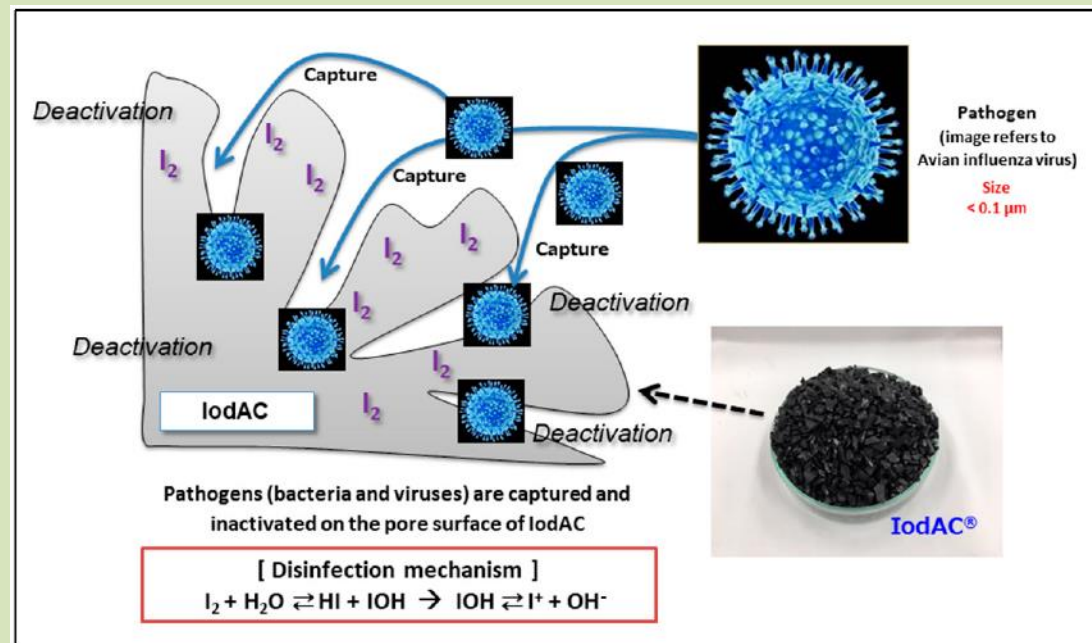
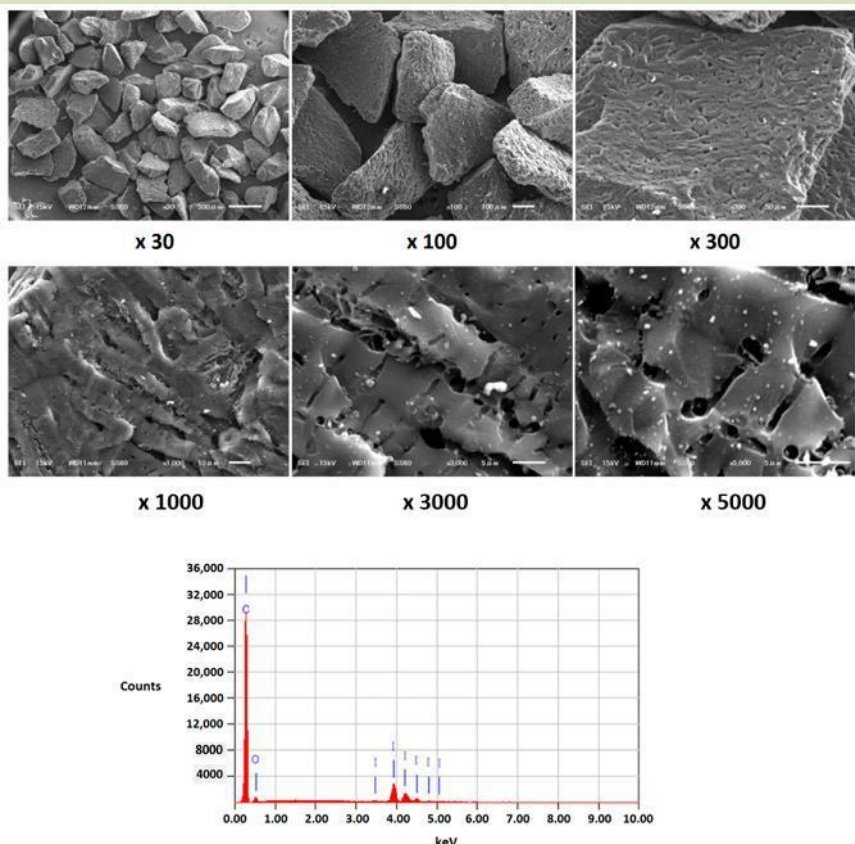


Applications of activated carbon impregnated with elementary iodine -- Potential applications in the medical field --

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IodAC[®]

An activated carbon impregnated with elementary iodine



An iodine-doped activated carbon (IodAC) was developed by adsorbing molecular iodine (I_2) on commercially available activated carbon (AC). It can be produced using different amounts of iodine. The experiments hereafter presented were performed using IodAC(30) type, a IodAC carrying 30 g of I_2 per 100 g of product.

