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INVITED REVIEW

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Review of novel human β-coronavirus (2019-nCoV or SARS-CoV-2) from the food industry perspective—Food plant health principles

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Abstract

Coronaviruses, enveloped non-segmented positive-sense RNA viruses, distinguished in the mid-60s can infect humans and a variety of birds and mammals. The purpose of this study was to review these coronaviruses, especially SARS (because of its very similar gene sequence to the 2019-nCoV or SARS-CoV-2), from the perspective of observing the food plant health principles including observing the personal hygiene principles, that is, identification and prevention of workers suspected of carrying COVID-19 in the food production lines, implementation of the hazard analysis and critical control points (HACCP), good manufacturing practice (GMP), and good hygienic practice (GHP) principles from farm to table; utilizing the appropriate chemical sanitizers, that is, incorporation of copper alloy surfaces in conjunction with effective cleaning regimens; use of food plant surface and cleaning-in-place-program sanitizers; utilizing the different light spectrums, that is, Surface sanitizing with UVC light or surface sanitizing with methylene blue in conjunction with visible light in food production lines; and providing unfavorable environmental conditions for coronavirus survival (minimum heat treatment, for example, low temperature long time and greater for liquid food products, pH ≤3, minimum-storage relative-humidity). Considering these aspects during times and times and places of with the high prevalence of β-coronavirus (2019-nCoV or SARS-CoV-2) will be essential for preventing further outbreaks at the community level.

1 | INTRODUCTION

Coronaviruses are surrounded non-segmented positive-sense RNA viruses relating to the family Coronaviridae, the sub-family Orthocoronavirinae [divided into four genera that is, α, β (divided into five sub-genera, that is, Embecovirus, Hibecovirus, Merbecovirus, Nobecovirus, and Sarbecovirus), δ and γ-coronavirus] that extendedly spread in mammals and birds (ICTV, 2020). The primary target cells of coronaviruses compromise the respiratory and gastrointestinal region epithelial cells due to their cell features and delivery through fomites, airborne, or fecal-oral routes (Yin & Wunderink, 2018). The current 2019-nCoV, which causes an acute respiratory disease case is closely related to SARS-CoV, that is, within the genus β-coronavirus and subgenus Sarbecovirus (WHO, 2020). The majority of infected individuals reported visiting the Wuhan-Seafood Wholesale Market recently before disease invasion, but some did not have any direct connection with the food market and that is why that person-to-person transmission may have occurred. Although 2019-nCoV has a high structural similarity with other bat-borne coronaviruses, and the resulting

Abbreviations: 2019-nCoV, 2019-novel coronavirus; CIP, cleaning-in-place; COVID-19, coronavirus disease 2019; GHP, good hygienic practice; GMP, good manufacturing practice; HACCP, hazard analysis and critical control points; HCoV, human coronavirus; LTLT, low temperature long time; MERS-CoV, middle east respiratory syndrome-coronavirus; SARS-CoV, severe acute respiratory syndrome-coronavirus; SADS, Swine acute diarrhea syndrome.

disease is much milder than SARS-CoV and MERS-CoV, bats are thought to be the main reservoir of these viruses. Whether the virus is transmitted directly from bats or through a host to, for example, mammalian and avian species, is still unclear. Therefore, accurate knowledge of the intrinsic properties of the virus, its evolution and how to monitor it is essential for disease control to prevent future outbreaks of these viruses (Shanmugaraj, Malla, & Phoolcharoen, 2020). Since there is little epidemiological and pathogenic information about this virus, as well as genetic analysis of this virus is very similar to SARS-CoV and is sometimes referred to as SARS-CoV-2 (ECDC, 2020a, 2020b). Therefore, animal and human origin safety authorities in the EU/EEA countries ought to follow the recommendations used for SARS-CoV and MERS-CoV outbreaks (ECDC, 2020a, 2020b).

Therefore, the purpose of this study was to review these coronaviruses, especially SARS (because of its very similar clinical presentation and highly comparable gene sequence to 2019-nCoV or SARS-CoV-2) from the food industry perspective, because livestock and poultry are potential carriers of SARS-CoV, as well as animal-to-human and human-to-human transmission is possible. Considering food plant health principles, which will be effective in preventing further outbreaks at the community level.

2 | CURRENT ACTIVITY

This review summarizes for the first time all available data related to emerging SARS-CoV, MERS-CoV, and novel-SARS-CoV-2 (i.e., 2019-nCoV) from the perspective of observing the food plant health principles in three parts including, observing the personal hygiene principles, utilizing the appropriate chemical sanitizers and different light spectrums.

