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Assessment of Food Temperature and Food Holding Time among Cafeterias in UiTM Dungun Terengganu

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ABSTRACT

This study was conducted on 4 food cafeterias in Universiti Teknologi MARA (UiTM) Dungun Terengganu, Malaysia to seek the compliance level and degree for safe food temperature and food holding time practices based on the U.S. Food and Drug Administration (FDA) 2004 assessment method and practice. The study incorporated onsite observations, field assessments and interviews at the designated cafeterias in order to verify the current states and practices. Safe temperatures were analysed by taking the temperature of each food, while food holding time were observed for 5 hours after the foods were served at the tray lines during lunch hour. The results showed that only one cafeteria was at the compliance level with an average means > 3.2 or > 80% while the others were considered as out of the compliance level with an average means < 3.2 or < 80%.

KEYWORDS: Compliance Level, FDA 2004, Food Holding Time, Safe Food Temperature.

INTRODUCTION

One major consideration in preparing food for consumers is to make sure the foods prepared are safe for the human consumption. Food contamination can occur due to improper food practices, and this will lead to foodborne illness. Foodborne illness can be defined as an illness caused by consuming food, which is contaminated with pathogenic bacteria or chemicals [1].

The trend of food poisoning cases in Malaysia for the past 10 years has expressed inconstancy. It is noted that food poisoning contributed as the highest number of food borne illness cases as compared to typhoid, cholera, hepatitis A and dysentery. Many foodborne related diseases were affiliated with outbreaks in institutions witnessed 62% of the incidents occurred in schools, 17% in academic institutions and community gatherings reported at 8% incidents [2]. However, the true incidence of foodborne illness in Malaysia is still unknown, and minimal efforts have been exerted to explore the issue. It is reported that minimal foodborne disease investigation had been executed in the most developing countries, thus most outbreaks often goes undetected [3]. However, it is interesting to note that in year 2006, a total of 6938 cases of food poisoning were reported with an incidence rate of 26.04%, followed by a 100% rise of food poisoning cases in 2007 with incidence rate of 53.19%. The dramatic rise of cases in year 2007 may not show a true increase in food poisoning cases, but the increase may be due to the improvement of the reporting and registration system through the establishment of the Crisis Preparedness and Response Center in May 2007 [2].

Five risk factors that need to be evaluated and assessed in complying with safe food preparation and consumption by reducing further foodborne illness occurrences have been outlined [4-5]. It consists of safe food sources, food storing temperature and stock control, personal hygiene, cross contamination and safe food holding temperature. Among the 5 risks factors mentioned above, safe temperature and food holding time were identified to be the most crucial risks assessment in food management especially in institutions.

Safe temperature and holding time are the most influencing factors that have contributed to the foodborne illness. Holding food act is used as a critical control point to maintain proper temperature in serving safe and healthy food. Cooks and chefs must have adequate knowledge on holding food's proper temperature, monitoring the holding process as well as recording temperatures during food holding [6]. Observing temperature history during food preparation, handling, delivery and depository are the simplest ways to prevent the incidence of food poisoning by reducing the number of microbial growth. The reading and analysis of temperature profiles generated by computer programs (based on predictive models) nowadays has granted the opportunity for shelf life and safety of foods decision [7].

The remainder of the paper is organised as follows. This study begins with literature review and several methods that were used in this study. Section III reports the empirical results followed by conclusion in the last section.

LITERATURE REVIEW

Food Temperature

It is highlighted that long holding time of food will increase the bacterial growth inside the food and cause food poisoning [4]. Cooked food should be served and eat within 4-5 hours prior serving time. While the holding temperature for cooked food should be between 60°C and above. On the other hand, chilled food should be held at the temperature of 5°C or less while for

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frozen food, it should be at -10°C and below. The word temperature abuse can be defined as allowing food to remain at the temperature danger zone which is between 5°C-57°C for unacceptable period of time. In order to avoid the improper holding food temperature, there are some conditions that need to be emphasized:

- The accurate temperature for heating up and reheating is at 57°C and above. At this condition, most of the bacteria are killed by heat or 'slow growth'. It is recommended to reheat food again if the temperature of food decreases below 57°C.
- For pork, fish and egg, the recommended temperature for cooking is at 63°C and above.
- For poultry based food, the recommended temperature is at 74°C. This is a minimum cook and reheats temperature for poultry.