Iodine is strongly adsorbed on the AC' surface: both volatilization and elution are negligible

Comparison of IodAC with commonly used disinfecting agents

Disinfecting agent	Active ingredient	Effect	Effective life
Inorganic	Ag, Cu, Zn, TiO ₂	Weak	Long
Organic	Alcohol, Thiazoline, Imidazol	Medium ~ Strong	Short
Chlorine	Hypochlorite, Trichloroisocyanuric acid	Medium ~ Strong	Short
Peroxide	H ₂ O ₂ , ClO ₂ , CH ₃ COOOH	Medium ~ Strong	Short
IodAC	Elementary Iodine (I₂)	Strong	Long

Wide range of potential applications

No.	Field	Field & Usage	Effect
1	Environment	Water bloom, Bird flu.	Water purification, Removing bacteria
2	Drinking water	Oxidation of As(III)	Aseptic water As(III) oxidation → As(V)
3	Medical feed	Disinfectant, Feed, Egg washing	Inactivation of Bird flu., Campylobacteriosis, Salmonella
4	Medical Sanitary	Gut sterilization treatment, Blood sterilization treatment, Medical article, antibacterial bandage, gauze and cotton	Sapraemia treatment, Hypersensitive gut syndrome and ulcerative colitis, Skin sterilization
5	Defense	Antibacterial mask, Antibacterial mask for biological weapons	Antibacterial, Antivirus
6	Deodorization	Air conditioning filter, Aseptic room (Biotechnology laboratory, Hospital)	Antibacterial, Deodorization
7	Food	Fresh food pack & seat	Keeping of freshness, Anti-corruption bacteria, Anti-food poisoning bacteria
8	Electrical appliances	Electrical (water) appliances, Pool water, Bath water	Antibacterial, Antivirus
9	Clothes Daily necessities	Clothes, Household goods	Antibacterial, Sterilization, Deodorization
10	Construction	Surface treatment, Floor, Wall	Antibacterial prevention mold in a building wall
11	Fish keeper	Water treatment for fish culture	Measure for sickness of fish (skin disease)
12	Import & Export	Post-harvest for imported citrus, etc.	Mold prevention during transportation after harvest
13	Agriculture	Agricultural product	Replant failure prevention

Confirmed antibacterial activity

Example of antibacterial tests

Three test tubes containing “Brilliant Green Bile Lactose Broth” (BGBLB) medium, spiked with Escherichia coli solution, were prepared.

Tube 1: 1 g of IodAC was added.

Tube 2: 1 g of raw Activated carbon (AC without iodine treatment) was added.

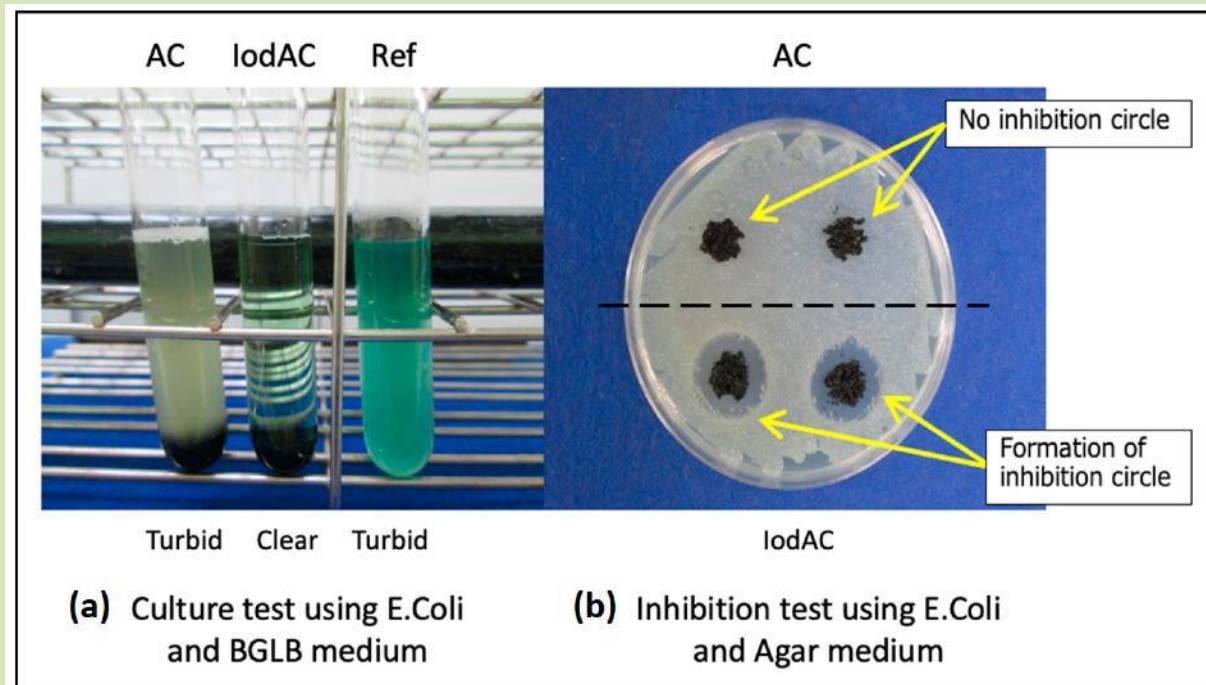
Tube 3: Reference.