3 | EVALUATE RESEARCH

3.1 | Coronavirus from the perspective of observing food plant health principles

3.1.1 | Clinical manifestations

Fever, nonproductive cough, nasal congestion, and fatigue as the clinical characteristics of COVID-19 start after less than a week of infection (Table 1). Lymphopenia and elevation of inflammatory markers including C-reactive protein and pro-inflammatory cytokines considered as diagnostic clinical laboratory manifestation so that anthogenesis of 2019-nCoV is genetically similar to SARS-CoV-1 and MERS-CoV, 79, and 50%, respectively (Kouhpayeh et al., 2020; Lu et al., 2020). Although most of the human coronavirus infections are mild and asymptomatic, the pandemics of the two β-coronaviruses, that is, SARS-CoV (β-coronavirus, subgenus Sarbecovirus, 2002–2003, case fatality rate 10%) (Drosten et al., 2003; Ksiazek et al., 2003; Kuiken, Fouchier, & Schutten, 2003) and MERS-CoV (Betacoronavirus, subgenus Merbecovirus, 2012, case fatality rate 35%) (De Groot et al., 2013; Zaki, van Boheemen, Bestebroer, Osterhaus, & Fouchier, 2012) have caused vast fatal human pneumonia, especially in the immunocompromised people, the cardiopulmonary patients and the old ones and adolescents (ECDC, 2020a; 2020b; WHO, 2020). SARS-CoV-infected humans due to eating animals infected with bat coronavirus, that is, Himalayan palm civets, Chinese ferret badgers and raccoon dogs sold for food, can cause human-human transmission. The most relevant animal reservoirs of human MERS-CoV are dromedary camels that caused human-human infections, especially in healthcare environments, in Saudi Arabia, 2012 (Hui et al., 2018; Park, Jung, & Kim, 2018).

TABLE 1 Preventive strategies to combat the spread of β-coronavirus from the perspective of observing the personal hygiene principles

Preventive measures	Scientific reasons	References
Identification and prevention of workers suspected of carrying COVID-19 in the food production lines.	• The incubation time ranges from 2 to 14 days after infection. • The clinical display of this infection relates to SARS-CoV and includes fever, dry cough, and shortness of breath in most instances. • Non-respiratory signs such as headache, muscle ache, dyspnea, rhinorrhea, sneezing, sore throat, diarrhea, nausea, and vomiting are also described in a few cases. • The best way to avoid virus infection is to avoid infected people, and strict personal hygienic measures are essential.	Huang (2020); Lee et al. (2003); Chen et al. (2020); Lu et al. (2020); Kouhpayeh et al. (2020)
Implementation of the HACCP, GMP, and GHP principles from farm to table.	• Human-to-human conveyances have been reported with 2–10 day incubation times, promoting virus spread via droplets and contaminated hands or surfaces. • The WHO recommended precautionary measures to the general public including cleaning hands; wearing a facemask, gloves, and glasses; wearing a hat; avoiding close contact with infected persons or farm animals; avoiding consumption of raw or under-cooked meat/eggs; and following good food safety practices.	Chang, Yan, and Wang (2020); Kampf, Todt, Pfaender, and Steinmann (2020); WHO (2020)
Adhering to the principles of personal hygiene, especially by production line personnel, disinfecting hands with soap and then 68–72% ethanol after toileting.	It is unknown whether the virus spreads only by human contact or if there is possible oral-fecal transmission.	Shanmugaraj et al. (2020)

3.1.2 | Observing health principles from farm to table (HACCP, GMP, and GHP)