A proper heat processing procedures should be able to destroy, kill harmful or reduce vegetative cells of microorganisms which are caused by workers, contaminated irrigation water or poor slaughtering procedures. The products prepared should not be at the danger zone (5°C-57°C). In order to control this from happening, the food must be at proper cooking temperature and the food has to be reheated and placed at a proper holding machine. Most of the disease-causing bacteria can grow within this temperature range. Some disease-causing bacteria such as Listeria monocytogenes, can grow at temperature below 41°F (5°C), but the rate of growth is very slow [8]. Table 1 described the safe holding food products temperature and times for heating while Table 2 explained on bacteria growth times.

Table 1: Explanation of safe holding food products temperature and times for heating [9]

Food product	Minimum internal temperature	Time for heating
Meat, pork (other than roasts) and fish	145°F (63°C)	15 seconds
Ground meat, ground pork, ground game animal	155°F (68°C)	15 seconds
Meats roast (medium), pork roast and ham	145°F (63°C)	4 minutes
Poultry, stuffed meat, stuffed food products	165°F (74°C)	15 seconds

Time

Under ideal condition, bacterial cells can double in numbers in every 15-30 minutes. Clostridium perfringens bacteria can double in every 10 minutes [8]. For most bacteria, an individual cell can multiply over 1 million cells in just 5 hours. In order to avoid it, proper storage and handling of food such as proper cooking process are suggested in ensuring the bacteria do not have any opportunity to multiply and able to avoid the occurrence of food poisoning.

Table 2: Explanation on bacteria growth times [9]

Time	0	15 min.	30 min.	60 min.	3 hrs.	5 hrs.
No. of cells	1	2	4	16	>1000	>1 million

Due to vegetative cells, bacteria are identified to be multiplied in shorter time. In food preparation, the bacteria required roughly 4 hours to cultivate and multiply aggressively that can lead and spread illness [8]. Four hours is needed for the minimum time of holding foods. If the food are reached at 4 hours in holding or served, it must be reheated in order to avoid it from being affected by the bacteria. Therefore, based on the aforesaid findings and practices, this study is intended to assess the compliance level of safe food temperature and food holding time practices in Universiti Teknologi MARA (UiTM) Dungun Terengganu cafeterias and to reduce the risks of foodborne illness occurrence.

METHODOLOGY

The study incorporated onsite observations, field assessments and interviews at the designated cafeterias in order to ascertain the current situation and practices. Four (4) cafeterias in UiTM Dungun Terengganu were employed as the sample of the study. These samples were selected based on the justification that potential threats of food poisoning can occur pertaining to higher number of the students utilizing these cafeterias on a daily basis, roughly 5,024 students as listed in Table 3.

Table 3: Explanation on number of students in colleges and cafeterias in UiTM Dungun Terengganu [10]

College	Number of students	Cafeteria
Redang	1428	
Tenggol	760	Redang or Tenggol
Gemia	876	
Perhentian	764	
Kapas	292	Kapas or Perhentian
Duyung	904	
Total	5024	

Audit Form Development

This study adopted the audit form used by UiTM Health Centre which is based on the Premise and Food Safety Ordinance under the Section 10 and 11 of the Malaysian Food Act 1983 [11]. Few modifications were made especially on the sentence structure to ease the assessment process and to suit with the current study. While the audit form evaluation criterion was based on the compliance level of foodservice operators involved in the U.S. Food and Drug Administration (FDA) 2004 assessment's

methods and practices. Both organizations evaluation questions were combined and used. However, it is noted that only half of the whole evaluation criterion suitable with the Malaysian setting.

