of this zoonosis. For this reason, different studies have evaluated detection and genotyping methods. Recently, similar sensitivity and specificity has been observed of the B1 and ROP8 genes for detection, whereas the latter seems more appropriate for genotyping [80].

One of the most relevant steps for molecular methods detection is the DNA extraction approach, that depends on matrix analyses. However, few studies have been done that are related it. Temesgen et al. (2020) compared two commercially available DNA extraction procedures in berry fruits [81]. On the other hand, Gisbert-Algaba et al. (2017) have developed a method for its use in meat based on DNA extraction by magnetic capture, which has proven to be sensitive, economical and reliable, and validated by ISO 17025 [82]. This technique is a potential alternative to the mouse bioassay for the screening of various types of tissue and meat, with the advantage of being quantitative. Now, this is the most validated method for the detection of T. gondii in food, but it requires further validation before it can be applied to other food samples. Furthermore, since qPCR only allows determining the presence of the parasite, but cannot directly confirm the viability [31], recently some authors are fine-tunning the analysis of T. gondii RNA using reverse transcription and subsequent PCR (RT-PCR). This technique uses the enzyme reverse transcriptase to synthetize complementary DNA (cDNA) from the RNA molecules that are present in the sample. Although this technique has a high sensitivity, RNA degrades much faster than DNA and it is more easily contaminated, so this technique must be performed by highly qualified and experienced personnel. It has difficulty detecting tissue cysts, since it needs the parasite to be metabolically active at the time of analysis [66]. Recently, the cloth-based hybridization array system (CHAS) has been developed to confirm of PCR-positive results as a cheaper and easier method than sequencing [36] and a new real-time isothermal amplification method (real-time recombinase-aided amplification, RT-RAA) with more sensitivity and specificity than traditional RT-PCR has been tried in pork blood samples [83].

Loreck et al. (2019) developed a protein microarray for the simultaneous detection of IgG antibodies against different zoonotic agents and pathogens that cause disease in pigs, among which is T. gondii [84]. This is an efficient and valid method for detection since it allows the detection of antibodies against these zoonotic agents in a single measurement. Duong et al. (2020) developed a Luciferase-linked antibody capture assay (LACA) to detect T. gondii in serum chicken, and they obtained high sensitivity (90.5%) and specificity (95.4%) [85]. The best results were obtained by Fabian et al. (2020) that recently developed
a new serological method that was named bead-based multiple assay (BBMA) using the Luminex technology with high sensibility (98.5%) and specificity (100%) relative to a reference of ELISA, IFAT, and MAT [53].

Different recent studies are aimed at improving sensitivity, looking for alternatives to bioassays that allow detecting the viability of the parasite, and a possible validation to be able to apply in the food industry. Moreover, the detection of different parasites simultaneously is relevant to the food industry, so the lack of standardized protocols does not only refer to *T. gondii*, but which is generalized in all foodborne parasites, to a lesser or greater extent. In this context, a novel metabarcoding assay followed by next generation sequencing (NGS) has been developed to simultaneously detect *Cryptosporidium* spp., *Giardia* spp., and *T. gondii* in shellfish [86]. The application of this type of technique in other products would allow us to achieve the control of parasitic diseases that are transmitted by food. Furthermore, it would be interesting to have a method that allows the detection of all infectious stages of *T. gondii* (tachyzoites, tissue cysts, and oocysts). About this, Guggisberg et al. (2020) have fine-tuned a one-way sequential sieving method to identify different stages of parasites in lettuce [87]. Even so, much research is still required to be able to apply these methods in the food industry in the future and improve the current situation of parasitic diseases, including toxoplasmosis.

3. Prevalence of *Toxoplasma gondii* in Food Products

Transmission through food is the main system of transmission of *T. gondii* to humans [18]. Tissues cysts and tachyzoites are responsible for infection thought meat and milk, respectively [56], and sporulated oocysts can contaminate fresh products, shellfish, and water, and infect humans after consumption [88]. Next, we will try to delve into the transmission mechanisms depending on the type of food.

3.1. Meat and Meat Products

*T. gondii* infections have been reported in all meat production animals around the world, although the prevalence depends on the detection method that is used (Table 1). Tissue cysts of parasites in meat are an important source of human infection, due to the fact of that these animals are secondary hosts of the parasite, which can survive long periods of time in these asymptomatic animals, which will later become meat products.

Different techniques are available to detect its presence. The mouse bioassay and PCR are the most widely used direct detection methods, followed by microscopy and the cat bioassay [31]. On the other hand, the MAT, IFAT, and ELISA tests are the most widely used serological methods for the detection of *T. gondii* infection in cattle and meat products [73]. Table 2 shows the animal and sample that was contaminated, the country of contamination, the method that was used for detection, and prevalence that was found.

**Table 2.** *T. gondii* in animals and animal products. The table shows the producer animal, sample contaminated, country of contamination, method that was used for detection, and prevalence that was found.

| Animal | Sample Analyzed | Detection Method | Number of Samples Tested | Number of Positive Samples (%) | Location | Reference |
|--------|-----------------|------------------|--------------------------|-------------------------------|----------|-----------|
| Sheep  | Serum           | ELISA            | 150                      | 26 (17.3%)                    | Iran     | [89]      |
| Sheep  | Serum           | ELISA            | 550                      | 59 (10.8%)                    | Iran     | [90]      |
| Sheep  | Serum           | ELISA            | 1039                     | 179 (17.2%)                   | Latvia   | [91]      |
| Sheep  | Serum           | MAT              | 100                      | 42 (42%)                      | Lebanon  | [92]      |
| Sheep  | Serum           | ELISA            | 64                       | 30 (47%)                      | Slovakia | [93]      |
| Sheep  | Serum           | DAT              | 252                      | 148 (58.2%)                   | Ethiopia | [94]      |
| Liver  | PCR             | 150              | 26 (17.3%)               | Iran                          | [89]      |
| Liver  | PCR             | 90               | 13 (14.4%)               | Iran                          | [95]      |
| Animal              | Sample Analyzed | Detection Method | Number of Samples Tested | Number of Positive Samples (%) | Location | Reference |
|---------------------|----------------|------------------|--------------------------|-------------------------------|----------|-----------|
| Heart               | PCR            | 150              | 48 (32%)                 | Iran                          | [89]     |
| Brain and heart     | MAT            | 136              | 10 (7.4%)                | India                         | [96]     |
| Meat juice          | ELISA          | 227              | 126 (28.6%)              | Italy                         | [97]     |
| Meat juice          | MAT            | 166              | 11 (6.6%)                | China                         | [98]     |
| Meat                | PCR            | 150              | 33 (22%)                 | Iran                          | [89]     |
| Meat                | PCR            | 438              | 43 (9.8)                 | China                         | [99]     |
| Meat                | PCR            | 150              | 50 (33.3)                | Tunisia                       | [100]    |
| Meat                | ELISA          | 109              | 38 (34.9%)               | Malaysia                      | [101]    |
| Meat                | PCR            | 79               | 34 (43%)                 | Australia                     | [102]    |
| Meat                | PCR            | 177              | 3 (1.7%)                 | India                         | [103]    |
| Goat                | Serum ELISA    | 150              | 16 (10.7%)               | Iran                          | [89]     |
| Goat                | Serum ELISA    | 185              | 37 (20%)                 | Iran                          | [90]     |
| Goat                | Serum ELISA    | 445              | 189 (42.5%)              | India                         | [104]    |
| Goat                | Serum MAT      | 80               | 27 (34%)                 | Lebanon                       | [93]     |
| Goat                | Serum ELISA    | 39               | 8 (21%)                  | Slovakia                      | [93]     |
| Goat                | Serum LAT      | 116              | 64 (55.2%)               | Ethiopia                      | [94]     |
| Goat                | Liver PCR      | 150              | 24 (16%)                 | Iran                          | [89]     |
| Goat                | Liver PCR      | 90               | 8 (8.8%)                 | India                         | [95]     |
| Goat                | Heart PCR      | 150              | 36 (24%)                 | Iran                          | [89]     |
| Goat                | Brain and heart| MAT              | 57                       | Iran                          | [96]     |
| Goat                | Meat juice ELISA| 51              | 14 (27.5%)               | Italy                         | [97]     |
| Goat                | Meat PCR       | 150              | 26 (17.3%)               | Iran                          | [89]     |
| Goat                | Meat PCR       | 254              | 27 (10.7)                | China                         | [99]     |
| Goat                | Meat PCR       | 120              | 39 (32.5)                | Tunisia                       | [100]    |
| Goat                | Meat ELISA     | 75               | 41 (54.7%)               | Malaysia                      | [101]    |
| Goat                | Meat PCR       | 223              | 3 (1.3%)                 | India                         | [104]    |
| Cattle              | Serum ELISA    | 57               | 13 (22.8%)               | Italy                         | [105]    |
| Cattle              | Serum DAT      | 2411             | 313 (13%)                | Poland                        | [106]    |
| Cattle              | Serum ELISA    | 400              | 52 (13%)                 | Iran                          | [107]    |
| Cattle              | Serum IFAT     | 500              | 2.3 (40.6%)              | Brazil                        | [108]    |
| Cattle              | Meat PCR       | 150              | 29 (19.3)                | Tunisia                       | [100]    |
| Cattle              | Meat ELISA     | 392              | 98 (25%)                 | Malaysia                      | [101]    |
| Cattle              | Meat PCR       | 48               | 5 (10.4%)                | Brazil                        | [108]    |
| Pig                 | Serum ELISA    | 653              | 4 (0.6%)                 | Finland                       | [109]    |
| Pig                 | Serum ELISA    | 447              | 73 (16.3%)               | Denmark                       | [110]    |
| Pig                 | Serum DAT      | 3111             | 370 (11.9%)              | Poland                        | [106]    |
| Pig                 | Serum IFAT     | 94               | 44 (46.8%)               | Romania                       | [111]    |
| Pig                 | Serum ELISA    | 420              | 56 (23.3%)               | Cuba                          | [112]    |
| Pig                 | Serum ELISA    | 370              | 14 (3.8%)                | Italy                         | [113]    |
| Pig                 | Serum ELISA and IFAT | 127           | 56 (44.1%)               | Italy                         | [114]    |
| Pig                 | Serum MAT      | 375              | 8 (2.1%)                 | Italy                         | [115]    |
| Pig                 | Serum ELISA    | 414              | 214 (51.7%)              | Italy                         | [116]    |
| Pig                 | Serum MAT      | 182              | 31 (17%)                 | Serbia                        | [117]    |
| Pig                 | Serum MAT and IFAT | 356           | 25 (7%) and 48 (13.5%), respectively | Brazil | [118] |
Table 2. Cont.

| Animal                              | Sample Analyzed | Detection Method(s) | Number of Samples Tested | Number of Positive Samples (%) | Location | Reference |
|-------------------------------------|-----------------|---------------------|--------------------------|--------------------------------|----------|-----------|
| Serum                               | Serum MAT and IFAT | 400                | 26 (6.5%)                | Brazil                         | [119]    |
| Serum                               | Serum IFAT       | 60                  | 44 (77%)                 | Brazil                         | [120]    |
| Serum                               | Serum IHA        | 784                 | 156 (19.9%)              | China                          | [121]    |
| Tongue                              | Tongue PCR       | 60                  | 20 (33.3%)               | Brazil                         | [120]    |
| Tongue and muscle                   | Tongue and muscle PCR | 810          | 54 (6.7%)                | India                          | [122]    |
| Brain                               | Brain PCR        | 339                 | 34 (10%)                 | China                          | [123]    |
| Brain                               | Brain PCR        | 107                 | 51 (47.7%)               | Italy                          | [116]    |
| Heart                               | Heart PCR        | 94                  | 25 (26.6%)               | Romania                         | [111]    |
| Heart                               | Heart qPCR       | 103                 | 12 (11.6%)               | Italy                          | [124]    |
| Diaphragm                           | Diaphragm PCR    | 45                  | 15 (33.3%)               | Serbia                         | [117]    |
| Diaphragm                           | Diaphragm PCR    | 1223                | 107 (8.7%)               | China                          | [125]    |
| Diaphragm                           | Diaphragm PCR    | 60                  | 24 (40%)                 | Brazil                         | [120]    |
| Diaphragm                           | Diaphragm qPCR   | 103                 | 2 (1.9%)                 | Italy                          | [126]    |
| Tissue of seropositive animals      | Mouse bioassay   | 26                  | 18 (69.2%)               | Brazil                         | [119]    |
| Muscle                              | Muscle PCR       | 60                  | 23 (38.3%)               | Brazil                         | [120]    |
| Meat juice                          | Meat ELISA       | 212                 | 33 (15.6%)               | Denmark                        | [110]    |
| Meat                                | Meat qPCR        | 118                 | 46 (39%)                 | Brazil                         | [126]    |
| Meat                                | Meat PCR         | 498                 | 165 (33.1%)              | Italy                          | [64]     |
| Meat                                | Meat PCR         | 49                  | 3 (6.1%)                 | Brazil                         | [108]    |
| Raw meat products                   | Raw meat products PCR | 3223         | 175 (5.4%)               | Poland                         | [127]    |
| Chicken                             | Serum IFAT       | 200                 | 72 (36%)                 | Brazil                         | [128]    |
| Chicken                             | Serum ELISA      | 522                 | 34 (6.5%)                | India                          | [129]    |
| Chicken                             | Serum LACA       | 267                 | 29 (10.9%)               | Japan                          | [85]     |
| Chicken                             | Mouse bioassay   | 14                  | 2 (14.3%)                | Brazil                         | [128]    |
| Chicken                             | Heart MAT        | 1185                | 230 (19.4%)              | USA                            | [130]    |
| Chicken                             | Heart juice MAT  | 1185                | 230 (19.4%)              | USA                            | [130]    |
| Chicken                             | Heart juice MAT  | 1185                | 230 (19.4%)              | USA                            | [130]    |
| Chicken                             | Heart juice MAT  | 1185                | 230 (19.4%)              | USA                            | [130]    |
| Chicken                             | Muscle PCR       | 522                 | 12 (2.3%)                | India                          | [129]    |
| Chicken                             | Muscle PCR       | 257                 | 21 (8.2%)                | China                          | [131]    |
| Ducks                               | Meat PCR         | 115                 | 9 (7.8%)                 | China                          | [131]    |
| Geese                               | Meat PCR         | 42                  | 2 (4.8%)                 | China                          | [131]    |
| Rabbit                              | Brain and heart PCR | 470          | 13 (2.8%)                | China                          | [132]    |
| Rabbit                              | Brain and heart PCR | 470          | 13 (2.8%)                | China                          | [132]    |
| Rabbit                              | Brain and heart PCR | 470          | 13 (2.8%)                | China                          | [132]    |
| Rabbit                              | Brain and heart PCR | 470          | 13 (2.8%)                | China                          | [132]    |
| Rabbit                              | Brain and heart PCR | 470          | 13 (2.8%)                | China                          | [132]    |
| Rabbit                              | Brain and heart PCR | 470          | 13 (2.8%)                | China                          | [132]    |
| Kibbeh                              | Meat PCR         | 44                  | 1 (2.3%)                 | Brazil                         | [108]    |
| Water Buffalo                       | Serum MAT and ELISA | 197          | 16 (8.1%) and 13 (6.6%), respectively | Romania                        | [133]    |
| Ostriches (farmed)                  | Serum LAT        | 409                 | 149 (36%)                | Czech Republic                 | [134]    |
| Common quails (farmed)              | Serum MAT        | 620                 | 59 (9.5%)                | China                          | [135]    |
Table 2. Cont.