The samples were stored at 35 °C for 24 h.

Similar test was conducted employing standard agar culture medium in Petri dishes, spiked with the Escherichia coli solution.

IodAC and untreated AC were placed on Petri dishes, covering a diameter of about 1 cm on the surface of the agar medium.

The dishes were stored at about 35 °C for 22 h.

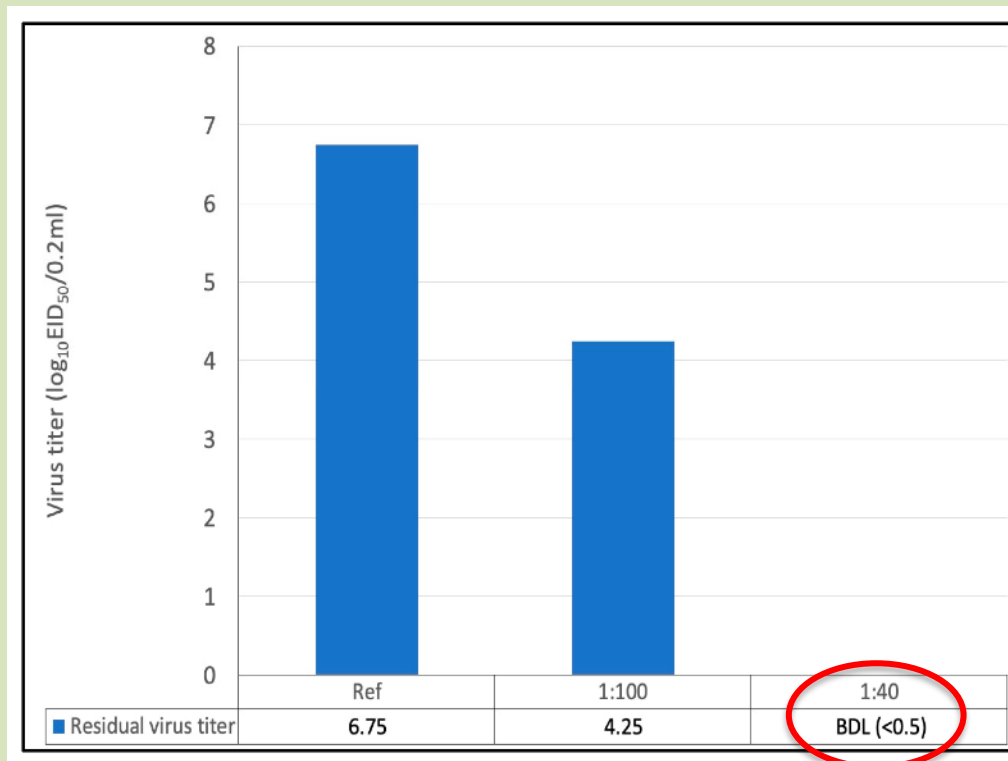


Confirmed antiviral activity

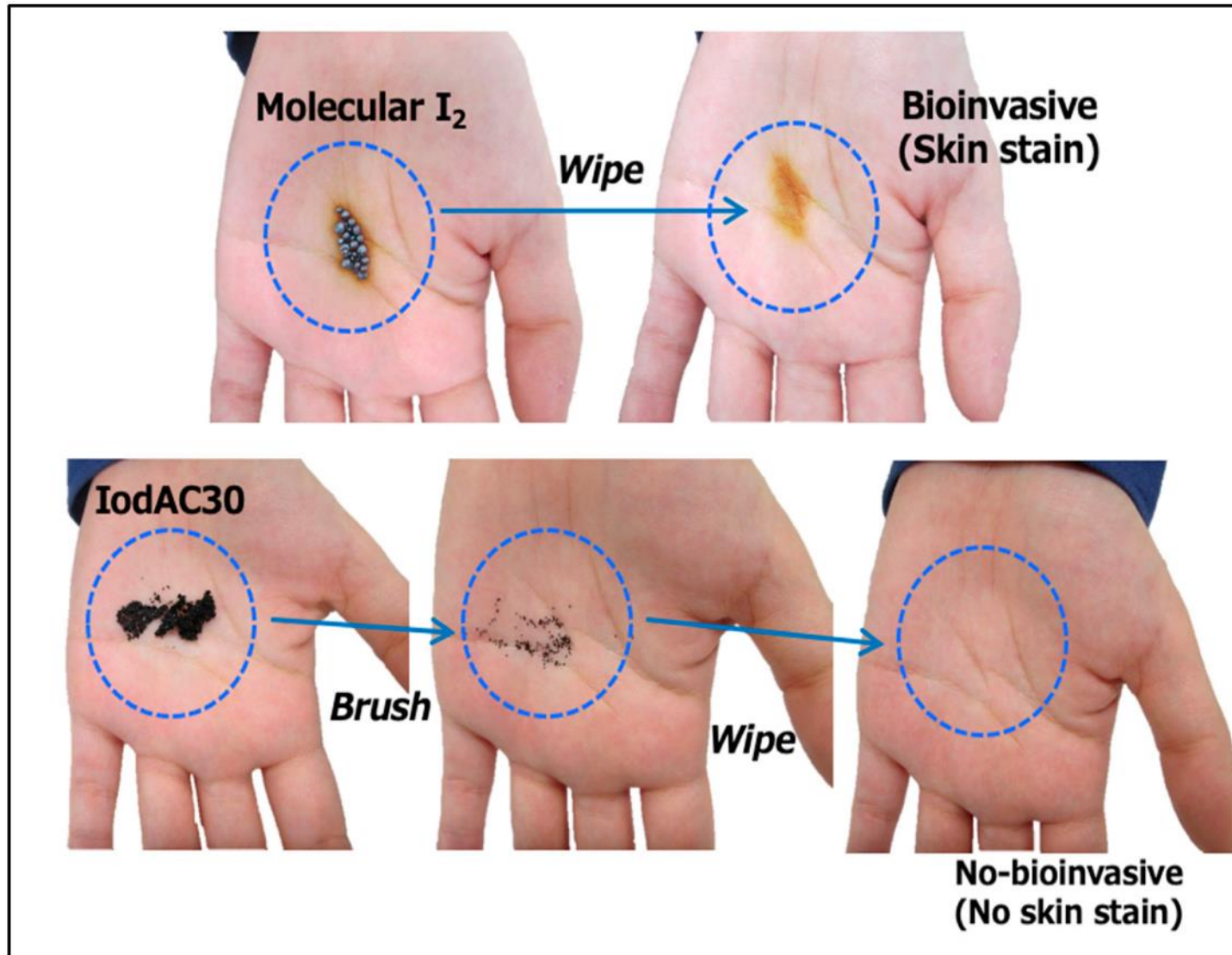
Example of antiviral tests (based on avian influenza virus (A/whistling swan/Shimane/499/83/(H5N3) strain).

Virus was inoculated in the allantoic cavity of 10-day-old embryonated chicken eggs, cultured at 35 °C for 2 days, then the allantoic fluid was collected and used to prepare the virus solution for the experiments. The 50% Egg Infectious Dose (EID₅₀) was calculated and adjusted to about 10^{7.5}EID₅₀/0.2 mL with sterile Phosphate-Buffered Saline (PBS).

The virus solution and IodAC were added to a test tube and mixed for 10 min, testing several IodAC-to-virus solution ratios (such as 1:40, that is, 1cc of IodAC in 40cc of virus solution, or 1:100, etc.) in order to study the variation of the antiviral efficiency. The residual virus titer was calculated as EID₅₀ using the Reed and Muench method.

