INFLUENCE OF Immersion Time Tofu IN SALT SOLUTION ON FORMALINE RESIDUE

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ABSTRACT

Tofu is a food ingredient made from soybeans and contains a lot of nutritional value, so there are traders who use formalin as a preservative. Formalin is an efficient chemical additive, but is prohibited from being added to food (food). This study aims to determine the presence of formalin residues in tofu based on variations in salt solution soaking time.

The research method used is experimental. Data obtained from the Test Kit Formaldehyda with two treatments based on the addition of formalin and salt solution. The treatments were: 1. P1 (6% formalin) and 2. P2 (6% salt solution).

The results showed that from 32 samples of tofu soaked in salt solution 45 minutes, 60 minutes, 75 minutes and 90 minutes were tested using reagents A1 1 ml and A2 3 ml. It shows a decrease in formalin residue as much as 45.63%, 69.28%, 82.36% and 91.80%.

Keywords: Soaking Time Tofu, Salt Solution, and Residue Formalin

INTRODUCTION

Tofu contains a variety of nutritional supplements, such as protein, fat, carbohydrates, minerals, calories, potassium, calcium, phosphorus, vitamin E and vitamin B12. At first there was only one type of tofu, namely white tofu. However, along with culinary growth, the type of tofu in general has experienced a lot of growth, namely the type of yellow tofu, milk tofu, silk (tufo), skin tofu and water tofu. The types of tofu that are marketed are generally white with yellow types. While the type of silk tofu is not often marketed because it costs more than white tofu with yellow tofu.

Tofu as a complementary food ingredient is still faced with the problem of a low storage period, tofu has properties that are easily damaged/rotten. Under normal conditions (room temperature) it can only last up to 2 times 24 hours. After exceeding the limit, the taste will turn sour and then rot over time, so it is no longer suitable for consumption. This means that the water content in tofu is relatively large, which is 86-89 percent, and the protein content of tofu is around 8-12 percent. Tofu also has 4.8 percent fat with 1.6 percent carbohydrates.

Tofu is a dish made using soybeans that is widely known locally and in great demand, because it is simple, easy to obtain, and contains many health benefits. Tofu originated in China, and the coagulation of the protein found in soybeans. Protein coagulation was carried out by acid fixation, then the coagulation derived from soy protein was separated

and compacted into tofu. In Indonesia, the tofu business is growing rapidly. In addition to a rather broad market, the tofu business can also be carried out in a family environment so it does not require large costs.

Food quality can be seen from the microbiological, physical (smell, taste, texture and color) and nutritional content. Naturally available food is not always free from compounds that are not needed by the body, it can even contain compounds that are detrimental to health and should not be contained in a food ingredient, can be produced through chemical and biochemical reactions that occur during processing and storage, either due to contamination. or naturally. In addition, food additives are often added intentionally to improve texture, color, and other quality components in the food processing process.[5].

Food Additives Requirements

Permenkes No. 33 of 2012 states, food additives must meet the following requirements:

(1) Food additives are not intended to be consumed directly and or are not treated as food raw materials.
(2) Food additives may or may not have nutritional value, which are intentionally added to food for technological purposes in the manufacture, processing, treatment, packing, packaging, storage or transportation of food to produce or are expected to produce a component or affect the nature of the food. , either directly or indirectly.
(3) Food additives do not include contaminants or materials added to food to maintain or increase nutritional value.

The process of making tofu is as follows:

a) Immersion

Soaking the seeds will soften the cell structure so that it will reduce the energy required during processing. The fine cell structure will also work by extracting the juice from the pulp. Soaking time depends on the water immersion temperature, age and type of soybean. Water absorption is faster if using hot water, but if the water used is too hot (more than 550C) it can cause the soybeans to be half cooked so that the soy milk is further reduced. The immersion system is generally done manually by the workers themselves. The soaking equipment consisted of plastic buckets and some of them were still covered in sacks. Soybean soaking is done by pouring dry soybeans into a soaking tub (plastic bucket) either in bulk or wrapped in sacks and then given enough water.