| Animal                  | Sample Analyzed | Detection Method | Number of Samples Tested | Number of Positive Samples (%) | Location | Reference |
|-------------------------|-----------------|------------------|--------------------------|--------------------------------|----------|-----------|
| Donkey (farmed)         | Meat            | PCR              | 618                      | 57 (9.2%)                      | China    | [136]     |
| Tolai hares (farmed)    | Serum           | PCR              | 358                      | 29 (8.1%)                      | China    | [137]     |
|                         | Brain           | PCR              | 358                      | 23 (6.4%)                      | China    | [137]     |
| Feral swine             | Serum           | ELISA            | 376                      | 34 (9%)                        | USA      | [138]     |
| Wild boar (farmed)      | Serum           | LAT              | 882                      | 88 (10%)                       | China    | [139]     |
| Wild boar               | Serum           | ELISA            | 331                      | 164 (49%)                      | Italy    | [140]     |
|                         | Serum           | ELISA            | 181                      | 17 (9%)                        | Finland  | [141]     |
|                         | Serum IFAT      | PCR              | 26                       | 20 (76.9%)                     | Brazil   | [142]     |
|                         | Serum ELISA     | PCR              | 306                      | 61 (20%)                       | Germany  | [143]     |
|                         | Tissue Mouse bioassay |              | 22                      | 1 (4.5%)                       | Brazil   | [142]     |
|                         | Brain qPCR      | 141              | 44 (31.2%)               | Italy                          | [144]     |
|                         | Heart qPCR      | 166              | 47 (28.3%)               | Italy                          | [144]     |
|                         | Heart PCR       | 310              | 70 (22.6%)               | Italy                          | [145]     |
|                         | Muscle qPCR     | 165              | 40 (24.2%)               | Italy                          | [144]     |
|                         | Muscle PCR      | 311              | 74 (23.8%)               | Italy                          | [145]     |
|                         | Meat juice ELISA | 97                  | 42 (43.3%)               | Italy                          | [146]     |
|                         | Meata qPCR      | 306              | 37 (12%)                 | Germany                        | [143]     |
| Venison                 | Serum MAT       | 914              | 329 (36%)                | USA                            | [147]     |
|                         | Heart Mouse bioassay |              | 36                      | 11 (30.6%)                     | USA      | [147]     |
| Roe deer                | Serum LAT       | 356              | 141 (39.6%)              | Spain                          | [148]     |
|                         | Serum ELISA     | 323              | 130 (40.2%)              | Italy                          | [149]     |
|                         | Serum ELISA     | 184              | 20 (11%)                 | Germany                        | [143]     |
|                         | Meat qPCR       | 184              | 11 (6%)                  | Germany                        | [143]     |
| Fallow deer             | Serum LAT       | 372              | 138 (37.1%)              | Spain                          | [150]     |
|                         | Serum ELISA     | 167              | 17 (10%)                 | Slovakia                       | [93]      |
|                         | Meat qPCR       | 80               | 2 (2%)                   | Germany                        | [143]     |
| Red deer                | Serum LAT       | 553              | 92 (16.6%)               | Spain                          | [148]     |
|                         | Serum ELISA     | 96               | 19 (19.8%)               | Italy                          | [140]     |
|                         | Serum ELISA     | 65               | 4 (6%)                   | Germany                        | [143]     |
|                         | Meat qPCR       | 65               | 2 (2%)                   | Germany                        | [143]     |
| Southern chamois        | Serum LAT       | 186              | 26 (14%)                 | Spain                          | [148]     |
| Mouflon                 | Serum LAT       | 209              | 24 (11.5%)               | Spain                          | [148]     |
|                         | Serum ELISA     | 50               | 12 (24%)                 | Italy                          | [149]     |
| Iberian wild goat       | Serum LAT       | 346              | 27 (7.8%)                | Spain                          | [148]     |
| Chamois                 | Serum ELISA     | 104              | 4 (3.8%)                 | Italy                          | [140]     |
Table 2. Cont.

| Animal            | Sample Analyzed | Detection Method | Number of Samples Tested | Number of Positive Samples (%) | Location            | Reference |
|-------------------|-----------------|------------------|--------------------------|--------------------------------|---------------------|-----------|
| Barbary sheep     | Serum           | LAT              | 18                       | 1 (5.6%)                       | Spain               | [148]     |
| Moose             | Serum           | DAT              | 463                      | 111 (23.9%)                    | Estonia             | [149]     |
| Wild ducks        | Brain           | qPCR             | 280                      | 7 (2.5%)                       | Czech Republic      | [150]     |
|                   | Heart           | qPCR             | 280                      | 11 (3.9%)                      | Czech Republic      | [150]     |
|                   | Muscle          | qPCR             | 280                      | 4 (1.4%)                       | Czech Republic      | [150]     |
| Common pheasants  | Brain           | qPCR             | 350                      | 8 (2.3%)                       | Czech Republic      | [150]     |
|                   | Heart           | qPCR             | 350                      | 4 (1.1%)                       | Czech Republic      | [150]     |
|                   | Muscle          | qPCR             | 350                      | 3 (0.9%)                       | Czech Republic      | [150]     |

1 ELISA: Enzyme-Linked Immunosorbent Assay; MAT: modified agglutination test; DAT: direct agglutination test; PCR: Polymerase chain reaction; LAT: latex agglutination test; IFAT: indirect fluorescent antibody test; qPCR: real-time PCR.

Beef cattle may contain *T. gondii* cysts in their tissues, and they may pose a risk if meat from infected animals is eaten raw or undercooked [34]. Tissue cysts are less resistant to environmental conditions than oocysts. Even so, they remain infectious in refrigerated carcasses (around one to four degrees) or in minced meat for three weeks, that is, while the meat is fit for human consumption [151]. *T. gondii* DNA has been found in cured bacon, raw or smoked sausages, ham, and minced meat [128]. Infections of parasites are more frequent in lamb and pork than in beef and chicken, with sheep meat representing the highest risk of infection in humans [152]. Opsteegh et al. (2016) confirmed that 1.6% of the bovines that were analyzed by bioassay were positive, which indicates the presence of viable tissue cysts and, therefore, represents a potential risk for consumers [31]. In Italy, the seroprevalence was 8.7% of cattle, lower than the 13.4% of seroprevalence in animals that were imported [105]. The last data are in accordance with the results that were observed in other countries, such as Iran [107]. In Poland, using the direct agglutination test (DAT) method, the seropositive samples were 13% [106], and in Brazil, the IFAT method detected 40.6% of positive blood samples in beef cattle that were slaughtered [153]. Molecular methods indicated high values for meat cattle samples, with a 19.3% rate of positive results in Tunisia [100].

Sheep and goats present *T. gondii* in their consumable organs [89]. Serological and molecular methods have demonstrated that around of 10–24% of liver, meat, and heart samples were positive for sheep and goat [89]. In Italy, the meat juices from 28.6% sheep and 27.5% goat were positive by commercial ELISA [97]; in Lebanon, the data are high, with a seroprevalence of 42% and 34% in sheep and goats, respectively [92], and other countries show even higher seroprevalences [94,104]. However, studies with molecular methods indicated a low prevalence in sheep and goat meat in Iran, with 14.4% and 11.1%, respectively [97], whereas in Tunisia, the data were 33.3% for sheep and 32.5% for goat meat samples [100], and in Australia molecular methods detected 43% of positive lambs that were examined [102]. To decrease this rate of infection, some strategies have been carried out. For example, in Denmark, seroprevalence in organic herds has been studied, concluding that organic herds present a higher prevalence, therefore, risk mitigation strategies in processing plants could be alternatives to serological surveillance [110]. This elevated prevalence of *T. gondii* in organic herds is due to the high risk of being exposed and infected with environmental oocysts of parasites or from the ingestion of infected rodents [154,155].
Pork meat consumption has been estimated to cause 41% of foodborne toxoplasmosis cases in the USA [156]. In Brazil, some studies indicated that 6.5% of pig serum that was examined was positive of *T. gondii* by IFAT and MAT, and 69.2% of them presented positive PCR in meat [119], whereas other studies show with the IFAT method, a 77% rate of seropositive animals, and the parasitic DNA was found in 66.7% of tissue samples that were recovered [120]. In Cuba, the seroprevalence was 13.3% [114]. In Poland, using the DAT method, the authors found 11.9% of seropositive animals [157]. Molecular detection showed a prevalence of 6.7% in India [122]. The results that were observed by different ELISA and molecular procedures, IFAT, and MAT showed that the test and cut-off that were used influence the results that were obtained [114,158]. The production system seems to be influential as well with the higher prevalence found in extensive systems or organic farms than in intensive ones [113,116]. However, Gomez-Samblas et al. (2021) found only a 10% of *T. gondii* infection in Iberian sows that were raised as outdoor livestock [159]. These authors did not find infection in cured products, so a correct and thorough curing process could eliminate the presence of the parasite. These data may be higher when the meat is not subjected to industrial processes. In Romania, where backyard pigs are a common practice in rural areas, the seroprevalence was 46.8% and 36.4% of meat that was evaluated presented the DNA of the parasite [113].

In China, Japan, and the USA, recent studies indicated a 10–20% infection rate of quick-frozen chickens [85,130,160]. In India, the chicken tissue prevalence is 2.3% and the seroprevalence is around 6.5% [130], whereas in Brazil the seroprevalence is around 36% [128]. *T. gondii* infection may be accompanied by infection from other pathogens of chickens, as *Eimeria tenella* [161]. Not only broilers have *T. gondii* infection. Positive laying hens have been found in samples of serum and organs [162]. But *T. gondii* has been detected in other species for that are not common in meat production or meat consumption. For example, the overall seroprevalence of *T. gondii* in water buffaloes was around 8% in Romania [135]. In the Czech Republic, the presence of this protozoan has been demonstrated in feathered game and ostriches, with a 5.4% of prevalence in wild ducks, 3.4% in common pheasants, and 36% of ostriches by molecular methods [134,150], while white-tailed deer presented 36% of seroprevalence in USA [147]. In Canada, the presence of *T. gondii* in serum and organs of wolverines (*Gulo gulo*) has been detected by different methods [163]. The common quails presented a seroprevalence of 13.1% in China [136]. In this country, donkey meat and Tolai hare’s consumption is common in some provinces. In these meats, the prevalence of *T. gondii* DNA was 9.2% and 8.1%, respectively [136,137].