In total, 27 (66%) of 41 people infected with 2019-nCoV had directly exposed to the seafood market comprised 49-year median age and 13 (32%) have minimum one underlying-illness (Huang, 2020). The global health system has been faced with developing pathogens effective for extending infectious diseases such as SARS, MERS, and influenza. The 2019-nCoV has newly considered to the list of problematical emerging pathogens originated from individuals exposed to the seafood or wet market proposing animal-human transmission (Huang, 2020; WHO, 2020). Extended research stated numerous SARS-like and MERS-like coronaviruses are bats originated and can directly transmit to humans from market civets and dromedary camels, respectively. Since the human angiotensin-converting enzyme II (ACE II) as a receptor can be used by the whole genome sequence of bats SARS-like coronavirus, thus these viruses can be replicated in human cells and are considered as a global health threat. Trustworthy quick pathogen trial and possible differential diagnoses based on the clinical reports are important for clinicians in their first contact with suspected cases. 2019-nCoV ought to carefully monitor to observe its future host adaption, viral evolution, infectivity, transmissibility, and pathogenicity because it is rapidly becoming epidemic (Huang, 2020). Therefore, taking immediate preventive measures, including identification of workers infected with COVID-19, infection prevention, and determination of carriers of the disease in the food production line, are necessary. Implementation of HACCP, GMP GHP principles from farm to table and adhering to the principles of personal hygiene, especially among production line personnel, by disinfecting hands with soap and then 68–72% ethanol after toileting, is necessary (Table 1).

3.1.3 | Persistence of coronaviruses on inanimate surfaces

Enveloped viruses are oftentimes sensitive to environmental tensions, but the human-coronaviruses causing SARS and MERS have recently provoked expanding the attention towards contact transmission while prevalence. The pathogenic human-coronavirus 229E originated from an infected human lung cell was persisted in at least a 5-day duration time on a variety of common surfaces, including Teflon, PVC, ceramic, glass, silicone rubber, and stainless-steel 304 and 316, while noroviruses are damaged on copper-alloy surfaces. Human-coronavirus 229E was rapidly destroyed on a variety of copper-alloys, and Cu/Zn-alloys were very efficient at destroying the virus at low copper concentrations. Exposure to copper destroyed the viral genomes and irreversibly modified virus morphology, including the destruction of the envelope and dispersal of surface spikes. Reactive oxygen at the alloy surface intensifies the inactivation power of coppers 1 and 2, even faster than inactivation of non-enveloped viruses on copper. Ultimately, copper alloy surfaces could be employed in common areas and could help protect public health. However, fast destruction, irreversible decomposition of viral RNA, and extensive structural destruction were recognized in coronaviruses exposed to copper and copper-alloy surfaces. The use of copper alloy surfaces in combination with efficient cleaning programs and GHP could help to control the transfer of respiratory coronaviruses, including MERS and SARS (Warnes, Little, & Keevil, 2015; Table 2).

3.1.4 | Inactivation of coronaviruses by biocidal agents

In carrier tests, application of ethanol (78–95%) for 30 s, 2-propanol (70–100%) for 30 s, the combination of 45% 2-propanol with 30% 1-propanol for 30 s, glutaraldehyde (0.5–2.5%) for 2–5 min, formaldehyde (0.7–1%) for 2 min, povidone-iodine (0.23–7.5%) for 15–60 s, sodium hypochlorite (0.21%) for 30 s, and H_2O_2 (0.5%) for 1 min immediately inactivated coronavirus infectivity by 4 $\log_{10}$ or greater (Eggers, Koburger-Janssen, Eickmann, & Zorn, 2018; Kampf et al., 2020; Rabenau et al., 2005; Saknimit, Inatsuki, Sugiyama, & Yagami, 1988). Whereas, in carrier tests, ethanol at concentrations between 62 and 71% reduced coronavirus infectivity in exposure time 1 min by 2.0–4.0 $\log_{10}$. Concentrations of 0.1–0.5% sodium hypochlorite and 2% glutaraldehyde were also quite effective with a >3.0 $\log_{10}$ reduction in viral titer. In contrast, 0.04% benzalkonium chloride, 0.06% sodium hypochlorite, and 0.55% orthophtalaldehyde were less effective (Casanova et al., 2010; Goyal et al., 2014; Hulkower et al., 2011; Kampf et al., 2020; Warnes et al., 2015). Therefore, using specified food plant surfaces and cleaning-in-place sanitizers (Table 2) is strongly suggested.

