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The History and Modernization of Poultry Inspection Systems in the United States and the Food Safety Hazards that are Being Diminished because of Those Systems

Abstract

The accessibility, health benefits and low cost have kept the demand for poultry consumption up and poultry slaughter production plants moving forward; however, up until recent years there has been a lack of quality inspection standards leading to an increased amount of food safety issues. The pathogens that contaminate raw poultry products for human consumption are an issue in the United States. There have been new advances in technology which has led to an improvement in modernizing the poultry slaughter process to help keep potentially harmful pathogens from contaminating our food supply. Government regulations and new laws have helped both the general public in knowing that the poultry they buy at the grocery store is safe to eat, as well as the companies that produce the poultry to develop their own means of screening for potential hazards.

Introduction

According to the United States Department of Agriculture (USDA), poultry has become the most heavily consumed meat. This is due to poultry's inexpensive accessibility from farms and groceries stores across the United States. Poultry meat is a healthy choice for human consumption because of the lower fat content and lower calorie content than other meats. The nutritional value provides essential amino acids that aids in building and maintaining muscle structure after exercise. Consuming poultry meat is less

likely to be associated with cardiovascular disease because of minerals and vitamins that aid our heart health. Poultry offers many benefits to the human body, however it may harbor potential harmful bacterial such as Salmonella or Campylobacter, which are common causes of foodborne illness. Poultry meat can also carry E. coli, typically caused by fecal contamination.

According to the United States Centers for Disease Control and Prevention (CDC), there are more morbidity cases linked to poultry than any other types of meat because the Salmonella and Campylobacter content found in the intestinal tracts of birds. These pathogens may transfer to a carcass at slaughter facilities or processing plants (Jay and others 2005). Even though the poultry industries have well developed systems when dealing with pathogen reduction, inevitable outbreaks from pathogenic bacteria in poultry production do occur. In order to achieve public health and welfare, the USDA Food Safety and Inspection Service (FSIS) revises regulations over and over again to minimize the rate of foodborne illness. Recently, the FSIS proposed a new regulation in order to improve food safety on poultry and its processed products because the agency believes this will effectively reduce the occurrence of Salmonella and Campylobacter. (FSIS 2014).

Upton Sinclair's, " The Jungle", heavily criticized the unsanitary conditions of meat processing and packaging plants in Chicago in the early twentieth century. The book led to tension among meat consumers (Sinclair 1935).

This book also caught the eye of lawmakers who needed a way forward, not only to ensure food safety, but also gain back the faith of meat consumers.

The nation benefitted immensely from meat and therefore needed that part of the economy to stay alive. Only after the allegations from the novel were

investigated by the government were sanitary and safety procedures put in place within the meat packaging industry.

The meat inspection act of 1906 gave rise to the subsequent 1957 act (Light 2002). This act further committed the U. S. congress to ensure proper branding of poultry products and ensure cleanliness in the slaughter houses. The poultry inspection process has various requirements regarding the sanitary conditions of poultry.

This situation was considered urgent after President Theodore Roosevelt put together a team to verify the claims written by the author, Upton Sinclair. Hence, the Federal Meat Inspection Act (FMIA) was enacted in 1906 to set up safety standards, and upon establishment, the act did not fully apply to poultry because of the lack of consumers. The act closely centered on other domesticated animals, but was not keen on fowl. There were very few poultry processing plants throughout the U. S. (Jay and others 2005) at that time, and the public could only get chicken or turkey from local farms or small flocks (Sams 2001). Attention was given to poultry farming in 1920, when avian influenza broke out in New York, the main source being identified as poultry. This was the key factor that brought responsiveness to the poultry products the populations were consuming. Therefore, the Federal Poultry Inspection Service Act (FPIS) passed in 1926, and inspections were established and conducted by United States Department of Agricultural (USDA).

World War II brought about an increased demand for all food available; hence, there was a need to inspect poultry or ensure it was free of disease before consumption. This growth of the market for poultry continued through

the late 1950's and 60's. Many poultry farmers developed their own means of inspection, which were not satisfactory, thus putting pressure on the poultry inspection system to reduce the spread of disease.