In the last years, several studies have indicated that wildlife can be a source of infection by *T. gondii* and a reservoir of the parasite. Wild ruminants have been analyzed in different European countries and the studies showed a high seroprevalence in roe deer (39.6%), fallow deer (37.1%), red deer (16.6%), Southern chamois (14%), mouflon (11.5%), Iberian wild goat (7.8%), Barbary sheep (5.6%) [148], and other hunting species (Table 1). In the USA, the most common wildlife species with antibodies of parasite are feral swine (9% of prevalence) and venison (36%) [138,147]. From retail outlets, Plaza et al. (2020) estimated the presence of antibodies in 5.3% of beef, 14.3% chicken, 16.5% lamb, 14.1% pork, and 16% in venison samples in Scotland [164]. Wild boar is presented as the most relevant wildlife species for risk infection of *T. gondii* around the world, with a seroprevalence of 76.9% in Brazil [143], around 40% in Italy [144,145], 14% in USA [138], 15% in China [139], and 9% in Finland [140]. Crotta et al. (2022) detected 49% of seroprevalence in wild boars in Italy, with high percentage of co-infections with hepatitis E virus [140]. From these data, the conclusion is drawn that the presence of *T. gondii* in meat for human consumption is high in Asia, Europe, and the USA, with its detection and control before sale being of vital importance.
3.2. Milk and Dairy Products

Tachyzoites can be shed in the milk of acutely infected animals, so both raw milk and raw dairy products can pose a risk of infection for consumers [165] (Table 3). In fact, one of the factors that is related to infection in the USA is the ingestion of unpasteurized goat’s milk [166]. Different studies show the presence of *T. gondii* in milk samples from sheep, goat, camels, and donkeys [52,167–170], where the prevalence can reach up to 43–65% [159]. However, these data differ between production procedures, management, and techniques of detection, increasing with deficient biosecurity levels (related to the application of a health management program, vaccination protocols, correct quarantines, protocols for visitors, etc.) [171], and were higher for serological rather than molecular techniques. In goat, molecular techniques revealed the presence in 20.6% of milk samples, whereas the ELISA showed 63.3% [172]. Other studies showed that relationship between the prevalence of *T. gondii* antibodies in the goat serum with a prevalence of *T. gondii* DNA in milk samples [157].

Table 3. *T. gondii* in milk and dairy products. The table shows the producer animal, sample contaminated, country of contamination, method that was used for detection, and prevalence that was found.

| Animal   | Sample Analyzed | Detection Method | Number of Samples Tested | Number of Positive Samples (%) | Location | Reference |
|----------|-----------------|------------------|--------------------------|--------------------------------|----------|-----------|
| Donkey   | Milk            | ELISA            | 418                      | 41 (9.2%)                      | China    | [167]     |
| Goat     | Milk            | ELISA            | 30                       | 19 (63.3%)                     | Italy    | [172]     |
| Goat     | Milk            | PCR              | 60                       | 39 (65%)                       | Poland   | [157]     |
| Milk     | ELISA and qPCR  |                  | 30                       | 27 (90%) and 1 (3.3%),         | Egypt    | [173]     |
| Bulk tank milk | ELISA       |                  | 100                      | 59 (59%)                       | Italy    | [172]     |
| Sheep    | Milk            | PCR              | 58                       | 1 (1.7%)                       | Mongolia | [168]     |
| Milk     | ELISA and qPCR  |                  | 30                       | 18 (60%) and 1 (3.3%),         | Egypt    | [173]     |
| Camel    | Milk            | PCR              | 9                        | 8 (88.9%)                      | Mongolia | [168]     |
| Milk     | ELISA and qPCR  |                  | 30                       | 1 (3.3%) and 0 (0%),           | Egypt    | [173]     |
| Cattle   | Bulk tank milk  | ELISA            | 149                      | 8 (5.4%)                       | Iran     | [174]     |

1 ELISA: Enzyme-Linked Immunosorbent Assay; PCR: Polymerase chain reaction; qPCR: real-time PCR.

Although the transmission of *T. gondii* through cow’s milk has not been detected [167], tachyzoite survival in milk pH conditions has been demonstrated [175], which could indicate that although they have not yet been detected, we could find tachyzoites in unpasteurized cow’s milk, making it a possible route of transmission. Milk is considered a potential source of infection since the infectious parasite in its tachyzoite form can be transmitted by animal fluids. The main detection methods that are used in raw milk samples include the detection of parasitic DNA by PCR-based tests, usually targeting the 529 bp repeat sequence [170], or the B1 gene [30]. However, the detection of *T. gondii* DNA does not allow the viability of the parasite to be determined. For this reason, other techniques have been used to determine the viability of parasites in milk and dairy products, including the viability assay in cell culture, where the cytopathic effect of tachyzoites on Hep-2 cells is measured, including mouse and cat bioassays [175]. Mouse and cat bioassays were used to detect *T. gondii* in the milk and cheese of goats, demonstrating that fresh milk and cheese are a source of transmission, so the protozoan survives cold-enzyme treatment [29]. The ELISA test has also been used to evaluate the presence of *T. gondii* antibodies in goat milk samples. The study showed that this technique in milk samples could easily be applied to detect the seroprevalence of *T. gondii*, although it does not allow the detection of tachyzoites [171].
3.3. Fresh Products and Vegetables

Fresh products can become contaminated with *T. gondii* oocysts from cat feces or contaminated water, and act as a source of infection in humans. Oocyst detection in environmental and food samples is difficult due to complications in separating and concentrating oocysts from complex matrices, such as raw vegetables, so there is a lack of optimized laboratory methods for its detection [41]. However, Dumètre and Dardé (2003) have proposed possible methods for the detection of *T. gondii* in water, soil, and food samples (mainly, fruit and vegetables), based on methods that are used for other protozoa [176]. Hohweyer et al. (2016) developed an immunomagnetic separation assay (IMS) targeting the cell wall of oocysts, although it is not yet commercially available [67]. In addition to conventional methods such as microscopy, PCR or qPCR, a LAMP test has been developed to detect *T. gondii* in experimental contaminated baby ready-to-eat lettuces. The detection limit of this method was approximately 25 oocysts per 50 g of lettuce leaves [47]. Recently, special RT-PCR assay has been developed and it was effective to discriminate viable *T. gondii*, detecting two to nine oocysts per gram of spinach [43].

The first detection of *T. gondii* DNA in fruits and vegetables was in 2012 [177]. Nowadays, some studies have linked acute outbreaks of human toxoplasmosis with the ingestion of oocysts, where green vegetables have been identified as a possible vehicle of infection which can be contaminated by irrigation water [178–180]. In fact, Pinto-Ferreira et al. (2019) undertook a meta-analysis and concluded that vegetables will be the most common possible route of transmission in the future [181]. Contamination by *T. gondii* has been observed in different vegetables around the word, including lettuce, chicory, rocket, parsley, spinach, pack choi, cabbage, rape, asparagus, endive, Chinese chives, carrots, cucumbers, strawberries, and radish [182] (Table 4).

### Table 4. *T. gondii* in fresh products and vegetables. The table shows the product that was analyzed, country of contamination, method used for detection, and prevalence that was found.

| Product Analyzed | Detection Method | Number of Samples Tested | Number of Positive Samples (%) | Location | Reference |
|------------------|------------------|--------------------------|-------------------------------|----------|-----------|
| Mixed-salad packages | qPCR | 648 packages | 5 (0.8%) | Italy | [183] |
| | PCR | 90 packages | 8 (8.9%) | Czech Republic | [184] |
| Leafy greens | qPCR | 152 | 45 (29.6%) | Morocco | [185] |
| Carrot | qPCR | 30 | 3 (10%) | Morocco | [186] |
| | qPCR | 46 | 9 (19.5%) | Poland | [177] |
| | PCR | 93 | 7 (7.5%) | Czech Republic | [184] |
| Chicory | PCR | 40 | 2 (5%) | Brazil | [187] |
| Red cabbage | qPCR | 8 | 1 (1.2%) | China | [42] |
| Coriander | qPCR | 29 | 8 (27.6%) | Morocco | [186] |
| Cucumber | PCR | 109 | 13 (11.9%) | Czech Republic | [184] |
| Lettuce | qPCR | 28 | 3 (10.7%) | Morocco | [186] |
| | qPCR | 50 | 9 (18%) | Poland | [177] |
| | qPCR | 71 | 5 (7%) | China | [42] |
| | PCR | 168 | 5 (3%) | Brazil | [187] |
| Spinach | qPCR | 50 | 2 (4%) | China | [42] |
| Parsley | qPCR | 29 | 13 (44.8%) | Morocco | [186] |
| | PCR | 5 | 1 (20%) | Brazil | [187] |
| Pak Choi | qPCR | 34 | 1 (2.9%) | China | [42] |
| Radish | qPCR | 16 | 1 (6.3%) | Morocco | [186] |
| | qPCR | 60 | 3 (5%) | Poland | [42] |
| Rape | qPCR | 22 | 1 (4.5%) | China | [42] |
| Rocket | PCR | 7 | 1 (14.3%) | Brazil | [187] |

1 PCR: Polymerase chain reaction; qPCR: real-time PCR.
In Poland, vegetables from shops and home gardens presented a contamination rate by *T. gondii* of 9.7% [178]. In China, the prevalence of DNA protozoan was detected in 3.6% in vegetable analyses [42], whereas in Morocco these data increases to 21.2% [187]. In Italy, other studies did not found *T. gondii* in fresh produce [188] or it was at a low prevalence (0.8%) [183]. The prevalence in packaged ready-to-eat mixed salads was investigated by microscopic examination and detection by PCR, and the results revealed that 0.8% of the ready-to-eat salads were positive for *T. gondii*, where a high oocyst burden was found (from 62 to 554 per gram of vegetable) [188]. Also with molecular and microscopic methods, a mean of oocyst concentration in salad has been detected of approximately 23.5 oocysts per gram [37].

### 3.4. Marine Products

Aquatic environments can be contaminated with wastewater carrying *T. gondii* oocysts. Mollusks such as clams, mussels, oysters, and scallops, filter-feed and trap phytoplankton in the gills. This filter feeding process can also concentrate waterborne pathogens within their tissues, including oocysts, which can survive for long periods of time in both fresh- and salt-water [55]. For detection in mollusks, samples of whole tissue or organs can be used and the most frequent techniques that are used are those that are based on PCR, generally directed to the B1 gene [189,190]. Various molecular methods have been used for detection in fish, such as PCR, qPCR, and RT-PCR, targeting the same gene, or the 529 bp DNA repeat element. The last method seems more sensitive, with the five oocysts as a low limit of detection. But it is no more specific, requiring direct sequencing for definitive confirmation of *T. gondii* [191]. In addition, the techniques have been carried out in different matrices, such as the digestive tract, muscle, brain, and even gills, among others [192]. Serological techniques have also been used for the detection in fish, such as ELISA, by detecting IgG and IgM, suggesting the fish are actually infected with *T. gondii* [193], rather than just serving as paratenic hosts such as shellfish.

The consumption of raw mollusks is considered a risk factor for *T. gondii* infection. Table 5 shows the prevalence of parasite in different mollusks, bivalves, and fishes.

**Table 5. *T. gondii* in marine products.** The table shows the animal, sample contaminated, country of contamination, method that was used for detection, and prevalence that was found.

| Animal                    | Sample Analyzed | Detection Method | Number of Samples Tested | Number of Positive Samples (%) | Location     | Reference |
|---------------------------|-----------------|------------------|--------------------------|-------------------------------|--------------|-----------|
| Bivalve shellfish         | Tissue          | PCR              | 2907                     | 82 (2.8%)                     | China        | [194]     |
| Green-lipped mussels     | Tissue          | PCR              | 104                      | 13 (16.4%)                    | New Zealand  | [195]     |
| Mediterranean mussel      | Gills           | qPCR             | 53 pools at 795 specimens | 21 (39.6%)                    | Turkey       | [189]     |
| Clam                      | Tissue          | qPCR             | 61 pools at 1020 specimens | 4 (6.6%)                      | Tunisia      | [190]     |
|                          | Digestive gland | PCR              | 390                      | 6 (1.5%)                      | Canada       | [196]     |
|                          | Haemolymph      | PCR              | 390                      | 2 (0.6%)                      | Canada       | [196]     |
| Mediterranean scald fish  | Gills           | PCR              | 1 pool at 6 specimens    | 1 (100%)                      | Italy        | [197]     |
| Pacific oyster            | Gills           | PCR              | 6 pools at 109 specimens | 1 (16.67%)                    | Italy        | [198]     |
| Oyster                    | Mantle, gills, and rectum | qPCR | 1440 | 447 (31%) | USA | [199] |
Table 5. Cont.

| Animal               | Sample Analyzed | Detection Method | Number of Samples Tested | Number of Positive Samples (%) | Location | Reference |
|----------------------|-----------------|------------------|--------------------------|-------------------------------|----------|-----------|
| **Bogue**            |                 |                  |                          |                               |          |           |
| Gills                | PCR             | 26 pools at 260 specimens | 4 (15.4%)                | Italy                         | [197]    |
| Intestine            | PCR             | 26 pools at 260 specimens | 3 (11.5%)                | Italy                         | [197]    |
| Muscle               | PCR             | 26 pools at 260 fish | 6 (23.1%)                | Italy                         | [197]    |
| **White seabream**   | Muscle          | PCR              | 3 pools of 18 specimens  | 1 (33.3%)                     | Italy    | [197]    |
| **European anchovy** |                 |                  |                          |                               |          |           |
| Gills                | PCR             | 35 pools at 350 specimens | 2 (5.7%)                 | Italy                         | [197]    |
| Intestine            | PCR             | 35 pools at 350 specimens | 1 (2.9%)                 | Italy                         | [197]    |
| **European hake**    |                 |                  |                          |                               |          |           |
| Gills                | PCR             | 15 pools at 90 specimens | 1 (6.7%)                 | Italy                         | [197]    |
| Muscle               | PCR             | 15 pools at 90 specimens | 1 (6.7%)                 | Italy                         | [197]    |
| **Red mullet**       | Intestine       | PCR              | 11 pools at 110 specimens | 3 (27.3%)                    | Italy    | [197]    |
| **American prawn**   | Muscle          | PCR              | 618                      | 4                             | China    | [197]    |
| **Nippon shrimp**    | Muscle          | PCR              | 813                      | 1                             | China    | [200]    |
| **Axillary seabream**|                 |                  |                          |                               |          |           |
| Gills                | PCR             | 8 pools at 80 specimens | 2 (25%)                  | Italy                         | [197]    |
| Intestine            | PCR             | 8 pools at 80 specimens | 1 (12.5%)                | Italy                         | [197]    |
| Muscle               | PCR             | 8 pools at 80 specimens | 1 (12.5%)                | Italy                         | [197]    |
| **Common pandora**   |                 |                  |                          |                               |          |           |
| Gills                | PCR             | 3 pools at 18 specimens | 1 (33.3%)                | Italy                         | [197]    |
| Intestine            | PCR             | 3 pools at 18 specimens | 2 (66.7%)                | Italy                         | [197]    |
| Muscle               | PCR             | 3 pools at 18 specimens | 1 (33.3%)                | Italy                         | [197]    |
| **Thornback ray**    | Muscle          | PCR              | 1 fish                   | 1 (100%)                      | Italy    | [198]    |
| **Red scorpionfish** | Intestine       | PCR              | 1 pool at 3 specimens    | 1 (100%)                      | Italy    | [197]    |
| **Blotched picarel** | Muscle          | PCR              | 4 pools at 24 specimens  | 1 (25%)                       | Italy    | [197]    |
| **Atlantic horse mackerel** | Muscle | PCR          | 15 pools at 120 specimens | 4 (26.7%)                    | Italy    | [197]    |