3.1.5 | Influence of radiation on the coronaviruses infectivity

Ultra-violet light is divided into three groups: UV-A (320–400 nm), UV-B (280–320 nm), and UV-C (200–280 nm). RNA and DNA bases can absorb UV-C and be photochemical fused of two adjacent pyrimidines into covalently linked dimers, which then become non-pairing bases. The destructive power of UV-B is 20–100 times lower than UV-C. The destructive power of UV-A is much lower than that of the others, but it may produce genetic damage that oxidizes bases and breaks the strands by producing active oxygen. The 400-fold decrease in the infectious virus occurred while UV-C exposure time increased from 1 to 6 min. Additional inactivation was not recognized from 6 to 10 min. But after 15 min, the virus was effectively destructed to the limit of detection of the assay, that is, ≤1.0 $\log_{10}$. While significant destruction was not seen by UV-A even over 15-min exposure time. Notably, SARS-Viruses were inactivated by UV-C at a distance of 3 cm for 15 min (Darnella, Subbarao, Feinstone, & Taylora, 2004). Illumination with different wavelengths also influenced the activities of the SARS and MERS virus in the blood. UV-A and UV-B light in the presence of riboflavin could destruct the pathogens' nucleic acids. These commercial systems could reduce the activities of the SARS and MERS virus in plasma or platelet concentrates to different

TABLE 2 Preventive strategies to combat the spread of β-coronavirus from the perspective of utilizing the appropriate chemical sanitizers

Preventive measures	Scientific reasons	References
Incorporation of copper or copper alloy (e.g., Cu/Zn) surfaces in conjunction with effective cleaning regimens and good clinical practice could help to control the transmission of respiratory coronaviruses, including MERS and SARS.	Although there was no exogenous hydrogen peroxide to feed the Fenton reaction (Equation (3)), cu (I) reacted with molecular oxygen to produce superoxide (Equation (1)) and subsequently, hydrogen peroxide (Equation (2)), which could also produce hydroxyl radicals (Equation (3)), causing immutable and extensive fundamental damage to viral RNA. $2Cu + 2O_2$ (aquatic) $\rightarrow 2Cu^{2+} + 2O_2^-$ (1) $2O_2^- + 2H^+ \rightarrow H_2O_2 + O_2$ (2) $Cu^+ + H_2O_2 \rightarrow Cu^{2+} + OH^- + OH^\bullet$ (3)	Warnes et al. (2015)
Use of food plant surface chemical sanitizers including 62–72% ethanol, 0.5% hydrogen peroxide, 0.1–0.5% sodium hypochlorite, and 2% glutaraldehyde with an exposure time of 1 min.	SARS, MERS, and HCoV can endure on inanimate surfaces such as metal, paper, ceramic, Teflon, glass, and plastic for 2 hr to 9 days at 20–22°C (68–72 °F) and ≥28 days at refrigerator temperature, for example, 4–10°C. An exposure time of 1 min with the mentioned surface sanitizers could decrease viral infectivity by >3 $\log_{10}$	Kampf et al. (2020); Warnes et al. (2015); Casanova, Jeon, Rutala, Weber, and Sobsey (2010); Hulkower, Casanova, Rutala, Weber, and Sobsey (2011); Goyal, Chander, Yezli, and Otter (2014)
Equipment immersion or cleaning in place (CIP) of the production line with ethanol (78–95%) for 30 s, 2-propanol (70–100%) for 30 s, the combination of 45% 2-propanol with 30% 1-propanol for 30 s, glutaraldehyde (0.5–2.5%) for 2–5 min, formaldehyde (0.7–1%) for 2 min, povidone iodine (0.23–7.5%) for 15–60 s, sodium hypochlorite (0.21%) for 30 s, and hydrogen peroxide (0.5%) for 1 min.	These sanitizers used at the corresponding exposure times cause a >4 log10 decrease in SARS, MERS, and HCoV infectivity.	(Kampf et al., 2020; Rabenau et al., 2005; Saknimit et al., 1988; Eggers et al., 2018)

degrees. Therefore, sanitizing with riboflavin + UVB light treatment in dairy production lines could be suggested as a coronavirus removal solution because of the sufficient riboflavin in milk (Table 3). Methylene blue plus visible light also has the ability to inactivate coronaviruses in plasma (Chang et al., 2020; Eickmann et al., 2018; Eickmann et al., 2020; Keil et al., 2016). Therefore, sanitizing with methylene blue + visible light treatment in food production lines for coronavirus removal can be introduced as a surface sanitizing procedure (Table 3).