In 1957, the Congress enacted mandatory regulation, the Poultry Products Inspection Act (PPIA), eliminated poultry from being contaminated, misbranded, or sold to consumers in an unsanitary condition. This required an FSIS inspector to examine bird carcasses fit and not fit for human consumption (USDA 1984). This act made all poultry inspection mandatory and controlled by the federal government. The inspection formed by the USDA primarily focus on carcass inspection, this included organoleptic method, which inspectors checked the carcasses by touch, smell, and sight, as well as inspection of every single carcass in slaughter operations (USDA 1984). The FSIS not only employed an online organoleptic method to check chicken carcass at slaughter and process plants, but also inspected the internal and external body cavities and organs in order to prevent contaminated products to be consumed by humans (USDA 1959). This meant the freshness of poultry products maintained a perceivably properly labeled poultry product that was untainted and substantially inspected by uniform standards.

In 1968, the FSIS amended the Wholesome Poultry Products Act, which established a state federal cooperative program of inspection to ensure all poultry products were being equally inspected by the USDA at all slaughter and process plants as a federal standard.

Method:

FSIS enactment is a means of performance standard for controlling pathogenic Salmonella and Campylobacter for chilled carcasses in chicken and turkey slaughterhouses (FSIS 2011), which included sample sets collected and examined whether the establishments were adhering with HACCP rule. The results from sample set criteria are accepted 5 positive out of 51 samples sets with respect to young chicken while 4 positive samples in 56 sample sets for turkey (FSIS 2011).

Discussion

Potential Pathogens of Poultry

A study has shown the proportion of poultry contamination has increased by about 6 fold in chicken products and by 17 times in turkey products (Foley and other 2007). The two most abundant species, Salmonella and Campylobacter, are most accessible on commercial chicken and turkey as food vehicles. Poultry products are the major source of human infection linked to Salmonella and Campylobacter. Salmonella, Campylobacter, and E. coli. may be present on the carcasses or in chickens' gastro-internal tract (Ghafir 2008). Salmonella and Campylobacter may also be transmitted to humans by eating foods contaminated with animal feces. Salmonella in poultry products is a leading contribution of pathogen causing foodborne illness in the United States. Some studies conducted that fresh or raw poultry products are the primarily source of Salmonella and Campylobacter correlated to human infection (Hald and others 2004). The Salmonella and Campylobacter present in livestock transmit from the farm to the slaughter plants, and influence the prevalence of chicken carcasses and parts

throughout the slaughtering and chilling process. At slaughter, Salmonella can also be transmitted from one flock to another if there are unwholesome birds present in the flock and cross contamination can be extremely rapid from bird to bird. Hence, it is important to implement an effective and efficient control program in the slaughtering and chilling process to minimize or eliminate the contamination of poultry of Salmonella or Campylobacter. These two species are the main concerns of food borne illness that are associated with poultry products; hence it is crucial to have microbiological testing of poultry products.

Contamination during Processing

Raw poultry has been reported as a major source of foodborne infection, some studies indicated by the presence of Salmonella and Campylobacter can introduce microorganisms into the plants and to the final products (Jorgensen and others 2002), which is why each single processed step is vital and may contribute to later contamination if inadequate sanitation and disinfection do not occur in relation to residual fecal contamination. Bacterial contamination at multiple processing steps has been associated with the growth of a variety of microorganisms at abattoir (Refer to Figure 1).

Figure 1: Flow of broiler slaughtering process at the evisceration step with regard to scalding step.

The native microorganisms of poultry are composed of many bacteria. A high consistency of pathogenic Salmonella and Campylobacter can be also found on broiler skin or feathers and later carried into the processing plant (Pandya and others 1995). Flock transportation could induce cross contamination among the poultry in crates (Davis and others 1998). After the stunning,