1 PCR: Polymerase chain reaction; qPCR: real-time PCR.

Different studies showed the prevalence of infection in Mediterranean bivalves of 6.6% to 9.4% in countries such as Turkey and Italy [189,190,198]. In China, 2.8% of marine bivalve shellfish analyses were positive for the DNA of protozoan, and depended on the temperature and precipitation, with a higher presence of *T. gondii* with elevated temperatures and precipitations [194]. Similar results were found in New Zealand, where the prevalence was 16.4% [195]. Recently, the presence of *T. gondii* in fish has been investigated. There is still controversy about possible parasitic infection in cold-blooded hosts. Some studies support that these animals can act as mechanical vectors, such as mollusks, containing oocysts in their digestive system [194]. In fact, *T gondii* DNA has been found in different
fish species of local fish markets [197] and marine animals species. A recent review showed high prevalence in mustelids (54.8%) and cetaceans (30.92%) [201].

4. Control and Food Safety

The control of *T. gondii* infection must be done at several levels. First, certain risk factors increase the prevalence of the parasite in farm animals. Hygienic management practices and correct management which involves keeping cats away from crops and gardens and animal feed, are essential to control this pathogen in farms [121]. Temperature and humidity control could decrease the survival and distribution of the parasite, as well as a late replacement of the animals, since older animals present higher prevalence than young ones [94,202]. The intensive systems of production present lower prevalence than extensive or semi-intensive ones [171]. In the same way, organic farms present higher prevalence than conventional farms, probably due to due to the high risk of being exposed and infected with environmental oocyst of parasites or from ingested infected rodents [110]. Nevertheless, the most important factor in all production systems seems to be the biosecurity level (control of exposition and infection of animals with environmental parasites and control of domestic animals that are infected near the farms) and early detection [110,112]. Consumption of fresh milk and dairy products are other of factors that cause *T. gondii* infection in humans. In fact, pasteurization of milk and milk products is also an important control measure. Undoubtedly, stopping consuming these types of products could considerably reduce the prevalence of infection in humans. On the other hand, as occurs in meat products, adequate hygienic and sanitary conditions on farms would lead to this reduction. In fresh products and vegetables, the most common mechanism of contamination is irrigation with water that is contaminated by oocyst, so sanitary control measures in irrigation water would be interesting. Furthermore, washing fresh produce after harvest and before consumption is an important control measure, since the chemical disinfectants are not effective [18].

The control of *T. gondii* in food production is essential. However, control measures during food inspection are not applied [21]. Currently, different methods of inactivation exist, although in the industry they are not applied directly for the control of this parasite. The most used methods of control are thermal methods, including both high and low temperatures. Heat treatments can destroy oocysts from both sporulated and non-sporulated strains. It is also possible to eliminate bradyzoites and tachyzoites, although the elimination of the first requires higher temperatures and longer times [58,203]. Relationship between raw meat or other animal products have been demonstrated by several studies. In meat products, the main control measure to prevent infection is an adequate cooking and proper prevention of cross-contamination [204]. In fact, *T. gondii* can be eliminated from meat in 5–6 min at 49 °C, in 44 s at 55 °C, or in 6 s at 61 °C [205]. Different meat products require different temperature conditions for inactivation. For example, beef should be cooked at least 63 °C; whereas pork meat, minced meat, and bushmeat at 71 °C; and poultry at 82 °C. In general, meat should be cooked to at least 67 °C before consumption. In dairy products, the pasteurization of milk, at 63 °C for 30 min is sufficient to eliminate tachyzoites [206]. Rani and Pradhan (2021) published an exhaustive study that was related to the survival of *T. gondii* during cooking and low temperature storage and concluded that the parasite was not found when the internal temperature reached 64 °C and below −18 °C [207].

However, these elevated temperatures are not applicable to all food matrices. This is the case of vegetables and fresh products [208]. Regarding inactivation by low temperatures, it has been shown that freezing can inactivate tissue cysts of *T. gondii*. To inactivate isolate tissue cysts, a minimum of three days is required at −20 °C [209]. In addition to thermal methods, other non-thermal methods can be used for the inactivation, such as high-pressure processing [55,154,210], ionizing radiation [211,212], and curing or salt [34,75]. The inactivation of *T. gondii* in food for thermal and non-thermal methods has been extensively analyzed in the review that was published by Mirza et al. (2018) [213].

The inactivation of *T. gondii* in food products has been realized traditionally with high temperatures (thermal methods) and when cured and salted [207,214], whereas the
non-thermal methods are presented as emerging technologies for the control of *T. gondii* in food. High pressure processing (HHP) is a novel method for liquid and solid food products where pressures of 340–550 MPa during 1 min can inactive cysts of the parasite [215]. The second new method is ionizing radiation (IR), which is capable of inactivating or killing *T. gondii* cysts in meat [58]. However, these methods have not yet been tested in other food matrices or to inactive other parasitic forms.

5. Future Perspectives

Currently, most of the control of *T. gondii* infection is carried out at home, setting recommendations on food consumption in the groups that are most vulnerable to the parasite. This situation occurs because there are no regulations governing control measures against *T. gondii* in the food industry. Inactivation methods have yet to be optimized and validated to be applied against this parasite is a systematic way. More, different prevention measures could also be applied to its control. In farms, biosecurity and control will be factors of great relevance for infection control. Other measures such as restricting the access of cats to crops, gardens, and livestock feed, or the development of a vaccine that is aimed at cats to prevent the active release of oocysts could be used. Prevention measures could also be implemented at the livestock farm, such as the vaccination of cattle. Today, a vaccine against *T. gondii* is available for sheep, which prevents the spread of parasites to the placenta, and is used for the prevention of abortions in this species [216]. This vaccine also prevents the spread to other tissues, reducing the development of tissue cysts [217]. This measure seems to be a promising strategy, but it is still in the experimental phase and needs further development.

It would be useful to carry out a follow-up program at slaughter, detecting the meat that is positive for *T. gondii* and deriving its use for preheated or frozen meat products since, as we have seen, these methods are effective for the inactivation, as well as marking negative products as free from *T. gondii* [154]. Detection methods could be improved, mainly molecular methods given their high sensitivity, so that they can differentiate viable and non-viable parasites or use more than one detection method simultaneously (serological and molecular, for example). However, regulatory testing in meat animals is generally not considered practical due to the high prevalence in meat animals, i.e., many animals or carcasses would be found positive and would need to be destroyed or used for pre-cooked products. In short, a set of preventive measures, detection methods, and fine-tuning of inactivation methods are required to achieve control of this parasite and produce safe food for consumers.

6. Conclusions

*T. gondii* is the food parasite with the greatest epidemiological relevance, which is distributed worldwide, and with a complex life cycle that makes its detection very difficult. The main foods that are involved in the transmission of this parasite are meat and fresh products (vegetables and fruits) products through tissue cysts, mollusks, and fish, as well as through oocysts, and milk and dairy products through tachyzoites. Currently, the main detection methods are bioassays, in vitro culture, molecular methods (PCR and LAMP), and microscopy as direct methods, and serological techniques as MAT, IFAT, and ELISA as indirect methods. Due to the limitations of these methods, the emerging detection methods are aimed at developing methods with greater sensitivity and reproducibility, and generally, are aimed at the detection of several parasites simultaneously, which would increase their efficiency and facilitate their application in the food industry. Control methods include thermal methods such as heat, cooking, and freezing, as well as non-thermal methods such as HPP, IR, curing, or salting. Most of the control of *T. gondii* is carried out at home since there are no microbiological criteria for this parasite in the food industry and, therefore, it is not mandatory to comply with control measures. In the future, new detection methods should be validated to optimize the control of infection in food and apply them in the food industry.
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References
1. Rabilloud, M.; Wallon, M.; Peyron, F. In Utero and at Birth Diagnosis of Congenital Toxoplasmosis: Use of Likelihood Ratios for Clinical Management. Pediatr. Infect. Dis. J. 2010, 29, 421–425. [CrossRef] [PubMed]
2. Maldonado, Y.A.; Read, J.S.; Committee on Infectious Diseases. Diagnosis, Treatment, and Prevention of Congenital Toxoplasmosis in the United States. Pediatrics 2017, 139, e20163860. [CrossRef]
3. Wallon, M.; Peyron, F. Effect of Antenatal Treatment on the Severity of Congenital Toxoplasmosis. Clin. Infect. Dis. 2016, 62, 811–812. [CrossRef] [PubMed]
4. Conceição, A.R.; Beluck, D.N.; Missio, L.; Gustavo Brenner, L.; Henrique Monteiro, M.; Ribeiro, K.S.; Costa, D.F.; Valadão, M.C.d.S.; Commodaro, A.G.; de Oliveira Dias, J.R.; et al. Ocular Findings in Infants with Congenital Toxoplasmosis after a Toxoplasmosis Outbreak. Ophthalmology 2021, 128, 1346–1355. [CrossRef] [PubMed]
5. Daher, D.; Shaghlil, A.; Sebb, E.; Hamie, M.; Hassan, M.E.; Moumneh, M.B.; Itani, S.; El Hajj, R.; Tawk, L.; El Sabban, M.; et al. Comprehensive Overview of Toxoplasma Gondii-Induced and Associated Diseases. Pathogens 2021, 10, 1351. [CrossRef]
6. Robert-Gangneux, F.; Dardé, M.-L. Epidemiology of and Diagnostic Strategies for Toxoplasmosis. Clin. Microbiol. Rev. 2012, 25, 264–296. [CrossRef]
7. Rajapakse, S.; Weeratunga, P.; Rodrigo, C.; de Silva, N.L.; Fernando, S.D. Prophylaxis of Human Toxoplasmosis: A Systematic Review. Pathog. Glob. Health 2017, 111, 333–342. [CrossRef]
8. Yazdani, M.R.; Mehrabi, Z.; Ataei, B.; Ghahfarokhi, A.B.; Moslemi, R.; Pourahmad, M. Frequency of Sero-Positivity in Household Members of the Patients with Positive Toxoplasma Serology. Rev. Esp. Quim. 2018, 31, 506–510.
9. Montoya, J.G.; Liesenfeld, O. Toxoplasmosis. Lancet 2004, 363, 1965–1976. [CrossRef]
10. Matta, S.K.; Rinkenberger, N.; Dunay, I.R.; Sibley, L.D. Toxoplasma gondii Infection and Its Implications within the Central Nervous System. Nat. Rev. Microbiol. 2021, 19, 467–480. [CrossRef]
11. Hermes, G.; Ajikoka, J.W.; Kelly, K.A.; Mui, E.; Roberts, F.; Kasza, K.; Mayr, T.; Kirisits, M.J.; Wollmann, R.; Ferguson, D.J.; et al. Neurological and Behavioral Abnormalities, Ventricular Dilatation, Altered Cellular Functions, Inflammation, and Neuronal Injury in Brains of Mice Due to Common, Persistent, Parasitic Infection. J. Neuroinflammation 2008, 5, 48. [CrossRef]
12. Xiao, J.; Li, Y.; Gressitt, K.L.; He, H.; Kannan, G.; Schultz, T.L.; Svezhova, N.; Carruthers, V.B.; Pletnikov, M.V.; Yolken, R.H.; et al. Cerebral Complement C1q Activation in Chronic Toxoplasma Infection. Brain Behav. Immun. 2016, 58, 52–56. [CrossRef] [PubMed]
13. Johnson, H.J.; Koshy, A.A. Latent Toxoplasmosis Effects on Rodents and Humans: How Much Is Real and How Much Is Media Hype? mBio 2020, 11, e02164-19. [CrossRef] [PubMed]
14. Johnson, S.K.; Johnson, P.T.J. Toxoplasmosis: Recent Advances in Understanding the Link Between Infection and Host Behavior. Annu. Rev. Anim. Biosci. 2021, 9, 249–264. [CrossRef] [PubMed]
15. Vallochi, A.L.; Goldberg, A.C.; Falcai, A.; Ramasawmy, R.; Kalil, J.; Silveira, C.; Belfort, L.; Rizzolo, L.V. Molecular Markers of Susceptibility to Ocular Toxoplasmosis, Host and Guest Behaving Badly. Clin. Ophthalmol. 2008, 2, 837–848.
16. Scallan, E.; Hoekstra, R.M.; Angulo, F.J.; Tauxe, R.V.; Widdowson, M.-A.; Roy, S.L.; Jones, J.L.; Griffin, P.M. Foodborne Illness Acquired in the United States—Major Pathogens. Emerg. Infect. Dis. 2011, 17, 7–15. [CrossRef]
17. Chaichan, P.; Mercier, A.; Galal, L.; Mahittikorn, A.; Ariley, F.; Morand, S.; Boumediène, F.; Udonson, R.; Hamidovic, A.; Murat, J.B.; et al. Geographical Distribution of Toxoplasma gondii Genotypes in Asia: A Link with Neighboring Continents. Infect. Genet. Evol. 2017, 53, 227–238. [CrossRef]
18. Almería, S.; Dubey, J.P. Foodborne Transmission of Toxoplasma gondii Infection in the Last Decade. An Overview. Rev. Vet. Sci. 2021, 135, 371–385. [CrossRef]
19. Shapiro, K.; Kim, M.; Rajal, V.B.; Arrowood, M.; Packham, A.; Aguilar, B.; Wuertz, S. Simultaneous Detection of Four Protozoan Parasites on Leafy Greens Using a Novel Multiplex PCR Assay. Food Microbiol. 2019, 84, 103252. [CrossRef]
20. Luna, J.C.; Zamora, A.; Hernández-Arango, N.; Muñoz-Sánchez, D.; Pinzón, M.I.; Cortés-Vecino, J.A.; Lora-Suarez, F.; Gómez-Marin, J.E. Food Safety Assessment and Risk for Toxoplasmosis in School Restaurants in Armenia, Colombia. Parasitol. Res. 2019, 118, 3449–3457. [CrossRef]
45. Zhang, H.; Thekisoe, O.M.M.; Aboge, G.O.; Kyan, H.; Yamagishi, J.; Inoue, N.; Nishikawa, Y.; Zakimi, S.; Xuan, X. *Toxoplasma gondii*: Sensitive and Rapid Detection of Infection by Loop-Mediated Isothermal Amplification (LAMP) Method. *Exp. Parasitol.* **2009**, *122*, 47–50. [CrossRef]