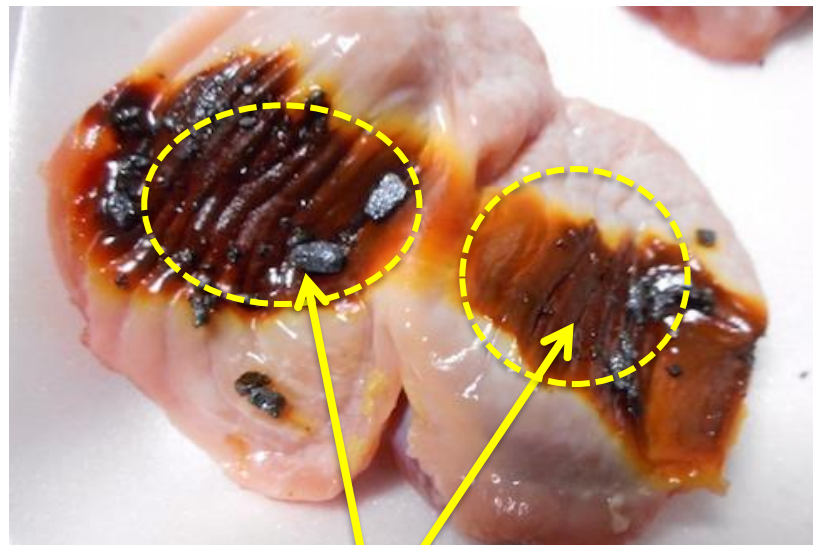


Bioinvasive test on human skin after one-minute direct contact



Bioinvasive test on chicken meat after direct contact for 8 hours

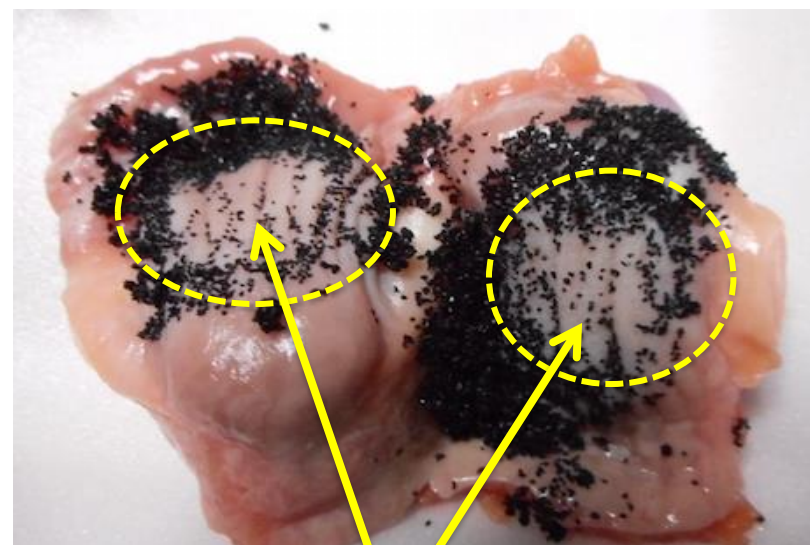
Iodine (I_2)



after wipe

Bioinvasive

IodAC



after wipe

No bioinvasive

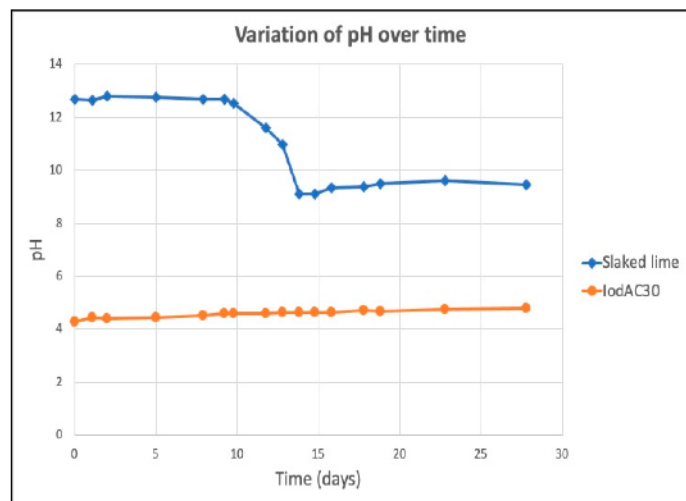
Indoor/outdoor disinfection (comparison with Slaked-lime)



Slaked lime powder is traditionally used as a disinfectant to prevent infectious diseases in livestock

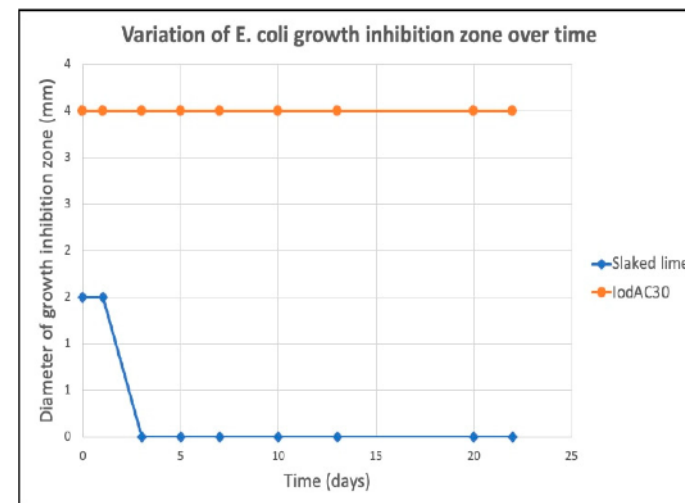
Used extensively during avian influenza and swine cholera outbreaks.

Indoor/outdoor disinfection (comparison with Slaked-lime)

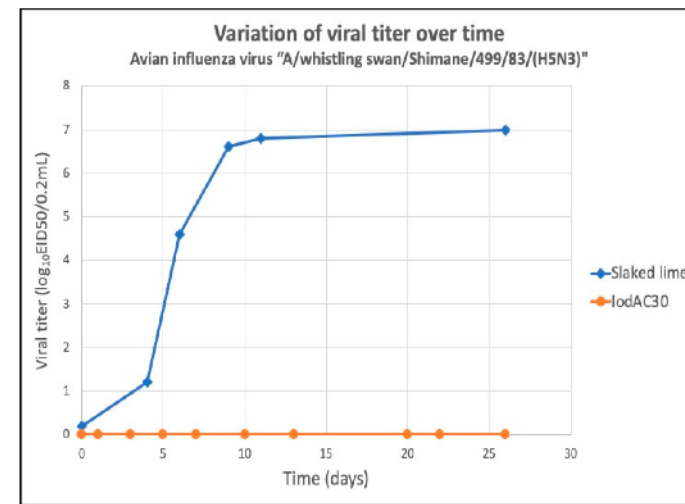


The native alkaline pH of slaked lime (pH = 12.8) decreased after 10 days and stabilized to about pH = 9 after two weeks. On the contrary, IodAC showed a stable pH (about 4.3–4.8) during the entire test span (4 weeks).