Soaking is usually done in the morning before grinding. The typical soaking is between 3-4 hours for imported soybeans and 4-5 hours for local soybeans. Soybean seeds that have been soaked are then cleaned by removing the soaking water and impurities that generally float on the water.

b) Milling

The soybean seeds are then ground into soy porridge. Processing is expected to reduce the molecular size of soybeans so that it will work by extracting protein into soy milk. During milling, water was added at a rate of 1.8 liters per minute.

c) Cooking

Soybean porridge obtained as a result of milling is then put into a cooking bath with the addition of water so that the soybean porridge becomes runny. Soybean porridge is then cooked. From observations, every 10 kg of dry soybeans will produce about 100-120 liters of cooked porridge.

The cooking system starts by putting a certain amount of water into the pan, then heating it. When hot, the

soy porridge from the processing system is put into a container and warmed until it becomes bubbly.

Soybean porridge cooking system affects the nature of the tofu made. The direct heating process in the pan causes a crust to form on the bottom wall of the pan. The crust arises due to the high temperature of the pan so that the soy porridge deposits move. When stirred this crust will mix with soybean porridge so that it becomes dirty and dark (brown). The crust causes a strong odor that will spread throughout the soybean porridge. The smell will carry over to the end of the process, namely printing. The tofu produced from this process is dark in color and has a strong smell.

d) Filtering

Soybean porridge that has been cooked is then filtered to get soybean juice (soy milk). Filtration is generally done by placing soybean porridge on top of a calico cloth (rough mori) or chiffon cloth that is intentionally placed above the container. Then the squeeze is ended by giving a clamping board and given the biggest load so that the water in the soybean porridge runs out. If necessary, squeeze the filter dregs again by adding some water.

Filtering is done by placing the soybean porridge in a basket lined with calico cloth, then stirring until the liquid comes out. Filtering is done several times with the addition of a certain amount of water to get the maximum soybean juice. The main product of this filtering is soybean juice, while the by-product is dregs which are widely used as animal feed. Soybean porridge juice will drip automatically into the reservoir which also acts as a clumping process. After the water from the soybean porridge is no longer dripping, the dregs from the soybean porridge which still contains the water from the soybean porridge are pressed with a press made of wood. This is done to get the remaining soy porridge juice that is still contained in the dregs.

e) Acidification

The process of acidification or better known as agglomeration has not used a machine tool. Clumping or acidification is the next process after the filtering process of cooked soybean porridge. To coagulate soybean juice, use an acidic ingredient called "seed". The “seeds” are the acid left over from the clumping process the day before. The remaining "seeds" during clumping that cannot coagulate the soy porridge juice are collected in a bucket container which is then cooled overnight to be used as an acidifying agent the next day.

f) Packaging and Printing

Soybean porridge that has been coagulated is then molded into tofu. Using the wrap printing technique. The wrapper printing procedure is carried out with the help of a press which has various shapes and sizes according to the type and size of the tofu to be made. The tofu that will be printed first is wrapped in calico material cut into small squares.

After the packaging and printing process is to release the calico cloth that is used as a wrapper during the printing process. The finished tofu can then be marketed. However, before being marketed, the finished tofu is colored and salted. To give color, tofu craftsmen use turmeric as a raw material. There are 2 forms of turmeric used by tofu craftsmen in the coloring process, namely natural turmeric (grated turmeric) and powdered turmeric in packaging.[15].

1) Types of Tofu Marketed

The types of tofu that are marketed and consumed in Indonesian society

include:

a) White Tofu

This type of tofu has a dense texture with rather large pores. On the market can be found in various shapes and sizes. The storage time of white tofu is not too long, it can only last for 2 days. More than that, there will be aroma and texture. Even the treatment of steaming and storage in the refrigerator only preserves up to 1 day.

b) Yellow Tofu

This tofu is known as Tahu takwa or Tahu Kediri, because the production focus of this tofu is mostly found in Kediri. The surface is very thick, supple, soft and smooth. Because it is denser than white tofu, it does not crumble easily and is easier to produce. The yellow color uses natural dyes derived from turmeric. Tofu production starts with tofu printing and then boiled in a solution of turmeric and salt. So even this type of tofu can be eaten without being processed, because boiling it makes the tofu ripe. In addition, the turmeric and salt solution makes the taste savory and not sour.

c) Silk Tofu (Tofu)

Named tofu silk because of its smooth texture. Generally, silken tofu is white, sold fresh and packaged in airtight plastic. Tofu silk there is also a shape. Cylinder and square. Silk tofu is also added with eggs known as egg tofu, the color is more yellow. While the silken tofu with the addition of shrimp, the name is shrimp tofu [4].