46. Durand, L.; La Carbona, S.; Geffard, A.; Possenti, A.; Dubey, J.P.; Lalle, M. Comparative Evaluation of Loop-Mediated Isothermal Amplification (LAMP) vs QPCR for Detection of *Toxoplasma gondii* Oocysts DNA in Mussels. *Exp. Parasitol.* **2020**, *208*, 107809. [CrossRef]

47. Lalle, M.; Possenti, A.; Dubey, J.P.; Pozio, E. Loop-Mediated Isothermal Amplification-Lateral-Flow Dipstick (LAMP-LFD) to Detect *Toxoplasma gondii* Oocysts in Ready-to-Eat Salad. *Food Microbiol.* **2018**, *70*, 137–142. [CrossRef]

48. Mahmoudi, M.R.; Kazemi, B.; Haghighi, A.; Karanis, P. Detection of Acanthamoeba and *Toxoplasma* in River Water Samples by Molecular Methods in Iran. *Iran. J. Parasitol.* **2015**, *10*, 250–257.

49. Fallahi, S.; Mazar, Z.A.; Ghasemian, M.; Haghighi, A. Challenging Loop-Mediated Isothermal Amplification (LAMP) Technique for Molecular Detection of *Toxoplasma gondii* in Sheep. *Asian Pac. J. Trop. Med.* **2015**, *8*, 366–372. [CrossRef]

50. Gior, S.B.; Edelhofer, R.; Grim, F.; Deplazes, P.; Basso, W. Evaluation of a Commercial ELISA Kit for Detection of Antibodies against *Toxoplasma gondii* in Serum, Plasma and Meat Juice from Experimentally and Naturally Infected Sheep. *Parasites Vectors* **2013**, *6*, 85. [CrossRef]

51. Schares, G.; Koethe, M.; Bangoura, B.; Geuthner, A.-C.; Randau, F.; Ludewig, M.; Maksimov, P.; Senz, M.; Bärwald, A.; Conraths, F.J.; et al. *Toxoplasma gondii* Infections in Chickens—Performance of Various Antibody Detection Techniques in Serum and Meat Juice Relative to DNA Detection Methods. *Int. J. Parasitol.* **2018**, *48*, 751–762. [CrossRef] [PubMed]

52. Mancianti, F.; Nardoni, S.; D’Ascenzi, C.; Pedonese, F.; Mugnaini, L.; Franco, F.; Papini, R. Seroprevalence, Detection of DNA in Blood and Milk, and Genotyping of *Toxoplasma gondii* in a Goat Population in Italy. *Biomol. Res. Int.* **2013**, *2013*, 905326. [CrossRef] [PubMed]

53. Fabian, B.T.; Hedar, F.; Koethe, M.; Bangoura, B.; Maksimov, P.; Conraths, F.J.; Villena, I.; Aubert, D.; Seeber, F.; Schares, G. Fluorescent Bead-Based Serological Detection of *Toxoplasma gondii* Infection in Chickens. *Parasites Vectors* **2020**, *13*, 388. [CrossRef]

54. Dubey, J.P.; Murata, F.H.A.; Cerqueira-Castro, V.L.; Kwan, O.C.H. Epidemiologic and Public Health Significance of *Toxoplasma gondii* Infections in Vermon: 2009–2020. *J. Parasitol.* **2021**, *107*, 309–319. [CrossRef]

55. Lindsay, D.S.; Dubey, J.P. Long-Term Survival of *Toxoplasma gondii* Sporulated Oocysts in Seawater. *J. Parasitol.* **2009**, *95*, 1019–1020. [CrossRef] [PubMed]

56. Jones, J.L.; Dubey, J.P. Foodborne Toxoplasmosis. *Clin. Infect. Dis.* **2012**, *55*, 845–851. [CrossRef]

57. Kniel, K.E.; Lindsay, D.S.; Sumner, S.S.; Hackney, C.R.; Pierson, M.D.; Dubey, J.P. Examination of Attachment and Survival of *Toxoplasma gondii* Oocysts on Raspberries and Blueberries. *J. Parasitol.* **2002**, *88*, 790–793. [CrossRef]

58. El-Nawawi, F.A.; Tawfik, M.A.; Shaapan, R.M. Methods for Inactivation of *Toxoplasma gondii* Cysts in Meat and Tissues of Experimentally Infected Sheep. *Foodborne Pathog. Dis.* **2008**, *5*, 687–690. [CrossRef]

59. Juránková, J.; Basso, W.; Neumayerová, H.; Frenčová, A.; Baláž, V.; Deplazes, P.; Koudela, B. Predilection Sites for *Toxoplasma gondii* Infection in Sheep Tissues Revealed by Magnetic Capture and Real-Time PCR Detection. *Food Microbiol.* **2015**, *52*, 150–153. [CrossRef]

60. Geng, M.; Vismarra, A.; Mangia, C.; Faccini, S.; Vicari, N.; Rigamonti, S.; Prati, P.; Marino, A.M.; Kramer, L.; Fabbri, M. Lack of Viable Parasites in Cured “Parma Ham” (PDO), Following Experimental *Toxoplasma gondii* Infection of Pigs. *Food Microbiol.* **2017**, *66*, 157–164. [CrossRef]

61. da Costa-Silva, T.A.; da Silva Meira, C.; Frazzatti-Gallina, N.; Pereira-Chioccola, V.L. *Toxoplasma gondii* Antigens: Recovery Analysis of Tachyzoites Cell Cultivated in Vero Cells Maintained in Serum Free Medium. *Exp. Parasitol.* **2012**, *130*, 463–469. [CrossRef] [PubMed]

62. Zintl, A.; Halova, D.; Mulcahy, G.; O’Donovan, J.; Markay, B.; DeWaal, T. In Vitro Culture Combined with Quantitative TaqMan PCR for the Assessment of *Toxoplasma gondii* Tissue Cyst Viability. *Veter. Parasitol.* **2009**, *164*, 167–172. [CrossRef] [PubMed]

63. Dubey, J.P. *Toxoplasma gondii* Infections in Chickens (*Gallus domesticus*): Prevalence, Clinical Disease, Diagnosis and Public Health Significance. *Zoonoses Public Health* **2010**, *57*, 60–73. [CrossRef] [PubMed]

64. Veronesi, F.; Santoro, A.; Milardi, G.L.; Diaferia, M.; Branciari, R.; Miraglia, D.; Cioffi, A.; Gabrielli, S.; Ranucci, D. Comparison of PCR Assays Targeting the Multi-Copy Targets B1 Gene and 529 Bp Repetitive Element for Detection of *Toxoplasma gondii* in Swine Muscle. *Food Microbiol.* **2017**, *63*, 213–216. [CrossRef]

65. Bayarri, S.; Gracia, M.J.; Lázaro, R.; Pe Rez-Arquillú, C.; Barberán, M.; Herrera, A. Determination of the Viability of *Toxoplasma gondii* in Cured Ham Using Bioassay: Influence of Technological Processing and Food Safety Implications. *J. Food Prot.* **2010**, *73*, 2239–2243. [CrossRef]

66. Hohweyer, J.; Cazeaux, C.; Travaille, E.; Languet, E.; Dumètre, A.; Aubert, D.; Teryn, C.; Dubey, J.P.; Azas, N.; Houssin, M.; et al. Simultaneous Detection of the Protozoan Parasites *Toxoplasma* and *Cryptosporidium* and Giardia in Food Matrices and Their Persistence on Basil Leaves. *Food Microbiol.* **2016**, *57*, 36–44. [CrossRef]

67. Lemmon, G.H.; Gardner, S.N. Predicting the Sensitivity and Specificity of Published Real-Time PCR Assays. *Ann. Clin. Microbiol. Antimicrob.* **2008**, *7*, 18. [CrossRef]

68. Notomi, T.; Okayama, H.; Masubuchi, H.; Yonekawa, T.; Watanabe, K.; Amino, N.; Hase, T. Loop-Mediated Isothermal Amplification of DNA. *Nucleic Acids Res.* **2000**, *28*, E63. [CrossRef]

69. Nagamine, K.; Hase, T.; Notomi, T. Accelerated Reaction by Loop-Mediated Isothermal Amplification Using Loop Primers. *Mol. Cell. Probes* **2002**, *16*, 223–229. [CrossRef]
70. Qu, D.; Zhou, H.; Han, J.; Tao, S.; Zheng, B.; Chi, N.; Su, C.; Du, A. Development of Reverse Transcription Loop-Mediated Isothermal Amplification (RT-LAMP) as a Diagnostic Tool of Toxoplasma gondii in Pork. Vet. Parasitol. 2013, 192, 98–103. [CrossRef]

71. Fernández-Escobar, M.; Scharfs, G.; Maksimov, P.; Joeres, M.; Ortega-Mora, L.M.; Calero-Bernal, R. Toxoplasma gondii Genotyping: A Closer Look Into Europe. Front. Cell. Infect. Microbiol. 2022, 12, 842995. [CrossRef] [PubMed]

72. Rousseau, A.; Villena, L.; Dumètre, A.; Escotte-Binet, S.; Favennec, L.; Dubey, J.P.; Aubert, D.; La Carbona, S. Evaluation of Propidium Monoazide-Based QPCR to Detect Viable Oocysts of Toxoplasma Gondii. Parasitol. Res. 2019, 118, 999–1010. [CrossRef] [PubMed]

73. Guo, M.; Dubey, J.P.; Hill, D.; Buchanan, R.L.; Gamble, H.R.; Jones, J.L.; Pradhan, A.K. Prevalence and Risk Factors for Toxoplasma gondii Infection in Meat Animals and Meat Products Destined for Human Consumption. J. Food Prot. 2015, 78, 457–476. [CrossRef] [PubMed]

74. Gamble, H.R.; Dubey, J.P.; Lambillotte, D.N. Comparison of a Commercial ELISA with the Modified Agglutination Test for Detection of Toxoplasma gondii in the Domestic Pig. Vet. Parasitol. 2005, 128, 177–181. [CrossRef] [PubMed]

75. Hill, D.E.; Benedetto, S.M.C.; Coss, C.; McCrery, J.L.; Fournet, V.M.; Dubey, J.P. Effects of Time and Temperature on the Viability of Toxoplasma gondii Tissue Cysts in Fresh Pork Loin. J. Food Prot. 2006, 69, 1961–1965. [CrossRef]

76. Lalonde, L.F.; Gajadhar, A.A. Optimization and Validation of Methods for Isolation and Real-Time PCR Identification of Protozoan Oocysts on Leafy Green Vegetables and Berry Fruits. Food Waterborne Parasitol. 2016, 2, 1–7. [CrossRef]

77. Slana, I.; Bier, N.; Bartosova, B.; Marucci, G.; Possenti, A.; Mayer-Scholl, A.; Jokelainen, P.; Lalle, M. Molecular Methods for the Serological Detection and of Risk Factors of Neospora Caninum and Toxoplasma gondii Infection in The Netherlands. Int. J. Food Microbiol. 2011, 14, 305–310. [CrossRef]

78. Cazeaux, C.; Lalle, M.; Durand, L.; Aubert, D.; Favennec, L.; Dubey, J.P.; Geffard, A.; Villena, I.; La Carbona, S. Evaluation by Analysis of B1 and ROP8 Gene Regions. J. Microbiol. Methods 2020, 2017, 184, 106188. [CrossRef] [PubMed]