The pH value is particularly important, since it is strictly correlated to the disinfectant power of slaked lime. Indeed, when exposed to air, slaked lime starts to absorb CO₂, which induces a reaction that gradually lowers both the pH and the disinfectant power of slaked lime.

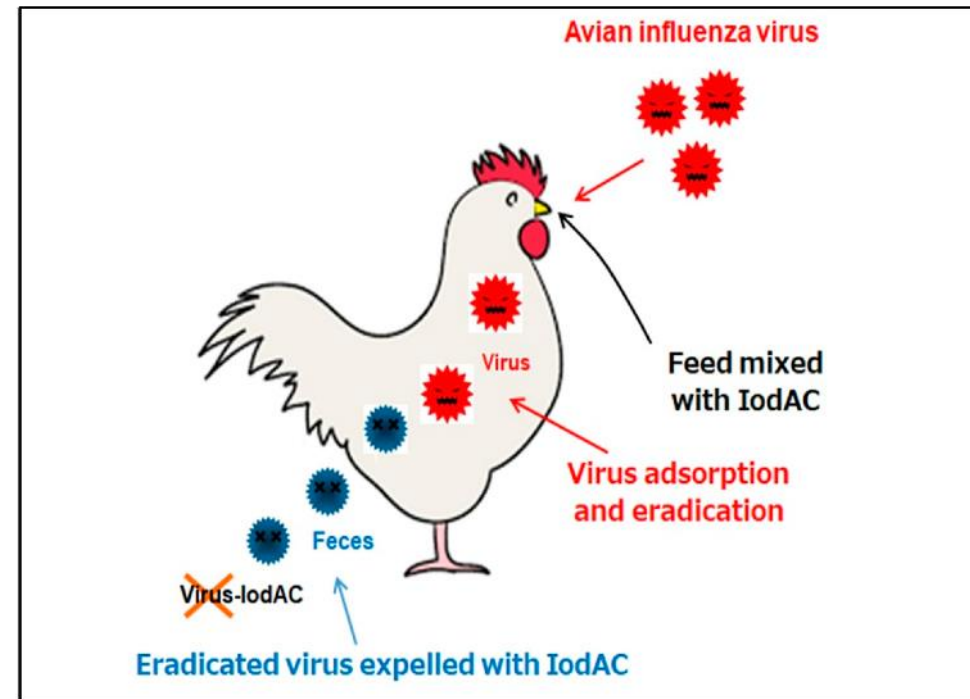


IodAC:
long-lasting antibacterial and antiviral effect



Supplement for poultry feed (avian influenza countermeasure)

IodAC can be used in breeding farms to inhibit the spread of infectious zoonoses. For example, it could be employed as a feed additive to prevent avian influenza, because animals' feces are a primary route of spread. Therefore, if mixed in proper quantity to poultry feed, IodAC has the potential to inactivate the virus directly inside the intestinal tract of the animal and, since it will not be digested, will be lastly expelled with the uninfected feces



Potential applicability in the medical field

[Proposal-1] Surgical Site Infections

Surgical Site Infection: SSI

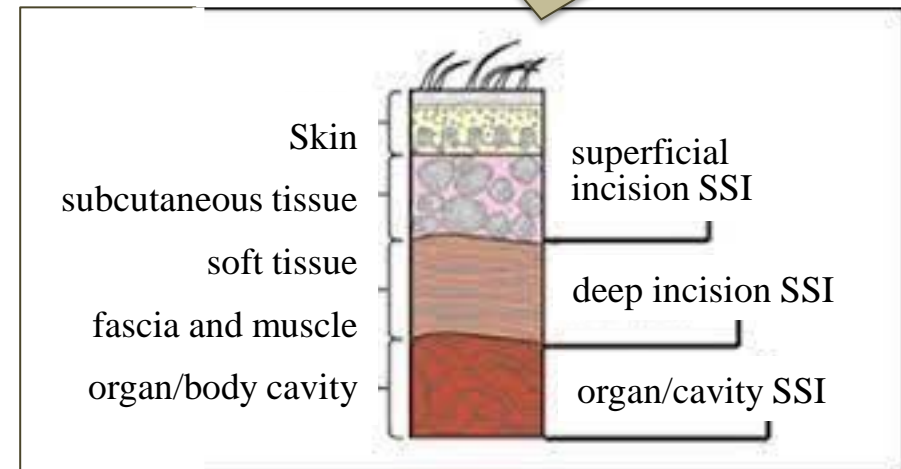
SSI is an infection that occurs after surgery in the part of the body where the surgery took place. Surgical site infections can sometimes be superficial infections involving the skin only. Other surgical site infections are more serious and can involve tissues under the skin, organs, or implanted material.

SSI can be caused by bacteria transmitted from the operating room environment, from healthcare workers, or the patient's own intestinal or skin flora. The latter factor is considered more important, and pathogens such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterococci*, and *Coliforms* are isolated relatively frequently.