killing and bleeding processes, scalding is a process that birds pass through a tank held at temperatures between 50° C to 65 ° C with agitated water and the optimal scalding time varies from 60 to 120 seconds (Löhren 2012). Rosenquist and others (2006) conducted the greatest microbial cross contaminations that poultry processing plants could possess including scalding, de-feathering, evisceration, washing and chilling. With higher temperature and longer time submerged in the tank that fosters the loosening of feathers, this step aids to lower the microbial count in carcass contamination, but instead increases the chance of microbial transmission between carcasses. There is a contradictory study conducted on the amount of *Campylobacter* whereas the count has not changed significantly on the surface of the carcass (Rosenquist, 2006), due to the immersion of the carcass in the tank and transmitted to the scalding tank. If there is a potential of a high quantity of microflora submerged, they may transfer to many others in the tank. The level of microorganisms in the tank depends on water pH and temperature. Increasing the pH of the water would be contributing to decreasing the *Campylobacter* and *Salmonella* load in water (Humphrey and others 1987), and the temperature of scald can influence the number of the microbial load. Another study compared the carcass scald at 60° C, 56° C, and 52° C, and found that if a carcass were submerged at 60° C, it would have higher bacterial load than the other variables (Mulder and others 1997). *Salmonella* adhered onto the poultry carcasses and was more heat resistance than *Campylobacter*, hence Humphrey (1987) indicated that in an attempt to minimize *Salmonella*, he implemented a pH of 9 scald water would inhibit contamination at scalding

from birds and be more effective than submerged carcasses at 52° C.

In addition, reports indicate there's a potential risk of cross contamination at the de-feathering point, and automated feather picking machines tend to favor in *Campylobacter* and *Salmonella* contamination on turkey and chicken carcasses (Acuff and others 1986; Wempe and other 1983, Yufusu and others 1983; Geornaras 1997). The main risk that has been reported as a major source that contributes to cross contamination is by the contact of carcasses through picker finger; compressed carcasses results in the expulsion of internal feces to the surface, and contaminates feathers pulled by the plucker (Ventura de Silva 2008) and contributes to cross contamination.

At evisceration, carcasses can be contaminated through a spill of the intestines, due to a vent that was opened and would transfer bacteria from established personnel to carcasses if evisceration were done by hand at small processing plants (Ventura de silva 2008). Bacteria can be susceptible to contamination with residual fecal during the evisceration process (Perko Mäkelä and others 2009). Another report revealed an increased number of *Campylobacter* contaminations on turkey skin after evisceration (Alter 2005) because chicken skin would be a potential harbor for *Campylobacter* spp. (Berang and others 2002).

The initial washing can be a contributor to attach a *Campylobacter* and *Salmonella* contamination to carcasses and the FSIS believes it was due to cross contamination caused by extensive contact between carcasses.

Chilling has been considered as a possible persistence point, and the effect of chilling on *Salmonella* rely on the frequency at which carcasses tend to

reduce rates of bacteria by chilling (FSIS 2014). The majority of the food industry has employed water chilling to reduce the temperature of carcasses, however, Sanchez and others (2002) found the level of *Campylobacter* on chilled carcasses was higher in immersion water compared to air chilled. Hence, USDA allows the use organic acid to chill the carcasses to prevent cross contamination.

Performance standard

With respect to the performance standard, which plays an important role on preventing customers from biohazard, numbers of microorganisms are affected with fecal contamination, septicemia, and toxemia condition. The performance standard is based on the samples collected by a third party and indicates the defective carcasses in the establishments. The standard for septicemia and toxemia is 0.1 % and for visible fecal contamination is 1.5%. FSIS conducted a verification sample per line per shift and gave a defect rate which is more close to the true defect rate (9 CFR 381).

Sampling Program

FSIS claims that the new sampling plan will save nearly \$80 million dollars per year and they believe the old regulation seems not effective enough to process the control for the broiler. The FSIS conducted a new sampling plan which can monitor the process procedures and allows establishments the flexibility to decide which indicator microorganism or pathogen may be best suited to implement and control processed activities, but also allows establishments to determine sampling number and sites. The agency believes that each plant will be able to execute and develop and validate the

rule. Later, these samples will be collected by FSIS inspectors and analyzed by FSIS laboratories for microbiological contaminants and verify the effectiveness of controlled process. With regard to the testing program, this allows the federal agency to verify additional points of concern in the process (FSIS 2014).

In general, the location in which the most samples are present is the control microbial food safety after the chilling process (Swanson and others 2011). Sampling after feathers have been removed as an intervention for later processes. Post-sampling verifies how establishments effectively minimize the contamination. Usually, in the process of sampling, this is not collected. Testing for Salmonella and E. coli. gives operations a better idea of whether there are unacceptable amounts of Salmonella. The FSIS (1996) conducted that E. coli. testing is best suited for process control, due to the high amounts of bacteria in fecal matter and would be reliable detection if present in a low amount (Potter and others 2012).