79. Temesgen, T.T.; Barlaam, A.; Tysnes, K.R.; Robertson, L.J. Comparative Evaluation of UNEX-Based DNA Extraction for Molecular Detection of Cyclospora catayanensis, Toxoplasma gondii, and Cryptosporidium parvum as Contaminants of Berries. Food Microbiol. 2020, 89, 103447. [CrossRef] [PubMed]

80. Azimpour-Ardakan, T.; Fotouhi-Ardakani, R.; Hoghooghi-Rad, N.; Rokni, N.; Motallebi, A. Designing and Developing of High-Resolution Melting Technique for Separating Different Types of Toxoplasma gondii by Analysis of B1 and ROP8 Gene Regions. J. Microbiol. Methods 2021, 177, 109489. [CrossRef] [PubMed]

81. Gisbert Algaba, I.; Geerts, M.; Jennes, M.; Coucke, W.; Opsteegh, M.; Cox, E.; Dorny, P.; Dierick, K.; De Craeye, S. A More Sensitive, Efficient and ISO 17025 Validated Magnetic Capture Real Time PCR Method for the Detection of Archetypal Toxoplasma gondii Strains in Meats. Int. J. Parasitol. 2017, 47, 875–884. [CrossRef] [PubMed]

82. Wang, Z.-H.; Zhang, W.; Zhang, X.-Z.; Yao, X.-R.; Huang, W.; Jia, H.; Liu, X.-L.; Hou, S.-H.; Wang, X.-J. Development of a Real-Time Recombinase-Aided Amplification (RT-RAA) Molecular Diagnosis Assay for Sensitive and Rapid Detection of Toxoplasma Gondii. Vet. Parasitol. 2021, 298, 109489. [CrossRef] [PubMed]

83. Loreck, K.; Mitrenga, S.; Meemken, D.; Heinez, R.; Reissig, A.; Mueller, E.; Ehrlich, R.; Engemann, C.; Greiner, M. Development of a Miniaturized Protein Microarray as a New Serological IgG Screening Test for Zoonotic Agents and Production Diseases in Pigs. PLoS ONE 2019, 14, e0217290. [CrossRef] [PubMed]

84. Duong, H.D.; Appiah-Kwasteng, C.; Takashima, Y.; Aye, K.M.; Nagayasu, E.; Yoshida, A. A Novel Luciferase-Linked Antibody Capture Assay (LACA) for the Diagnosis of Toxoplasma gondii Infection in Chickens. Parasitol. Int. 2020, 77, 102125. [CrossRef]

85. DeMone, C.; Huang, M.-H.; Feng, Z.; McClure, J.T.; Greenwood, S.J.; Fung, R.; Kim, M.; Weese, J.S.; Shapiro, K. Application of next Generation Sequencing for Detection of Protozoan Pathogens in Shellfish. Food Waterborne Parasitol. 2020, 21, e00096. [CrossRef] [PubMed]

86. Guggisberg, A.R.; Alvarez Rojas, C.A.; Kronenberg, P.A.; Deplazes, P. A Sensitive, One-Way Sequential Sieving Method to Isolate Helminths’ Eggs and Protozoal Oocysts from Lettuce for Genetic Identification. Parasites 2021, 8, 103447. [CrossRef] [PubMed]

87. Gharekhani, J.; Yakhchali, M.; Esmaeielnejad, B.; Mardani, K.; Majidi, G.; Sohrabi, A.; Berahamat, R.; Hazhir Alaei, M. Seroprevalence and Risk Factors of Neospora Caninum and Toxoplasma gondii in Small Ruminants of Southwest Iran and the Potential Risks for Consumers. J. Verbrach. Lebensm. 2021, 16, 117–127. [CrossRef]

88. Opsteegh, M.; Prickaerts, S.; Frankenka, K.; Evers, E.G. A Quantitative Microbial Risk Assessment for Meatborne Toxoplasma gondii Infection in The Netherlands. Int. J. Food Microbiol. 2011, 150, 103–114. [CrossRef]

89. Yousefvand, A.; Mirhosseini, S.A.; Ghorbani, M.; Mohammadzadeh, T.; Moghadam, M.M.; Mohammadyari, S. Molecular and Serological Detection and of Risk Factors of Neospora Caninum and Toxoplasma gondii in Small Ruminants in Southwest of Iran. Arch. Razi Inst. 2018, 73, 305–310. [CrossRef]

90. Dekse, G.; Ligere, B.; Šneidere, A.; Jokelainen, P. Seroprevalence and Factors Associated with Toxoplasma gondii Infections in Sheep in Latvia: Latvian Dark Headed Sheep Breed Associated with Higher Seroprevalence. Vector borne Zoonotic Dis. 2017, 17, 478–482. [CrossRef] [PubMed]
Foods 2022, 11, 2542

92. El Safadi, D.; Abi Chahine, D.; Al Tarraf, A.; Raii, O.; Mesto, K.; Ismail, M.B.; Hamze, M. First Report on Seroprevalence and Risk Factors of Toxoplasma gondii Infection in Sheep and Goats in North Lebanon. J. Infect. Dev. Ctries. 2019, 13, 831–836. [CrossRef] [PubMed]

93. Moskwa, B.; Kornacka, A.; Cybulska, A.; Cabaj, W.; Reiterova, K.; Bogdaszewski, M.; Steiner-Bogdaszewska, Z.; Bien, J. Seroprevalence of Toxoplasma gondii and Neospora caninum Infection in Sheep, Goats, and Fallow Deer Farmed on the Same Area. J. Anim. Sci. 2018, 96, 2468–2473. [CrossRef] [PubMed]

94. Tegegne, D.; Kelifa, A.; Abduralrahman, M.; Yohannes, M. Seroprevalence and Associated Risk Factors of Toxoplasma gondii Infection in Sheep and Goats in Southwestern Ethiopia. BMC Vet. Res. 2016, 12, 280. [CrossRef] [PubMed]

95. Bahreh, M.; Hajimohammadi, B.; Eslami, G. Toxoplasma gondii Infection in Sheep and Goats from Central Iran. BMC Res. Notes 2021, 14, 46. [CrossRef]

96. Satbige, A.S.; Sreekumar, C.; Rajendran, C.; Vijaya Bharathi, M. Isolation and Characterization of Toxoplasma gondii from Small Ruminants (Sheep and Goats) in Chennai City, South India. J. Parasit. Dis. 2017, 41, 869–873. [CrossRef]

97. Gazzonis, A.L.; Zanzani, S.A.; Giangaspero, A.; Manfredi, M.T. Toxoplasma gondii Infection in Meat-Producing Small Ruminants: Meat Juice Serology and Genotyping. Parasitol. Int. 2020, 76, 102060. [CrossRef]

98. Jiang, N.; Su, R.; Jian, F.; Su, C.; Zhang, L.; Jiang, Y.; Yang, Y. Isolation and Characterization of Toxoplasma gondii from Juvenile Leaky Sheep in China: A Molecular Study. Vet. Parasitol. Reg. Stud. Rep. 2020, 16, 100002. [CrossRef] [PubMed]

99. Ai, K.; Huang, C.-Q.; Guo, J.-J.; Cong, H.; He, S.-Y.; Zhou, C.-X.; Cong, W. Molecular Detection of Toxoplasma gondii Infection in Slaughtered Ruminants (Sheep, Goats and Cattle) in Northwestern Tunisia. Meat Sci. 2017, 133, 180–184. [CrossRef]

100. Abdul Hamid, N.; Sadiq, M.B.; Ramanoon, S.Z.; Mansor, R.; Watanabe, M.; Md Isa, N.M.; Kamaludeen, J.; Syed-Hussain, S.S. Risk Factors of Toxoplasma gondii Infection in Slaughtered Pigs and Cattle in Poland: Seroprevalence, Molecular Detection and Genetic Characterization of Toxoplasma gondii in Infections. Parasitol. Res. 2020, 119, 3893–3898. [CrossRef]

101. Langoni, H.; Generoso, D.; Hayasaka, É.Y.; Mantovan, K.B.; Menozzi, B.D.; Richini-Pereira, V.B.; da Silva, R.C. Molecular Detection of Toxoplasma gondii and Sarcocystis spp. in Raw Kibbeh and Other Meat Samples Commercialized in Botucatu, Southeastern Brazil. Rev. Bras. Parasitol. Vet. 2021, 30, e029320. [CrossRef]

102. Felin, E.; Halli, O.; Heinonen, M.; Jukola, E.; Fredriksson-Ahomaa, M. Assessment of the Feasibility of Serological Monitoring and On-Farm Information about Health Status for the Future Meat Inspection of Fattening Pigs. Prev. Vet. Med. 2019, 162, 76–82. [CrossRef]

103. Olsen, A.; Sandberg, M.; Houe, H.; Nielsen, H.V.; Denwood, M.; Jensen, T.B.; Alban, L. Seroprevalence of Toxoplasma gondii Infection in Sows and Finishers from Conventional and Organic Herds in Denmark: Implications for Potential Future Serological Surveillance. Prev. Vet. Med. 2020, 185, 105149. [CrossRef]

104. Pajtú, A.I.; Cosma-Petrut, A.; Mercier, A.; Balea, A.; Galal, L.; Mircean, V.; Pușta, D.L.; Bogdan, L.; Györke, A. Prevalence and Genetic Characterization of Toxoplasma gondii in Naturally Infected Backyard Pigs Intended for Familial Consumption in Romania. Parasites Vectors 2019, 12, 586. [CrossRef] [PubMed]

105. Castillo-Cuenca, J.C.; Martínez-Moreno, Á.; Díaz-Cao, J.M.; Entrena-García, A.; Fraga, J.; Arias, P.C.; Almera, S.; García-Bocanegra, I. Seroprevalence of Toxoplasma gondii and Associated Risk Factors in Domestic Pigs Raised from Cuba. Parasitol. Res. 2021, 120, 2897–2903. [CrossRef] [PubMed]

106. Gazzonis, A.L.; Marangi, M.; Villa, L.; Ragona, M.E.; Olivieri, E.; Zanzani, S.A.; Giangaspero, A.; Manfredi, M.T. Toxoplasma gondii Infection and Biosecurity Levels in Fattening Pigs and Sows: Serological and Molecular Epidemiology in the Intensive Pig Industry (Lombardy, Northern Italy). Parasitol. Res. 2018, 117, 539–546. [CrossRef] [PubMed]

107. Macaluso, G.; Di Bella, S.; Purpari, G.; Giudice, E.; Mira, F.; Gaggiotti, F.; Marino, A.M.F.; Russo, C.; Gómez-Morales, M.A.; Guercio, A. Evaluation of a Commercial Enzyme-Linked Immunosorbent Assay (ELISA) for Detecting Antibodies against Toxoplasma gondii from Naturally and Experimentally Infected Pigs. Infect. Dis. 2019, 51, 26–31. [CrossRef]
115. Papini, R.; di Ciccio, P.; Maranghi, M.; Ghidini, S.; Zanardi, E.; Vergara, A.; Giangaspero, A.; Nardoni, S.; Rocchigiani, G.; Mancianti, F.; et al. Occurrence of Toxoplasma gondii in Carcasses of Pigs Reared in Intensive Systems in Northern Italy. J. Food Prot. 2017, 80, 515–522. [CrossRef]

116. Pipia, A.P.; Varcasia, A.; Dessi, G.; Panzalis, R.; Gai, C.; Nonnis, F.; Veronesi, F.; Tamponi, C.; Scala, A. Seroprevalence and Molecular Characterization of Toxoplasma gondii in Slaughtered Domestic Pigs in Northern Italy. Parasitol. Res. 2018, 117, 1637–1641. [CrossRef]

117. Kuruca, L.; Klun, I.; Uzelac, A.; Nikolić, A.; Bobić, B.; Simin, S.; Lalošević, V.; Lalošević, D.; Đurković-Djaković, O. Detection of Toxoplasma gondii in Milk from Cows of Different Rearing Systems in Northern Serbia. Parasitol. Res. 2017, 116, 3117–3123. [CrossRef]

118. Oliveira, G.C.; da Souza Almeida, H.M.; Sartori, R.S.; Rossi, G.A.M.; de Oliveira, L.G.; Langoni, H. Occurrence of Toxoplasma gondii in Slaughtered Domestic Rabbits in Central China. Parasitology 2018, 66, 185–192. [CrossRef]

119. Papini, R.; di Ciccio, P.; Maranghi, M.; Ghidini, S.; Zanardi, E.; Vergara, A.; Giangaspero, A.; Nardoni, S.; Rocchigiani, G.; Mancianti, F.; et al. Occurrence of Toxoplasma gondii in Swine of Non-Tecnified Rearing Farms of the Northeastern Region of the State of São Paulo, Brazil and Associated Risk Factors. Parasite Epidemiol. Control. 2019, 4, e00080. [CrossRef]

120. Silva, E.M.C.; Sousa, P.D.S.; de Carvalho, S.K.G.S.; Marques, I.C.L.; Costa, F.B.; da Costa, A.P.; Santos, L.D.; Braga, M.d.S.O.; Abreu-Silva, A.L.; Machado, R.Z.; et al. Prevalence of Toxoplasma gondii Isolated from Pigs for Human Consumption. Parasitol. Res. 2019, 118, 1593–1599. [CrossRef]

121. Wu, F.; Wang, Y.-L.; Yang, Z.; Li, X.-L.; Li, Z.-R.; Lin, Q. Seroprevalence and Risk Factors of Toxoplasma gondii in Slaughter Pigs in Shanxi Province, Northwestern China. Vector Borne Zoonotic Dis. 2017, 17, 517–519. [CrossRef]