TABLE 3 Preventive strategies to combat the spread of β-coronavirus from the perspective of utilizing the different light spectrums

Preventive measures	Scientific reasons	References
Surface sanitizing with UVC light in food production lines.	UV-C directly interacts with nucleic acids, causing the formation of nucleotide dimers and a ≥3.4 $\log_{10}$ decrease in SARS-CoV and a ≥3.7 $\log_{10}$ reduction in MERS-CoV.	Chang et al. (2020); Eickmann et al. (2020); Eickmann et al., 2018); Darnella et al. (2004)
Milk sanitizing with riboflavin + UVB light in dairy production lines.	Riboflavin associates with nucleic acids and mediates an oxygen-independent electron transfer upon UVB exposure.	Chang et al. (2020); Keil, Bowen, and Marschner (2016)
Surface sanitizing with methylene blue + visible light in food production lines.	Methylene blue intercalates into nucleic acid, mediates the production of singlet oxygen upon lightening, and causes a ≥ 3.1 $\log_{10}$ reduction in SARS-CoV and a ≥ 3.3 $\log_{10}$ reduction in MERS-CoV.	Chang et al. (2020); Keil et al. (2016)

3.1.6 | Environmental conditions (heat treatment, pH, protein protective effect, and relative humidity) effects on 2019-nCoV stability and survival

Coronaviruses are vulnerable to acid-pH, basic-pH, and heat (Rabenau et al., 2005) but seem to be more stable at 4°C (Lamarre & Talbot, 1989). The infectious titer of the virus did not display any significant reduction after 25-cycle thawing and freezing (Lamarre & Talbot, 1989). Usually, treatment with 60°C for 15–30 min is sufficient for the reduction of SARS-CoV in plasma without cells, and inactivation could be achieved by treatment with 60°C for 10 hr for plasma products. In another study, heating at 56°C for 25 min reduced the MERS -CoV by more than 4 $\log_{10}$ due to protein heat denaturation in blood products, it could only be used in manufacturing blood products derived plasma (Chang et al., 2020). The low-

TABLE 4 Preventive strategies to combat the spread of β-coronavirus from the perspective of disrupting the survival conditions of the coronavirus

Preventive measures	Scientific reasons	References
Avoidance of inadequate heat treatment (under-heating) in the production and processing of swine meat products.	One of the zoonotic SARS-, MERS-, or 2019-nCoV-like coronaviruses caused swine acute diarrhea syndrome (SADS), which struck the swine industry in 2017.	Yi, Kai, Zheng-Li, and Peng (2019)
	SARS-CoV and SADS-CoV were transmitted from bats to humans or swine.	Yi et al. (2019)
Uncertainty about the safety of frozen or refrigerated meat products.	• Freezing and refrigeration procedures (4–10°C) have no loss effects on coronavirus infectious titer. • The coronavirus seems to be more stable at 4°C. • The infectious titer of the virus did not show any significant reduction after 25 cycles of thawing and freezing.	Chang et al. (2020); Lamarre and Talbot (1989)
Apply minimal heat treatments, that is, low temperature long time (LTLT) and more for liquid food products	Heat treatments (60°C for at least 30 min) in protein-containing food solutions and a minimum temperature of 56°C in protein-free food solutions cause denaturing of the secondary structures of proteins and cause an acceptable reduction in MERS-CoV by 4 $\log_{10}$.	Chang et al. (2020); Rabenau et al. (2005)
Produce food products with pH ≤3 (i.e., fermented sausage and fermented dairy products), store at non-refrigeration temperatures, and preferably consume after a 14-day shelf life.	• The stability of human coronavirus 229E infectivity was at a maximum at pH 6.0 when incubated at either 4 or 33°C. • Viral infectivity was completely lost after a 14-day incubation period at 22, 33, or 37°C but remained relatively constant at 4°C for the same length of time. • Determining the optimum virus growth and storage conditions will facilitate the molecular characterization of this important pathogen.	Lamarre and Talbot (1989)
Establish preferably low relative humidity and high temperature in food production lines and warehouses.	• A higher temperature such as 30 or 40°C reduced the duration of persistence of highly pathogenic MERS-CoV, TGEV, and MHV. • At 4°C, the persistence of SARS-CoV (more than 28 d) > TGEV and MHV (2 h–9 d). • At room temperature, HCoV-229E persists more at 50% compared to 30% relative humidity.	Kampf et al. (2020); Casanova et al. (2010)