2) Formalin (Formaldehyde)

Formalin (CH2O) is a chemical compound consisting of hydrogen, carbon and oxygen. Formalin is also known as formaldehyde, formic aldehyde, methanal, methylene oxide, oxymethylene, methylaldehyde and oxomethane. Formalin in very small concentrations (<1%) can be used as a preservative for various non-food ingredients such as household cleaners, softeners, waxes, and carpets [16].

Formalin is included in the list of chemical additives that are prohibited from being used [3]. The main factors causing the use of formalin in food are the low level of consumer knowledge about preservatives, the durability of the food produced is better, the price is cheap, regardless of the dangers that can be caused. This is supported by the behavior of consumers who tend to buy food at low prices without regard to quality. The difficulty of distinguishing ordinary food from food with the addition of formalin is also one of the drivers of consumer behavior. Accurate formalin detection can only be done in the laboratory using chemicals, namely through the formalin test [3].

Formaldehyde is an efficient chemical additive, but is prohibited from being added to foodstuffs (food), but it is possible to use it in preserving milk, tofu, noodles, salted fish, wet fish, and other food products. Formaldehyde solution or formalin solution has the trade name formaldehyde, formol, or microbicide with the molecular formula CH2O containing about 37% formaldehyde gas in water. Usually 10-15% methanol is added to avoid polymerization [3].

Formalin is very dangerous if inhaled, in contact with the skin and if swallowed. The consequences can be: Burns on the skin, irritation of the respiratory tract, and allergic reactions.

The structure of formaldehyde is as follows:

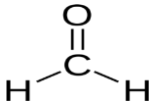

Figure 1 Chemical Structure *Formaldehyde*

Formaldehyde compounds called methanal or formalin, are aldehydes with the synthetic equation H_2CO as a gas or liquid known as formalin. Formaldehyde is usually soluble in water and undergoes polymerization so that very little is present in the form of the H_2CO monomer. Generally, these solutions contain a few percent methanol to limit the polymerization. Formalin is a solution of formaldehyde in water, with levels between 10%-40% [1].

3) Salt

Table salt is a type of mineral commonly eaten by humans. It is a white crystalline form, often produced from sea water. Commonly available table salt is sodium chloride (NaCl), with a composition of sodium (40%) and chloride (60%) [13].

Figure 2 Salt
Source: Anna, 2019

A salt solution is a solution obtained from the reaction of an acid and a base. A salt is a compound formed when the hydrogen from an acid is replaced by a metal.

Salt has hygroscopic characteristics which means it easily absorbs water, with a density level of 2.16 g/cm3, a melting point at a temperature of 8010C, and a boiling point of 14560C, and its solubility in water is 35.9 g/100 mL. Table salt is made by evaporation of sea water, with a simple process, and leaves a number of minerals and other elements so that it is considered the most natural salt [13].

Three Factors Triggering Food Destruction with several aspects that can lead to the formation of food destruction, including:

a. The development and activity of microbes within certain limits of the microbial content in foodstuffs does not significantly affect the resilience of these foodstuffs. However, if the environmental conditions allow microbes to grow and grow faster, the food will be easily damaged.
b. Enzyme activity in foodstuffs Enzymes can come naturally in foodstuffs, or can come from microbes that contaminate foodstuffs. Enzymes released by microbes can cause changes in smell, color, and texture in food.
c. Water content in foodstuffs Usually perishable foodstuffs are foodstuffs that have a large water content.

Water is needed by microbes in their growth and biochemical responses. The water needed is free water, if the water that is chemically bound is difficult for microbes to live. Therefore, by adding sugar, salt and the like in sufficient quantities, it can bind water, and food is always durable even though it has a large water content.

In the market there are several types of tofu including raw tofu, yellow tofu, fried tofu, round tofu, and many more. Each type of tofu has various tastes and has its own share of the entire industry. Production for each type of tofu is slightly unique. Indonesia knows that it has become a favorite menu that we often encounter in food stalls to restaurants. Not only as a side dish, tofu has also been processed into various special dishes such as meatball tofu, fried tofu, gado-gado, and various snacks such as tofu chips and others [12].