122. Thakur, R.; Sharma, R.; Aulakh, R.S.; Gill, J.P.; Singh, B.B. Prevalence, Molecular Detection and Risk Factors Investigation for the Occurrence of Toxoplasma gondii in Slaughter Pigs in North India. BMC Vet. Res. 2019, 15, 431. [CrossRef]

123. Gui, B.-Z.; Zheng, W.-B.; Zou, Y.; Lv, Q.-Y.; Liu, M.-T.; Li, F.; Yuan, A.-W.; Li, R.-C.; Liu, G.-H. Molecular Detection and Genotyping of Toxoplasma gondii in Pigs for Human Consumption in Hunan Province, China. Foodborne Pathog. Dis. 2018, 15, 809–813. [CrossRef]

124. Vergara, A.; Maranghi, M.; Caradonna, T.; Pennisi, L.; Paludi, D.; Papini, R.; Ianieri, A.; Giangaspero, A.; Normanno, G. Toxoplasma gondii Lineages Circulating in Slaughtered Industrial Pigs and Potential Risk for Consumers. J. Food Prot. 2018, 81, 1373–1378. [CrossRef]

125. Zhang, Y.; Xie, J.; Mi, R.; Ling, H.; Luo, L.; Jia, H.; Zhang, X.; Huang, Y.; Gong, H.; Han, X.; et al. Molecular Detection and Genetic Characterization of Toxoplasma gondii in Pork from Chongqing, Southwest China. Acta Trop. 2021, 224, 106314. [CrossRef]

126. Costa, D.F.; Fowler, F.; Silveira, C.; Nórega, M.J.; Nórega, H.A.J.; Nascimento, H.; Rizzo, L.V.; Comodaro, A.G.; Belfort, R. Prevalence of Toxoplasma gondii DNA in Processed Pork Meat. Foodborne Pathog. Dis. 2018, 15, 734–736. [CrossRef]

127. Sroka, J.; Bilska-Zajać, E.; Wójcik-Fałta, A.; Zajac, V.; Dutkiewicz, J.; Karamon, J.; Piotrowska, W.; Cenczek, T. Detection and Molecular Characteristics of Toxoplasma gondii DNA in Retail Raw Meat Products in Poland. Foodborne Pathog. Dis. 2019, 16, 195–204. [CrossRef]

128. Dos Santos Silva, A.C.; de Barros, L.D.; Barros, V.M.C.; de Alcântara, A.M.; Andrade, M.R.; Garcia, J.L.; Mota, R.A.; Porto, W.J.N. Occurrence of Atypical and New Genotypes of Toxoplasma gondii in Free-Range Chickens Intended for Human Consumption in Brazil. Acta Parasitol. 2020, 65, 774–778. [CrossRef]

129. Thakur, R.; Sharma, R.; Aulakh, R.S.; Singh, B.B. Toxoplasma gondii in Chickens (Gallus domesticus) from North India. Acta Parasitol. 2021, 66, 185–192. [CrossRef]

130. Ying, Y.; Verma, S.K.; Kwock, O.C.H.; Alihana, F.; McLeod, R.; Su, C.; Dubey, J.P.; Pradhan, A.K. Prevalence and Genetic Characterization of Toxoplasma gondii in Free-Range Chickens from Grocery Stores and Farms in Maryland, Ohio and Massachusetts, USA. Parasitol. Res. 2017, 116, 1591–1595. [CrossRef]

131. Zou, Y.; Nie, L.-B.; Zhang, N.-Z.; Zou, F.-C.; Zhu, X.-Q.; Cong, W. First Genetic Characterization of Toxoplasma gondii Infection in Poultry Meat Intended for Human Consumption in Eastern China. Infect. Genet. Evol. 2017, 55, 172–174. [CrossRef]

132. Qian, W.; Yan, W.; Lv, C.; Bai, R.; Wang, T. Occurrence and Genetic Characterization of Toxoplasma gondii in Neospora Caninum in Slaughtered Domestic Rabbits in Central China. Parasite 2019, 26, 36. [CrossRef]

133. Bárburas, D.; Győrke, A.; Blaga, R.; Bárbarus, R.; Kalmár, Z.; Vișan, S.; Mircean, V.; Blaižot, A.; Cozma, V. Toxoplasma gondii in Water Buffaloes (Bubalus bubalis) from Romania: What Is the Importance for Public Health? Parasitol. Res. 2019, 118, 2695–2703. [CrossRef]

134. Bártová, E.; Kobedová, K.; Budíková, M.; Račka, K. Serological and Molecular Detection of Toxoplasma gondii in Farm-Reared Ostriches (Struthio camelus) in the Czech Republic. Int. J. Food Microbiol. 2021, 356, 109333. [CrossRef]

135. Cong, W.; Chi, W.-B.; Sun, W.-W.; Shan, X.-F.; Kang, Y.-H.; Meng, Q.-F.; Qian, A.-D. First Report of Toxoplasma gondii Infection in Common Quails (Coturnix coturnix) Intended for Human Consumption in Three Provinces of Northeastern China. Vector Borne Zoonotic Dis. 2017, 17, 351–353. [CrossRef]

136. Cong, W.; Chen, L.; Shan, X.-F.; Qian, A.-D.; Meng, Q.-F. First Genetic Characterization of Toxoplasma gondii Infection in Donkey Meat Slaughtered for Human Consumption in Shandong Province, Eastern China. Infect. Genet. Evol. 2018, 61, 1–3. [CrossRef]

137. Cong, W.; Zhou, C.-X.; Chen, L.; Zou, Y.; Wang, W.-L.; Meng, Q.-F.; Qian, A.-D. Toxoplasma gondii and Neospora Caninum in Tolai Hares (Lepus tolai) Intended for Human Consumption. Int. J. Food Microbiol. 2018, 224, 27–30. [CrossRef]

138. Pedersen, K.; Bauer, N.E.; Rodgers, S.; Bazan, L.R.; Mesenbrink, B.T.; Gidlewski, T. Antibodies to Various Zoonotic Pathogens Detected in Feral Swine (Sus scrofa) at Abattoirs in Texas, USA. J. Food Prot. 2017, 80, 1239–1242. [CrossRef]
Foods 2022, 11, 2542

139. Bai, M.-J.; Zou, Y.; Elsheikha, H.M.; Ma, J.-G.; Zheng, W.-B.; Zhao, Q.; Zhang, X.-X.; Zhu, X.-Q. Toxoplasma gondii Infection in Farmed Wild Boars (Sus scrofa) in Three Cities of Northeast China. Foodborne Pathog. Dis. 2017, 14, 379–385. [CrossRef]

140. Crotta, M.; Pellicioli, L.; Gaffuri, A.; Trogu, T.; Formenti, N.; Tranquillo, V.; Luzzago, C.; Ferrari, N.; Lanfranchi, P. Analysis of Serore prevalence Data on Hepatitis E Virus and Toxoplasma gondii in Wild Ungulates for the Assessment of Human Exposure to Zoonotic Meat-Borne Pathogens. Food Microbiol. 2021, 101, 103890. [CrossRef]

141. Fredriksson-Ahomaa, M.; London, L.; Skrzypczak, T.; Kantala, T.; Laamanen, I.; Biström, M.; Maunula, L.; Gadd, T. Foodborne Zoonoses Common in Hunted Wild Boars. Ecohealth 2020, 17, 512–522. [CrossRef] [PubMed]

142. Machado, D.M.R.; de Barros, L.D.; de Souza Lima Nino, B.; de Souza Pollo, A.; Dos Santos Silva, A.C.; Perles, L.; André, M.R.; Zacarias Machado, R.; Garcia, J.L.; Lux Hoppe, E.G. Toxoplasma gondii Infection in Wild Boars (Sus scrofa) from the State of São Paulo, Brazil. Serology, Molecular Characterization, and Hunter’s Perception on Toxoplasmosis. Vet. Parasitol. Reg. Stud. Rep. 2021, 23, 100534. [CrossRef] [PubMed]

143. Stollberg, K.C.; Schares, G.; Mayer-Scholl, A.; Hrushetska, I.; Diescher, S.; Johne, A.; Richter, M.H.; Bier, N.S. Comparison of Direct and Indirect Toxoplasma gondii Detection and Genotyping in Game: Relationship and Challenges. Microorganisms 2021, 9, 1663. [CrossRef]

144. Santoro, M.; Viscardi, M.; Santoro, M.; Borriello, G.; D’Alessio, N.; Boccia, F.; Pacifico, L.; Fioretti, A.; Veneziano, V.; Fusco, G. Real-Time PCR Detection of Toxoplasma gondii in Tissue Samples of Wild Boars (Sus scrofa) from Southern Italy Reveals High Prevalence and Parasite Load. Parasites Vectors 2019, 12, 335. [CrossRef]

145. Skorpikova, L.; Reslova, N.; Lorencova, A.; Plhal, R.; Drimaj, J.; Kamler, J.; Slany, M. Molecular Detection of Toxoplasma gondii in Goat Milk. Parasites Vectors 2019, 12, 335. [CrossRef]

146. Gazzonis, A.L.; Villa, L.; Riehn, K.; Hamedy, A.; Minazzi, S.; Olivieri, E.; Zanzani, S.A.; Manfredi, M.T. Occurrence of Selected Actinobacteria in Farmed Wild Boars (Sus scrofa) in Italy. Parasitol. Res. 2018, 117, 2207–2215. [CrossRef]

147. Dubey, J.P.; Cerqueira-Cézar, C.K.; Murata, F.H.A.; Verma, S.K.; Kwok, O.C.H.; Pedersen, K.; Rosenthal, B.M.; Su, C. White-Tailed Deer (Odocoileus virginianus) Are a Reservoir of a Diversity of Toxoplasma gondii Strains in the USA and Pose a Risk to Consumers of Undercooked Venison. Parasitology 2020, 147, 775–781. [CrossRef]

148. Castro-Scholten, S.; Cano-Terriza, D.; Jiménez-Ruiz, S.; Almería, S.; Risalde, M.A.; Vicente, J.; Acevedo, P.; Arnal, M.C.; Balseiro, A.; Gómez-Guillamon, E.; et al. Seroprevalence and Epidemiological Survey of Toxoplasma gondii in Wild Ruminants in Spain. Zoonoses Public Health 2021, 68, 884–895. [CrossRef]

149. Remes, N.; Kärrsön, A.; Must, K.; Tagel, M.; Lassen, B.; Jokelainen, P. Toxoplasma gondii Seroprevalence in Free-Ranging Moose (Alces alces) Hunted for Human Consumption in Estonia: Indicator Host Species for Environmental Toxoplasma gondii Occyst Contamination. Vet. Parasitol. Reg. Stud. Rep. 2018, 11, 6–11. [CrossRef]

150. Skorpikova, L.; Reslova, N.; Lorencova, A.; Plhal, R.; Drimaj, J.; Kamler, J.; Slany, M. Molecular Detection of Toxoplasma gondii in Feathered Game Intended for Human Consumption in the Czech Republic. Int. J. Food Microbiol. 2018, 286, 75–79. [CrossRef]

151. Bayarri, S.; Gracia, M.J.; Lázaro, R.; Pérez-Arquillué, C.; Herrera, A. Toxoplasma gondii in Meat and Food Safety Implications—A Review; IntechOpen: London, UK, 2012; ISBN 978-953-51-4078-7.

152. Belluco, S.; Mancin, M.; Conficoni, D.; Simonato, G.; Pietrobelli, M.; Ricci, A. Investigating the Determinants of Toxoplasma gondii Prevalence in Meat: A Systematic Review and Meta-Regression. PLoS ONE 2016, 11, e0153856. [CrossRef] [PubMed]

153. Do Carmo, E.L.; Morais, R.D.A.P.B.; Lima, M.d.S.; de Moraes, C.C.G.; Albuquerque, G.R.; da Silva, A.V.; Póvoa, M.M. Anti-Toxoplasma gondii Antibodies in Beef Cattle Slaughtered in the Metropolitan Region of Belém, Brazilian Amazon. Rev. Bras. Parasitol. Vet. 2017, 26, 226–230. [CrossRef] [PubMed]

154. Kjølstad, A.; Jongert, E. Control of the Risk of Human Toxoplasmosis Transmitted by Meat. Int. J. Parasitol. 2008, 38, 1359–1370. [CrossRef] [PubMed]

155. van der Giessen, J.; Fonville, M.; Bouwknegt, M.; Langelaar, M.; Vollema, A. Seroprevalence of Trichinella spiralis and Toxoplasma gondii in Pigs from Different Housing Systems in The Netherlands. Vet. Parasitol. 2007, 148, 371–374. [CrossRef]

156. Batz, M.B.; Hoffmann, S.; Morris, J.G. Ranking the Disease Burden of 14 Pathogens in Food Sources in the United States Using Attribution Data from Outbreak Investigations and Expert Elicitation. J. Food Prot. 2012, 75, 1278–1291. [CrossRef]

157. Skoja, C.; Kusyk, P.; Bilaka-Zaajac, E.; Karamon, J.; Dutkiewicz, J.; Wojcik Fatla, A.; Zajac, V.; Stojecki, K.; Rozycki, M.; Cencek, T. Seroprevalence of Toxoplasma gondii Infection in Goats from the South-West Region of Poland and the Detection of T. Gondii DNA in Goat Milk. Folia Parasitol. 2017, 64, 023. [CrossRef]