The Federal agency and numerous companies establish criteria for indicators of process hygiene, such as E. coli. The analysis of the indicator organism E. coli. aids manufacturers in the identification of whether the process control is efficient. The slaughter processing line on carcasses has been decreasing E. coli. loads at scalding, washing and chilling in particular.

The Food Safety and Inspection Service (FSIS) not only employed an online organoleptic method to check chicken carcass at slaughter and processed plants, but also check the internal and external body cavities, surface and organs in order to prevent adulterated and unwholesome products to be consumed by humans (USDA 1959). This post-mortem program was

mandated in 1959 at processing plants to ensure each bird is free from disease (USDA 1984). To cut down on inspector oversight on fecal or other contaminations, which is labor extensive, costly and time consuming, the FSIS has passed the duty to the employees at the establishments under the NPIS. In 1959, the speed of inspection line operated at 30 birds per min (bpm) speed line, and one online inspector per line, later the speed was up to 70 birds per min with 2 online inspectors per line. The New Line Speed inspection system (NELS) employed the maximum speed line of 91 birds per min with 3 online inspectors (Watkins and others 1999).

Temperature

Temperature that poultry holds at slaughter and processing plants plays an important role with regard to the bacterial multiplication. The growth of microbials are concerned by the manufacturers as the holding temperature at the process plants and the time the microbials are exposed at that temperature dictates growth. A study conducted deduced that mesophilic species may not able to multiply at 0 and 4. 4 ° C, for example, E. coli., but are capable to grow at below 5° C (Ayres 1951, Barnes 1976). Carcass surface may become contaminated with bacteria in slaughter plants, especially during slaughter and dressing. Rapid cooling raw meat and carcasses would inhibit the growth of pathogenic bacteria on the surface of carcasses and lessen foodborne illness (). FSIS studied the chilling temperature of carcasses and raw meat products require prompt temperatures to reach 40° F or less at the evisceration processed unless further processed right after evisceration. Some studies indicated that bacterial growth generally multiplied faster at temperature of over 50 ° F ().

Establishments tend to chill the carcasses in part to minimize the growth of microbes; however, chilling temperature may affect the growth of Salmonella and Campylobacter spp. during the carcasses cooling. As the microorganisms may not be able to replicate and reproduce at that temperature, temperature is not optimal for their growth and not enough of time for them to grow at exponential pace so numbers of microorganisms may decrease. Overall, temperature is a means to control pathogens at poultry processing plants. Poultry carcasses are to be chilled to a temperature of < 40° F within 4 hours for broiler and 8 hours for turkey after slaughter (9 CFR 281.1992).

The New Poultry Inspection System

The new regulation produced by the USDA has made some adjustments to the PPIA of 1957. On the 31st of July, 2014, the Department released a statement that contained the changes that were to take immediate effect: (FSIS 2014) the New Poultry Inspection System, which is not a mandatory program; however, this does not disregard the expectation that all companies with have an inspection system, they just now have the right to choose which one (FSIS 2012). The federal agency gives poultry slaughterhouses six months to decide if they want to operate under the NPIS, and establishments are required to notify the district offices of FSIS that are willing to operate under the NPIS in writing and addressing at what date they are ready for application. The NPIS has a requirement that establishment's personnel sort carcasses and remove unacceptable ones before defect carcasses appear to FSIS inspectors (FSIS 2014). For the employees that will be sorting carcasses, the FSIS (2014) offers a guideline to plants in regards

to training the employees and giving them practical knowledge to ensure they will be able to correctly sort through and dispose of poultry carcasses that are unfit for human consumption. The FSIS (2014) offers classroom learning experiences complete with hands on learning labs to aid employees in recognizing parts of the poultry that are to be disposed of due to disease as well as teaching employees how to correctly document all “dispositions”. They also rely on continual maintenance of their employees (FSIS 2014). According to the FSIS (2014), inspection sorters make visual observations of a carcass, or disposition, that rate whether or not a poultry carcass has varying stages of infection or disease that would make it or parts of it unfit for human consumption. “Diseases and other abnormalities produce visual changes to poultry carcasses” (FSIS 2014). Of the diseases and infections that sorters and FSIS inspectors must look for that are unsafe for human consumption are among the following: Septicemia and Toxemia are toxins in the blood that create a “systemic change” in the carcass that creates blood hemorrhaging, dehydration of the skin and muscles, and turns the carcass a dark red brown color. Cadavers, or birds that did not have their throats properly cut or cut at all during the slaughter process, do not bleed out correctly and if they do not bleed out before entering the scalding process, the carcasses develop a bright red or purple color to either their neck or entire body. Birds that are dead on arrival (DOA) are birds that died before slaughter and were accidentally put through the slaughter process; DOA birds usually have limp necks, are stiff and fowl smelling and have a slight reddish purple color to them (FSIS 2014). Leukosis is a viral infection that causes small round tumors to form on the spleen, liver, kidney or feather