Traders usually add a little formalin, so that buyers are generally

confused to identify tofu that has formaldehyde and which does not contain formalin because only a small amount of formalin is added, so it doesn't sting the nose [8].

Minister of Health of the Republic of Indonesia No. 33 of 2012 Formalin is an ingredient that is prohibited from being added to dishes, because it contains preservatives. Formalin is a trademark of a combination of formaldehyde, water and methanol. At room temperature, formalin is a colorless gas with a sharp and pungent odor. Formalin is easily polymerized, and can form explosive combinations in air [10].

Formalin is a molecule that can directly stimulate tissue upon contact. The use of formalin as a food preservative continues to be widely tried by business actors who take advantage without prioritizing others. Formalin cannot be used as a dish additive, so it shouldn't be in the rest of the dish. Formalin can preserve food because it has an aldehyde group that is not difficult to bind to protein compounds to form methylene compounds (- NCHOH).

Formalin is a toxic material and is harmful to human health. If the content in the body is high, it will react chemically with almost all substances in the cell, suppress cell function, and cause cell death, causing poisoning in the body. In addition, the high formalin content in the body also causes gastric irritation, allergies, is carcinogenic (causing cancer) and mutagens (causing changes in cell/tissue function). People who consume it will vomit, diarrhea mixed with blood, urine mixed with blood, and death due to circulatory failure. Formalin can evaporate in the air, in the form of a colorless gas, with a sharp suffocating odor that stimulates the nose, throat, and eyes.

According to IPCS (International Program on Chemical Safety), in general the safe threshold for formalin in the body is 1 mg/l. Formalin can cause disturbances to the organs and systems of the human body if it enters the body beyond this threshold. These effects can occur in the short term and long term through inhalation, direct contact, or ingestion [3].

When protein dishes are soaked or watered using a formalin solution, the aldehyde group of formaldehyde will bind to protein components. Protein bound by this compound can prevent the entry of microscopic organisms of decay, so that formalin dishes will last longer. Symptoms of formalin use are not immediately apparent.

This effect is only visible in its entirety, unless the person has a large form of formalin poisoning. The ability of intense health effects caused by formalin is that it can cause irritation. Exposure that exceeds the limit can cause death. On the other hand, the potential for chronic health effects caused by formalin is to cause cancer and change the role of cells. Not only that, formalin is also teratogenic for humans.

Gorontalo Regency gets tofu dishes that do not meet safety requirements because they contain formalin. As one journalist pointed out, obtained from one of the employees of the Gorontalo (City) Health Office, 5 contents of food preservatives (Formalin) are sourced from marketed tofu.

Traders at the Central Market of Gorontalo City should not use dangerous food ingredients such as formalin, because it will damage the human body. More dangerous will result in death. This is done so that the tofu is more durable, and can benefit traders.

Based on observations made by researchers in 2021, there have not been found traders who use preservatives such as formalin, but researchers will make it with laboratory tests to examine the time in soaking tofu with a salt solution to reduce formalin, so that researchers can identify how long it takes in reducing formalin residue levels.

The Indonesian National Standard or SNI states that tofu is a food ingredient that has a solid structure with a smooth surface produced using soybeans or Glycine sp through a process of precipitation from protein and expansion of other permitted ingredients.

4) Tofu Quality Requirements

The Ministry of Industry has issued a tofu quality standard, namely SNI Number 01-3142-1998. This standard covers several parameters that affect the quality of tofu.

Table. 1 Tofu Quality Requirements

No	Test Type	Unit	Condition
1.	a. Sightings	-	Normal
	b. Color	-	Normal
	c. Flavor	-	Normal
	d. Smell	-	Normal
2.	Coarse fiber	%	Mac. 1.0
3.	Protein	%	Min. 9.0
4.	Fat	%	Min. 0.5
5.	Ash	%	Mac. 0.1
6.	Food additives	%	SNI 01-0222-M and Ment. Case No. 772/Ment. Case/per/IX/1998

(Source: Rahmawati, 2013)

5) Tofu Making

Basically, the process of making tofu consists of two parts, namely the manufacture of soy milk and the clumping of the protein. As a clotting agent, it is generally used as a starter, namely the liquid that comes out during squeezing and has been fermented for a while. As a substitute, you can use orange juice, vinegar, lactic acid solution, CaCl2 and CaSO4 solutions.