158. Felin, E.; Náreaho, A.; Fredriksson-Ahomaa, M. Comparison of Commercial ELISA Tests for the Detection of Toxoplasma Antibodies in the Meat Juice of Naturally Infected Pigs. Vet. Parasitol. 2017, 238, 30–34. [CrossRef]

159. Gomez-Samblas, M.; Vilchez, S.; Ortega-Velázquez, R.; Fuentes, M.V.; Osuna, A. Absence of Toxoplasma gondii in 100% Iberian Products from Experimentally Infected Pigs Cured Following a Specific Traditional Process. Food Microbiol. 2021, 95, 103665. [CrossRef]

160. Wang, R.; Zhao, N.; Zhang, H.; Wang, F.; Li, H.; Liu, Y.; Zhao, X.; Zhang, X. Prevalence of Toxoplasma gondii Infections in Chicken Hearts from Farmers’ Markets and Supermarkets in the Tai’an Region of China. J. Food Prot. 2020, 93, 338–341. [CrossRef]

161. Hiob, L.; Koethe, M.; Schares, G.; Goroll, T.; Daugschies, A.; Bangoura, B. Experimental Toxoplasma gondii and Eimeria tenella Co-Infection in Chickens. Parasitol. Res. 2017, 116, 3189–3203. [CrossRef]
186. Berrouch, S.; Escotte-Binet, S.; Amraouza, Y.; Flori, P.; Aubert, D.; Villena, I.; Hafid, J. Cryptosporidium spp., Giardia duodenalis and Toxoplasma gondii Detection in Fresh Vegetables Consumed in Marrakech, Morocco. Afr. Health Sci. 2020, 20, 1669–1678. [CrossRef] [PubMed]

187. Marchioro, A.A.; Tiyo, B.T.; Colli, C.M.; de Souza, C.Z.; Garcia, J.L.; Gomes, M.L.; Falavigna-Guilherme, A.L. First Detection of Toxoplasma gondii DNA in the Fresh Leaves of Vegetables in South America. Vector Borne Zoonotic Dis. 2016, 16, 624–626. [CrossRef]

188. Barlaam, A.; Temesgen, T.T.; Tysnes, K.R.; Rinaldi, L.; Ferrari, N.; Sannella, A.R.; Normanno, G.; Cacció, S.M.; Robertson, L.J.; Giangaspero, A. Contamination of Fresh Produce Sold on the Italian Market with Cyclospora cayetanensis and Echinococcus multilocularis. Food Microbiol. 2021, 38, 103792. [CrossRef]

189. Aksoy, U.; Marangi, M.; Papini, R.; Ozkoc, S.; Bayram Delibas, S.; Giangaspero, A. Detection of Toxoplasma gondii and Cyclospora cayetanensis in Mytilus Galloprovincialis from Izmir Province Coast (Turkey) by Real Time PCR/High-Resolution Melting Analysis (HRM). Food Microbiol. 2014, 44, 128–135. [CrossRef]

190. Ghozzi, K.; Marangi, M.; Papini, R.; Lahmar, I.; Challouf, R.; Houas, N.; Ben Dhiab, R.; Normanno, G.; Babba, H.; Giangaspero, A. First Report of Tunisian Coastal Water Contamination by Protozoan Parasites Using Mollusk Bivalves as Biological Indicators. Mar. Pollut. Bull. 2017, 117, 197–202. [CrossRef]

191. Coupe, A.; Howe, L.; Shapiro, K.; Roe, W.D. Comparison of PCR Assays to Detect Toxoplasma gondii Oocysts in Green-Lipped Mussels (Perna canaliculus). Parasitol. Res. 2019, 118, 2389–2398. [CrossRef]

192. Moratul, S.; Dea-Ayuela, M.A.; Cardells, J.; Marco-Hirs, N.M.; Puigcercós, J.E.; Howe, L.; Burrows, E.; Sine, A.; Pita, A.; Velathanthiri, N.; Vallée, E.; Lopez-Ramón, J. Potential Risk of Three Zoonotic Protozoa (Cryptosporidium spp., Giardia duodenalis, and Toxoplasma gondii) Transmission from Fish Consumption. Foods 2020, 9, 1913. [CrossRef] [PubMed]

193. Taghadosi, C.; Kojouri, G.A.; Taheri, M.A. Detection of Toxoplasma Antibodies in Sera of Salmonidae by ELISA. Comp. Clin. Pathol. 2010, 2, 203–206. [CrossRef]

194. Cong, W.; Li, M.-Y.; Zou, Y.; Ma, J.-Y.; Wang, B.; Jiang, Z.-Y.; Elsheikh, H.M. Prevalence, Genotypes and Risk Factors for Toxoplasma gondii contamination in Marine Bivalve Shellfish in Offshore Waters in Eastern China. Ecotoxicol. Environ. Saf. 2021, 213, 112048. [CrossRef] [PubMed]

195. Taghadosi, C.; Kojouri, G.A.; Taheri, M.A. Detection of Toxoplasma Antibodies in Sera of Salmonidae by ELISA. Comp. Clin. Pathol. 2010, 2, 203–206. [CrossRef]

196. Peng, W.; Li, M.-Y.; Zou, Y.; Ma, J.-Y.; Wang, B.; Jiang, Z.-Y.; Elsheikh, H.M. Prevalence, Genotypes and Risk Factors for Toxoplasma gondii contamination in Marine Bivalve Shellfish in Offshore Waters in Eastern China. Ecotoxicol. Environ. Saf. 2021, 213, 112048. [CrossRef] [PubMed]

197. Coupe, A.; Howe, L.; Shapiro, K.; Roe, W.D. First Report of Toxoplasma gondii Sporulated Oocysts and Giardia Duodenalis in Commercial Green-Lipped Mussels (Perna canaliculus) in New Zealand. Parasitol. Res. 2018, 117, 1453–1463. [CrossRef]

198. Fung, R.; Manore, A.J.W.; Harper, S.L.; Sargeant, J.M.; Shirley, J.; Caughey, A.; Shapiro, K. Clams and Potential Foodborne Toxoplasma gondii in Nunavut, Canada. Zoonoses Public Health 2021, 68, 277–283. [CrossRef]

199. Marino, A.M.F.; Giunta, R.P.; Salvaggio, A.; Castello, A.; Alfonzetti, T.; Barbagallo, A.; Apaoro, A.; Scalzo, F.; Reale, S.; Buffolano, W.; et al. Toxoplasma gondii in Edible Fishes Captured in the Mediterranean Basin. Zoonoses Public Health 2019, 66, 826–834. [CrossRef]

200. Putignani, L.; Mancinelli, L.; Del Chierico, F.; Menichella, D.; Adlerstein, D.; Angelici, M.C.; Marangi, M.; Berrilli, F.; Caffara, M.; di Regalbono, D.A.F.; et al. Investigation of Toxoplasma gondii Presence in Farmed Shellfish by Nested-PCR and Real-Time PCR Fluorescent Amplicon Generation Assay (FLAG). Exp. Parasitol. 2011, 127, 409–417. [CrossRef]

201. Marquis, N.D.; Bishop, T.J.; Record, N.R.; Countway, P.D.; Fernández Robledo, J.A. Molecular Epizootiology of Toxoplasma gondii and Cryptosporidium parvum in the Eastern Oyster (Crassostrea virginica) from Maine (USA). Pathogens 2019, 8, 125. [CrossRef]

202. Zhang, M.; Yang, Z.; Wang, S.; Tao, L.; Xu, L.; Yan, R.; Song, X.; Li, X. Detection of Toxoplasma gondii in Shellfish and Fish in Parts of China. Vet. Parasitol. 2014, 200, 85–89. [CrossRef] [PubMed]

203. Ahmadpour, E.; Rahimi, M.T.; Ghojoghi, A.; Rezaei, F.; Hatam-Nahavandi, K.; Oliveira, S.M.R.; de Lourdes Pereira, M.; Majidiani, H.; Siyadatpanah, A.; Elhamirad, S.; et al. Toxoplasma gondii Infection in Marine Animal Species, as a Potential Source of Food Contamination: A Systematic Review and Meta-Analysis. Acta Parasitol. 2022, 67, 592–605. [CrossRef]

204. Jones, J.K.; Kruuszon-Moran, D.; Wilson, M.; McQuillan, G.; Navin, T.; McAuley, J.B. Toxoplasma gondii Infection in the United States: Seroprevalence and Risk Factors. Am. J. Epidemiol. 2001, 154, 357–365. [CrossRef] [PubMed]

205. Hill, D.; Dubey, J.P. Toxoplasma gondii: Transmission, Diagnosis and Prevention. Clin. Microbiol. Infect. 2002, 8, 634–640. [CrossRef] [PubMed]

206. McCurdy, S.M.; Takeuchi, M.T.; Edwards, Z.M.; Edliefson, M.; Kang, D.; Elaine Mayes, V.; Hillers, V.N. Food Safety Education Initiative to Increase Consumer Use of Food Thermometers in the United States. Br. Food J. 2006, 108, 775–794. [CrossRef]

207. Hill, D.E.; Luchansky, J.; Porto-Fett, A.; Gamble, H.R.; Fournet, V.M.; Hawkins-Cooper, D.S.; Urban, J.F.; Gajadhar, A.A.; Holley, R.; Juneja, V.K.; et al. Rapid Inactivation of Toxoplasma gondii Bradyzoites during Formulation of Dry Cured Read-to-Eat Pork Sausage. Food Waterborne Parasitol. 2018, 12, e00029. [CrossRef] [PubMed]

208. Saridewi, R.; Lukman, D.; Sudarwanto, M.; Cahyanigsih, U.; Subekti, D. Survival of Toxoplasma gondii in Goat Milk after Pasteurization with Low Temperature and Long Time. Glob. Vet. 2013, 11, 789–793. [CrossRef]

209. Rani, S.; Pradhan, A.K. Evaluating Uncertainty and Variability Associated with Toxoplasma gondii Survival during Cooking and Low Temperature Storage of Fresh Cut Meats. Int. J. Food Microbiol. 2021, 341, 109031. [CrossRef] [PubMed]

210. Pinto-Ferreira, F.; Paschoal, A.T.P.; Pasquali, A.K.S.; Bernardes, J.C.; Caldart, E.T.; Freire, R.L.; Mitsuka-Breganó, R.; Navarro, I.T. Techniques for Inactivating Toxoplasma gondii Oocysts: A Systematic Review. Rev. Bras. Parasitol. Vet. 2021, 30, e026420. [CrossRef]

211. Djurkovic-Djakovic, O.; Milenkovic, V. Effect of Refrigeration and Freezing on Survival of Toxoplasma gondii Tissue Cysts. Acta Vet. 2000, 50, 375–380.
210. Considine, K.M.; Kelly, A.L.; Fitzgerald, G.F.; Hill, C.; Sleator, R.D. High-Pressure Processing–Effects on Microbial Food Safety and Food Quality. *FEMS Microbiol. Lett.* 2008, 281, 1–9. [CrossRef]

211. Kannan, G.; Prandovszky, E.; Steinfeldt, C.B.; Gressitt, K.L.; Yang, C.; Yolken, R.H.; Severance, E.G.; Jones-Brando, L.; Pletnikov, M.V. One Minute Ultraviolet Exposure Inhibits *Toxoplasma gondii* Tachyzoite Replication and Cyst Conversion without Diminishing Host Humoral-Mediated Immune Response. *Exp. Parasitol.* 2014, 145, 110–117. [CrossRef]

212. Lacombe, A.; Beard, A.; Hwang, C.-A.; Hill, D.; Fan, X.; Huang, L.; Yoo, B.K.; Niemira, B.A.; Gurtler, J.B.; Wu, V.C.H. Inactivation of *Toxoplasma gondii* on Blueberries Using Low Dose Irradiation without Affecting Quality. *Food Control* 2017, 73, 981–985. [CrossRef]

213. Mirza Alizadeh, A.; Jazaeri, S.; Shemshadi, B.; Hashempour-Baltork, F.; Sarlak, Z.; Pilevar, Z.; Hosseini, H. A Review on Inactivation Methods of *Toxoplasma gondii* in Foods. *Pathog. Glob. Health* 2018, 112, 306–319. [CrossRef] [PubMed]

214. Herrero, L.; Gracia, M.J.; Pérez-Arquillué, C.; Lázaro, R.; Herrera, A.; Bayarri, S. *Toxoplasma gondii* in Raw and Dry-Cured Ham: The Influence of the Curing Process. *Food Microbiol.* 2017, 65, 213–220. [CrossRef] [PubMed]

215. Lindsay, D.S.; Collins, M.V.; Holliman, D.; Flick, G.J.; Dubey, J.P. Effects of High-Pressure Processing on *Toxoplasma gondii* Tissue Cysts in Ground Pork. *J. Parasitol.* 2006, 92, 195–196. [CrossRef] [PubMed]

216. Innes, E.A.; Vermeulen, A.N. Vaccination as a Control Strategy against the Coccidial Parasites Eimeria, Toxoplasma and Neospora. *Parasitology* 2006, 133, S145–S168. [CrossRef]

217. Katzer, F.; Cantor, G.; Burrells, A.; Palarea-Albaladejo, J.; Horton, B.; Bartley, P.M.; Pang, Y.; Chianini, F.; Innes, E.A.; Benavides, J. Immunization of Lambs with the S48 Strain of *Toxoplasma gondii* Reduces Tissue Cyst Burden Following Oral Challenge with a Complete Strain of the Parasite. *Vet. Parasitol.* 2014, 205, 46–56. [CrossRef]