follicles if the infection is on the skin (FSIS 2014). Keratoacanthoma is a disease that gives the skin of poultry crater-like tumors, which can be cut off to make the remaining carcass wholesome enough to continue down the inspection line (FSIS 2014). Airsacculitis occurs in poultry that have respiratory issues that create swollen air sacs (FSIS 2014). Inflammatory Process is a bacterial infection that is on or under the skin that looks like yellow scabs (FSIS 2014). Synovitis is a hock joint, refer to Figure 2, injury that requires the legs to be removed to salvage the remainder of the carcass for the rest of the inspection process (FSIS 2014). A mutilated carcass is when machinery mauls the carcass throughout the slaughter process; mutilated carcasses are required to be disposed of, but the viscera can most likely be saved (FSIS 2014). When a carcass is left within the scalding tank for too long, it can potentially cook parts of the carcass, which in turn need to be trimmed off (FSIS 2014). Ascites is an overworked heart that creates a systemic change within the carcass that requires it to be disposed of (FSIS 2014). Breast atrophy is a muscle degeneration that requires

Figure 2: Skeleton of Domesticated Fowl (FSIS 2014)

trimming; the infected area is sometimes green and hard to the touch (FSIS 2014). Large bruises to the carcass also require trimming or disposing of (FSIS 2014). Organs of poultry carcasses also need to be inspected, refer to Figure 3, such as the liver and the heart for defects that would cause them to be unfit for human consumption.

Fecal contamination of carcasses are a large problem within the inspection process because even if carcasses were not infected to begin with, they can potentially become infected during the slaughter process due to surrounding

carcasses harboring fecal matter (FSIS 2014). Fecal matter can assume a liquid or paste consistency in the colors of yellow, green, brown or white (FSIS 2014). In 2012, the FSIS conducted a study on the success rate of on-line and off-line reprocessing for carcasses contaminated with feces. The rate of effectiveness of the trial was as follows: data was collected

Figure 3: Organs of Domesticated Fowl (FSIS 2014)

Figure 4: Data Analysis of Online and Offline Reprocessing (FSIS 2012).

With respect to the existing inspection activities, the online carcass inspector needs to inspect every single carcass, to ensure there are no defects found on carcasses. The NPIS assigns one online carcass inspector (CI) and offline verification inspector (VI) to each evisceration line. Since FSIS intends that the online inspector will check the carcasses that have been trimmed, washed, or reprocessed by onsite employees, then that one online inspector would be sufficient to confirm carcasses are unfit or unwholesome. This action shifts some duties to the operational employees; they have to sort carcasses before presenting to FSIS inspectors. This leaves FSIS (2014) inspectors to devote more time to food safety examination as well as moving about the plant to ensure the ethical handling of the birds going into slaughter, collecting microbial testing samples, ensuring sanitary conditions of establishments, and scrutinizing the slaughterhouse to have met performance standards and be following the compliance guidelines correctly. The USDA is aiming to reduce the rate of pathogens found in poultry products and improve the inspection processes to better utilize the resources of the FSIS and remove any barriers for further innovation of advanced inspection systems (Havelka and Farnsworth 2014). FSIS provides

compliance guidelines to aid poultry slaughterhouses in a better application of these procedures and performance standards for small poultry operations that produce edible poultry. The FSIS (2014) requires all poultry plants to prevent an outbreak of Salmonella and Campylobacter; and also requires plants to “ treat Salmonella as a food safety hazard”, in which a failure to contain these contaminations would result in a company production suspension until further investigation on standards are met. The Salmonella Action Plan, brought forth in 2013, was put in place to containing “ enteric pathogens” by developing a “ microbiological sampling plan” requiring all carcass samples to be tested before and after chilling to help monitor for traces of any pathogen that could be related to a food borne illness (Havelka and Farnsworth 2014). All poultry slaughter establishments are required (small businesses are required only one) to do two microbial testings of their poultry carcasses to ensure all regulations are being met (FSIS 2014).