IodAC® packaged in sterile mesh

Application on the surgical site



Types of surgical site infection (SSI)

[Proposal-2] IodAC applicability as an oral colon antiseptic

Intestinal flora transplantation

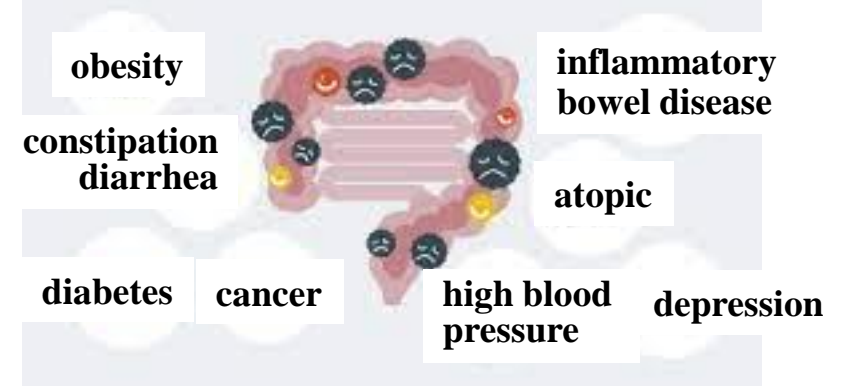
Intestinal flora transplantation (fecal microbial transplantation = fecal transplantation) is an attempt to restore the balance of the bacterial flora by injecting intestinal bacteria extracted from the feces of a healthy person into the patient's large intestine. In addition to intestinal diseases, it has begun to attract attention as a treatment method for diseases such as diabetes, cancer, arteriosclerosis, and hay fever, which have been pointed out to be related to bacterial flora. Already proposed by government agencies as an effective treatment for intractable intestinal infections in the United States. In Japan, it is already in clinical trials for use in the treatment of ulcerative colitis.

Intestinal disinfection with IodAC

Sufficient eradication of the intestinal bacteria prior to intestinal flora transplant surgery is likely to produce therapeutic effects and improve the success of the treatment.

IodAC could be used for this purpose.

If the intestinal flora is not in good condition

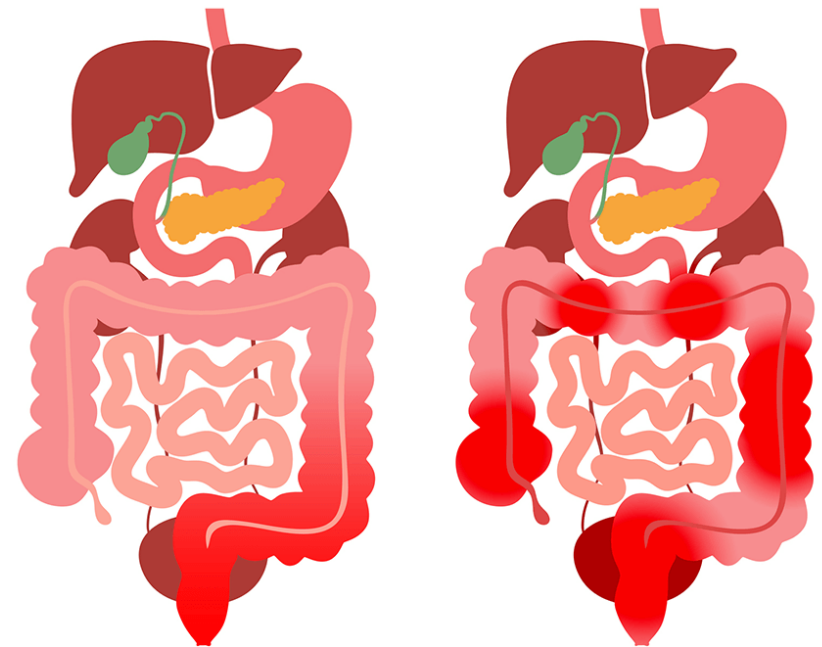


[Proposal-3] IodAC applicability as ulcerative colitis treatment

Inflammatory bowel disease (IBD) is a term for two conditions (Crohn's disease and ulcerative colitis) that are characterized by chronic inflammation of the gastrointestinal (GI) tract. Prolonged inflammation results in damage to the GI tract.

The possible role of some pathogens in the development and exacerbation of the inflammatory disease of the gastrointestinal tract has been described. Pathogens that could be associated with the IBD disease are: bacteria such as *Mycobacterium avium* subspecies *paratuberculosis*, *Clostridium difficile*, *Escherichia coli*, *Listeria monocytogenes*, *Campylobacter concisus*; viruses, such as, cytomegalovirus, Epstein-Barr Virus, and measles virus.