RESEARCH METHODS

This research approach is quantitative research. Quantitative research can be defined as a method used to study populations or illustrations, collecting research instrument information, analyzing statistical information, with the aim of testing established hypotheses.

This type of research is experimental to determine the effect of soaking tofu in a salt solution on the formalin residue.

This study found that all tofu samples were positive for formalin, this was seen from the semi-quantitative examination using the Colorimetric KIT Test which produced a purple solution. Samples were treated in the form of immersion in salt water with a concentration of 6%. Immersion was carried out with 4 (four) time durations, namely 45 minutes, 60 minutes, 75 minutes and 90 minutes. Each time variant was repeated 8 times so that the total experiment was 32 times, then the color change of the solution that formed purple to dark purple was observed after the sample was reacted with Reagent A1 and Reagent A2, indicating that the sample contained formalin. The results of changes in the color of the solution can be seen in the following table:

Table. 2 Results of Changes in Tofu Solution Color

No	1	2	3	4	5	6	7	8
Wana	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple
Results	+	+	+	+	+	+	+	+

(Source: Research Primary Data, 2021)

Based on Table 2, the results of the samples were examined quantitatively using the Colorimetric KIT Test, the results were that all samples were purple, indicating that the tofu contained formalin.

RESEARCH RESULT

Table. 3 Tofu Soaking Statistical Descriptive Test

Soaking Time	N	Min.	Max. ppm	mean ppm	Std. Deviation
45 minutes	8	1.70	1.85	1.78	0.04

(Source: Data Processing, 2021)

The table above shows the results of soaking tofu, the minimum value is 0.60 ppm, the maximum value is 1.85 ppm, the mean value is 1.78 ppm, and the standard deviation is 0.04 ppm.

Table. 4 Statistical Descriptive Test of Soaking Tofu in Salt Solution

Soaking Time	N	Min. Ppm	Max. Ppm	mean ppm	Std. Deviation
45 minutes	8	0.60	1.50	0.96	0.26
60 Minutes	8	0.40	0.80	0.65	0.14
75 Minutes	8	0.35	0.60	0.45	0.08
90 Minutes	8	0.15	0.40	0.27	0.10

(Source: Data Processing Results, 2021)

The table above produces tofu soaking in salt solution, with an immersion time of 45 minutes, a minimum value of 0.60 ppm, a maximum value of 1.50 ppm, a mean value of 0.96 ppm, and a standard deviation of 0.26. The immersion time is 60 minutes, the minimum value is 0.40 ppm, the maximum value is 0.80 ppm, the mean value is 0.65 ppm, and the standard deviation is 0.14 ppm. The immersion time is 75 minutes, the minimum value is 0.35 ppm, the maximum value is 0.60 ppm, the mean value is 0.45 ppm, and the standard deviation is 0.08 ppm. The immersion time is 90 minutes, the minimum value is 0.15 ppm, the maximum value is 0.40 ppm, the mean value is 0.27 ppm, and the standard deviation is 0.10 ppm.

Table. 5 Normality test

Soaking Time	Kolmogorov - Smirnova		Shapiro - Wilk	
	df	Sig	df	Sig
45 minutes	8	0.138	8	0.261
60 Minutes	8	0.109	8	0.056
75 Minutes	8	0.150	8	0.208
90 Minutes	8	0.200	8	0.179

(Source: Data Processing Results, 2021)

In Table 5 above, each time the test was carried out had a significance value of P > 0.05, thus concluding that the data were normally distributed.

Table. 6 Homogeneity Test

Levene Statistics	df1	df2	Sig
1,808	3	28	0.169
1,265	3	28	0.306
1,265	3	14,261	0.324
1,936	3	28	0.147

(Source: Data Processing Results, 2021)

In Table 6 above, it is shown that all of the tested data have a significance value of P > 0.05, thus concluding that the data is homogeneously distributed.

Table. 7 Anova Test

Residue	Sum of Squares	df	Mean Square	F	Sig
Between Groups	2,126	3	0.709	26,652	0.000
Within Groups	0.745	28	0.027		
Total	2,871	31			

(Source: Data Processing Results, 2021)

Table 7 above assesses the significance of 0.000 < 0.05, so it can be concluded that the average of the four immersion times in salt solution has a significant effect.