temperature long time (LTLT) heat treatment that is, 60°C for 30 min in liquid foods such as milk, etc., caused no infectious virus remaining, regardless of the presence of the protein additive. While 56°C for over 30 min in absent of protein caused the virus titer reached below the detection limit with a reduction factor > 5.01 $\log_{10}$ and in the presence of protein, for example, fetal calf serum 20%, the reduction factor was only 1.93 $\log_{10}$. At the refrigerated conditions, that is, 4°C (control), there was no loss of infectious titer, namely the reduction factor was zero (Rabenau et al., 2005). The SARS-CoV is more thermal- and chemical-sensitive and has significantly greater environmental stability compared to the human-CoV-229E. In a dried environment, SARS-CoV retained residual infectivity even after 6 days, while human-CoV-229E completely lost its infectivity within 24 hr (Rabenau et al., 2005). On a variety of substances, HCoV-229E can survive from 2 hr to 9 days. A higher temperature, that is, 30 or 40°C, persistence duration time of highly pathogenic, that is, MERS-CoV, transmissible gastroenteritis virus (TGEV), and murine hepatitis virus (MHV) was seriously reduced (Casanova et al., 2010; Kampf et al., 2020). The stability of human-CoV-229E infectivity was at a maximum state at pH 6.0 regardless, different incubation temperatures either 4 or 33°C. However, the influence of pH was more noticeable at higher temperatures. Viral infectivity was entirely lost after a 14-day incubation time at higher than 22°C but remained relatively constant at 4°C for the same length of time. Besides, 25-cycle and 15-cycle thawing–freezing (at least 2 hr at −70°C and then thawed in a 37°C water bath) did not have any reduction in human-CoV-229E and MHV-A59 infectivity, respectively. The pH and temperature are two important and easily controllable factors for other viral growth factors. Coronaviruses' infectivity had decreased as they exposed to acidic pH values at 37°C but had been relatively stable at 4°C (Lamarre & Talbot, 1989). The optimized conditions, for example, appropriate temperature and pH-value can facilitate the coronaviruses molecular properties (Lamarre & Talbot, 1989). The optimal stability of viral infectivity was observed at pH 6.0 at both 4 and 33°C. While in incubation temperature 4°C survival of viruses was more at pH-values >6.0. Indeed, viral infectivity was undetectable after exposure to pH 4.0 or 9.0 at 33°C, whereas at 4°C incubation temperature, 93 and 84% of viral infectivity remained after exposure to these pH values 4.0 or 9.0 and buffered pH-value 10, respectively. Finally, the best viral activity is in acidic and refrigeratory conditions between pH 5.0 and 8.0 and 4°C, respectively. For example, the avian infectious bronchitis virus is more stable at acidic pH values. The MHV-A59 was stable for 3 months at 4°C, whereas infectivity was undetectable after 14 days at 22 and 37°C (Lamarre & Talbot, 1989). Even, at 4°C, the persistence of TGEV and MHV can be raised to 28 days. Notably, SARS-CoV infectivity was longer even with a higher

inoculate. Also, it was shown that at 20–22°C, HCoV-229E is more persistent at 50% compared to 30% relative humidity (Casanova et al., 2010; Kampf et al., 2020; Warnes et al., 2015). Therefore, in these critical cases, some preventive measures are strongly recommended (Table 4).

4 | CONCLUSIONS

Observing the personal hygiene principles, that is, identification and prevention of workers suspected of carrying COVID-19 in the food production lines, implementation of the HACCP, GMP and GHP principles from farm to table; utilizing the appropriate chemical sanitizers, that is, incorporation of copper alloy surfaces in conjunction with effective cleaning regimens, as well as use of food plant surface and cleaning-in-place-program sanitizers, that is, 62–72% ethanol, 0.5% hydrogen peroxide, 0.1–0.5% sodium hypochlorite, and 2% glutaraldehyde at an exposure time of 1 min, and use of CIP-program sanitizers, that is, ethanol (78–95%) for 30 s, 2-propanol (70–100%) for 30 s, the combination of 45% 2-propanol with 30% 1-propanol for 30 s, glutaraldehyde (0.5–2.5%) for 2–5 min, formaldehyde (0.7–1%) for 2 min, povidone iodine (0.23–7.5%) for 15–60 s, sodium hypochlorite (0.21%) for 30 s, hydrogen peroxide (0.5%) for 1 min; and utilizing the different light spectrums, that is, Surface sanitizing with UVC light or surface sanitizing with methylene blue in conjunction with visible light in food production lines and providing unfavorable environmental conditions for coronavirus survival (minimum heat treatment, for example, low temperature long time and greater for liquid food products, pH ≤3, minimum-storage relative-humidity) in times and places of with the high prevalence of β-coronavirus (2019-nCoV or SARS-CoV-2) is strictly suggested.

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ETHICS STATEMENTS

The authors declare that they do not have any conflict of interest, and the study did not involve any human or animal testing.

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