INFLAMMATORY BOWEL DISEASE (IBD)



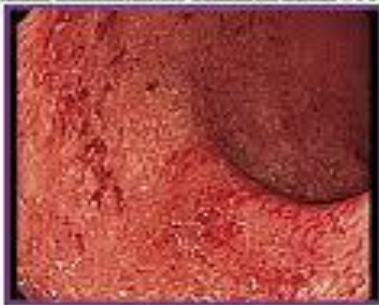
Ulcerative colitis

Crohn's disease

Inflammatory Bowel Disease (IBD)



normal colon

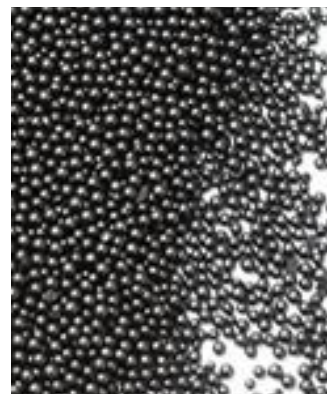


moderate IBD

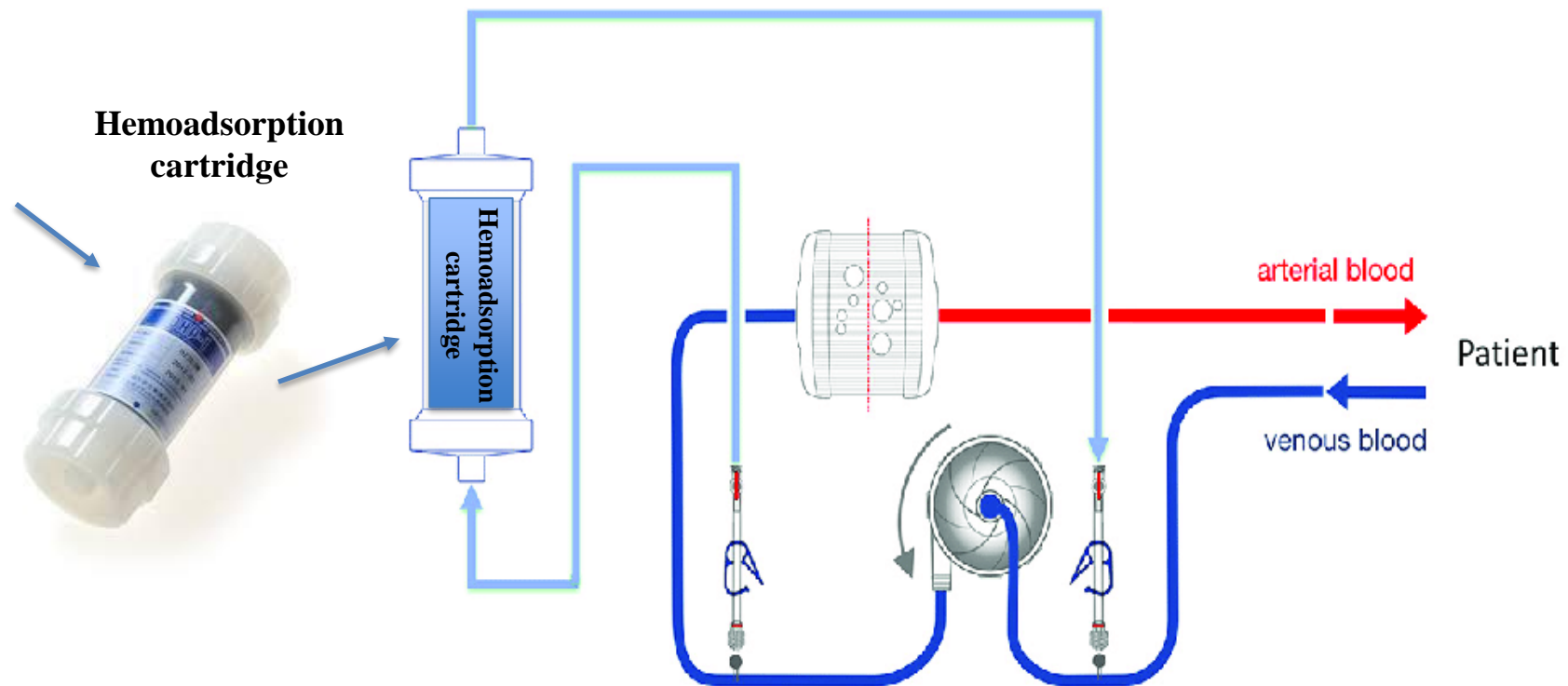
[Proposal-4] IodAC applicability as hemoadsorption therapy

Hemoadsorption therapy is a treatment method in which blood is drawn directly through a column and returned to the body. In the case of drug intoxication, the drug can be removed by adsorption by passing the blood through an activated carbon column.

IodAC could be used for blood disinfection protocols



IodAC



Conclusions

IodAC has unique and attractive properties and potential applicability in the medical fields. Investigations are in progress.

Joint research and collaborations are welcome.

For further information and collaborations, please contact Dr. Tatenuma Katsuyoshi (Kaken Inc., Japan): tatenuma@kakenlabo.co.jp

Thank you

<http://www.kakenlabo.co.jp/>

tatenuma@kakenlabo.co.jp

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Activated Carbon Impregnated with Elementary Iodine: Applications against Virus- and Bacteria-Related Issues. *C (Journal of Carbon research)* 7, 86.

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