Table. 8 Results of Percentage Reduction in Formalin Residue tofu

No	Immersion Time (minutes)	Average Formalin Concentration (ppm)		Difference (ppm)	Percentage Residue Formalin
		Before	After		
1	45 minutes	1.78	0.95	0.83	46.63
2	60 Minutes	1.78	0.65	1.13	63.48
3	75 Minutes	1.78	0.45	1.33	74.71
4	90 Minutes	1.78	0.25	1.53	85.96

(Source: Data Processing Results, 2021)

In Table 8 above, the formalin residue in tofu soaked in salt solution decreased after being treated. Where the percentage decrease in formalin residue at the time of immersion for 45 minutes was 46.63%, 60 minutes was 63.48%, 75 minutes was 74.71%, and 90 minutes was 85.96%.

Formalin is a material used to preserve corpses or biological preparations. The use of formalin as a

preservative is due to the link between formalin and protein that can kill germs by making the tissues in the germs lose body fluids, so that germ cells will dry and form new structures on the surface. That is, formalin not only kills germs, but also forms a new structure that protects the structure underneath to be resistant to other germs.

The research was continued by quantitative checking using the Colorimetric KIT Test, this equipment can be used to determine the presence of formalin content in the tofu by dripping the antalin test reagent into the response tube which already contains a solution of formalin tofu. Antiline test kit reagents or Schiff reagents have a relatively low visual detection limit for formaldehyde, which is 0 or 0.2 ppm.

Schiff's reagent is a solution of pararosaniline that has been removed apparently by sulfur dioxide which can detect an aldehyde compound. If the illustration knows does not have formaldehyde so it will not produce a color response, but if the illustration knows has formaldehyde it will cause a purple color response.

Continue to be intensive colors that seem to illustrate that the formaldehyde content in the illustration continues to be large. This reagent will later find out the formalin contained in the solution. Formalin is not good if it enters the body, if a person is poisoned with formalin so that the person will feel symptoms such as dizziness, coughing, skin irritation, cancer risk, and even worse death.

Checking the effect of tofu soaking time in salt solution on formalin residues totaled 4 illustrations that were repeated 32 times showing the presence of shrinkage of formalin residues. This indicates that the formalin residue can undergo shrinkage when immersed in a saline solution. The process of soaking in water or salt water can reduce the content of formaldehyde because of the nature of formaldehyde which is easily soluble in water. Formalin can be dissolved in a salt solution because salt is a surfactant, one of the characteristics of surfactants is that it can cause a saponification response (soap-making process) which can lower the formaldehyde content.[7].

White tofu that has been soaked in formalin with a concentration of 6%, then soaked in a salt solution with a concentration of 6% for 45 minutes, 60 minutes, 75 minutes, and 90 minutes. All formalin residues from measurements are not suitable for eating because according to the Minister of Health of the Republic of Indonesia No. 033 of 2012, formalin is a bonus ingredient that is prohibited from being used in food.[6].

Based on the percentage of formalin residue shrinkage, white tofu is listed in Table 8, the presentation of formalin residue shrinkage at the highest soaking time in salt solution is 90 minutes (85, 96%) and the lowest percentage of formalin residue shrinkage is 45 minutes (46, 63%). This shows that the longer the immersion in the salt solution continues to be, the lower the value of the resulting formalin residue presentation will be. The immersion time affects the shrinkage of the formalin content in white tofu [9].

Formalin is easily soluble in water. So that it continues to be a long soaking time, until the formalin continues to dissolve, and the formalin content in white tofu continues to be low. Know in this research that the salt content is early = 0. One of the characteristics of salt is hygroscopic, which means it easily binds to water [14].

The hygroscopic character of the salt causes the formalin found in white tofu to dissolve in water so that the formalin content decreases. The high salt content of white tofu causes the formalin soluble energy in white tofu to be greater. The dissolving of salt also causes the soaking

water to have salt. Another characteristic of salt is that it can elicit a saponification response (soap-making process), so that the clean energy of a solution containing salt is better for formalin.[5].

CONCLUSION

From the results of the research, it can be concluded that there is an effect of soaking tofu in a salt solution on the formalin residue. Continue to increase the concentration of the salt solution until it continues to be large in the shrinkage of the formalin residue.

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