Allowing those who own poultry plants to have their own inspection system regarding foodborne illness pathogens, such as Salmonella and Campylobacter, would infer that the government would not interfere with these inspections, and would leave plant owners to conduct it on their own. The government reported that it allowed this move in order to concentrate on other issues. New rules and regulations require plants to find defects on their own dime which would increase the chances of finding problems. The government has left the task of inspection to those who are willing, according to the rules, those unwilling to have their inspection done by the government.

A new regulation has come out this past year, in August of 2014, and

effective in October of 2014, the FSIS (2014) published a concluding standard on the NPIS, which states all slaughter plants must now include a recorded regulated time and temperature parameter at which to chill the raw poultry and those records must be present on all HACCP and SOP reports. The chilling process in a plant is imperative to prevent the spread of antimicrobial bacteria as to not cause poultry contamination and the spread of food borne illness related pathogens. HACCP and SOP system reports must include and maintain all written measures taken to prevent pathogen outbreaks, all sampling for both before and after the chilling process, and the processors must be keeping daily logs of all testing samples and whether or not the sampling has been effective in controlling microbial pathogens (Havelka and Farnsworth 2014). FSIS inspectors collect a sample once every 22, 000 chickens, and once every 3, 000 turkeys and other fowl to continually monitor safety within the poultry inspection processes (Havelka and Farnsworth 2014). FSIS inspectors reserve the right to suspend slaughter plant operations due to a fault in the effectiveness and reporting of the microbiological sampling and testing procedures (Havelka and Farnsworth 2014). All slaughter establishments must provide the FSIS with all scientific and technological data corresponding the design and maintenance of its own sampling plan, which includes the use of OLR and OFLR anti-microbial agents such as chlorinated water and other approved agents (Havelka and Farnsworth 2014).

New Technological Advances

According to the USDA FSIS (2014), new technologies have “ resulted in significant improvements in the safety of meat, poultry, and egg products in

recent years.” There are numerous ways that companies have been utilizing the technology around them to better their inspection and reprocessing systems (FSIS 2014). Technologies such as high pressure processing, steam vacuums, steam pasteurization and antimicrobial sprays, washes, etc. (FSIS 2014). The FSIS (2014) has been publishing monthly information updates on new technological advances to help in food safety in an attempt to “ increase public and industry awareness.” An example of some of the current technologies that the industry is utilizing is as follows: Tomco Equipment Company is using hypochlorous acid, tradename Pathiclean, for optimum reprocessing results; Safe Foods Corp. is using cetylpyridinium chloride, trade name Cecure, on all raw poultry carcasses; Freezing Machine, Inc. is using carbon monoxide as a liquid injection paired with a modified atmospheric pressure system for packaging safely; Tyson Foods is using trade name Perasan MP-2 in an OFLR; Albemarle Company is using trade name AviBrom (bromine) as an OFLR; and FMC Peroxygens is using trade name Spectrum 2000, a mix of peroxyacetic acid, acetic acid, hydrogen peroxide, hydroxyethylidene, diphosphonic acid and water for their online raw poultry dip tanks (FSIS 2014).

Conclusion

Up until recent years, the United States poultry slaughter and processing plants were still running off industry standards that were originally established in the mid 1950's. The demand for food products to be safe and fit for human (and animal) consumption has grown dramatically in recent years, thus pushing forth a new need to develop new technologies for the modernization of the poultry and other meat industries inspection standards.

Science based research and technological advances have created a new method in keeping raw perishable meats untainted with the many food borne illness pathogens such as E. coli, Samonella, and Campylobacter. The use of microbial data and the use of new systems to adequately suffice the requirements to be meet by the NPIS have meant great strides have been achieved in the modern meat processing and packaging industries. Food safety is not an issue to be taken lightly as the general public's health welfare is at stake, but it seems that all companies large and small are taking it upon themselves thanks to the NPIS to update their information and advance all preventative measures toward food safety.

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