Food Premises Auditing Process

Premise and food auditing process which involves interviews with the cafeterias' management that related to record reviews and food temperature recording were conducted. The audit score scale was based on 4 points; 4 (> 80%) is good, 3 (60-79%) is satisfactory, 2 (40-59%) is unsatisfactory, 1 (1-39%) is very unsatisfactory and nil (0) is for unable to observe and audit. The acceptable compliance level percentage for education institutions is 80% [4]. Table 4 below summarized the score of temperature holding food. While the formula for the compliance level is as follow.

Study Status

Compliance: within the compliance guidelines and based on the onsite observation. Score given to this level is 80% or score 4.
Not in compliance: out of the compliance guidelines and based on the onsite observation basis. Score set is below 80% or score 3 and below.
Average mean: 3.2 and above equal to 80%.

Equation for determining the compliance level according to FDA assessment methods and guidelines is shown in (1).

$$\frac{\text{Score given to each variables/subjects}}{\text{Total scores of each variables/subjects}} \text{x}100\% \quad (1)$$

Table 4: Score of temperature holding food

Score	Hot holding temperature (°C)	Cold / Chiller (°C)	Freezer (°C)
4 (good)	> 60	0-5	< -10
3 (satisfactory)	40-59	6-10	-5-(-9)
2 (unsatisfactory)	20-39	11-15	0-(-4)
1 (very unsatisfactory)	6-19	16-20	4-0
0 (unable to observe and audit)	Nil	Nil	Nil

For food temperature measures set in the audit form, 2 types of temperature checking devices or thermometer were used.

Thermocouple-EFC Fast, Pyrometer CH945

The auditing process requires 2 thermocouples to be utilized. For the food temperature assessment, the thermocouples were infused into the food respectively to achieve and collect the temperature readings. After that, thermocouples used were needed to be sterilized with tissue and water-logged with a combination of 70% ethanol and 30% distilled water. The preferred temperature readings need to be in line with the compliance level that comprise of 60°C and above (hot food), 0-5°C (cold food), -10°C and below (frozen food) [1].

Laser Thermometer, Retek (Calibrated by Teak) Pyrometer Service (M) Sdn Bhd

Laser thermometer was also utilized to actuate the food surface and surrounding temperature. It was done through pointing at the food item with the distance of less than 30.4cm. FDA had organized specific temperatures for desired surrounding such as below -10°C for freezer room, 3°C-5°C for chiller, 27°C and below for dry store as well as 27°C-30°C for food preparation room/kitchen [1].

RESULTS AND DISCUSSION

Both qualitative and quantitative approaches were deployed to analyze data gathered from this study. Researchers utilized Statistical Package for the Social Sciences (SPSS) software version 20.0 for data analysis process. The analyses involved were mean comparison, t-test (significance level set at $p < 0.05$) and Microsoft excel 2007 (graph). Table 5 indicate the assessment of the safe temperature and food holding time in UiTM Dungun Terengganu cafeteria with significant average mean differences ($p < 0.05$). This is done due to the temperature fluctuation recorded from the first hour to fifth hour of food displayed in the cafeteria mentioned.

Table 5: Safe temperature and food holding time practices assessment result

Variables	Sig. (2-tailed)	Mean	SD
Kapas	0.000	2.20	0.44721
Tenggol	0.004	2.40	0.89443
Redang	0.003	2.60	0.89443
Perhentian	0.001	3.20	0.83666

Based on the on-site observation, it is clearly shown that only Perhentian cafeteria is considered as complying with the food safety practices. It became one of the possible cafeterias that are able to prevent the occurrence of food poisoning with the average means of 3.2. Other cafeterias were stated as out of compliance with the average means below 3.2. They are Kapas

cafeteria = 2.20, Tenggol cafeteria = 2.40 and Redang cafeteria = 2.60. Preparing the food items which based on students' forecasting and always refill most of the foods are the main reasons where Perhentian cafeteria is able to maintain the safe temperature and holding time compared to the other cafeterias. In other cafeterias, the foods were prepared in bulk and improper food holding machine as well as malfunction thus lead to out of compliance level.

Five items which prepared in the cafeterias were being analysed. It was chosen based on the assumption that all these items were among the popular food items selling in the cafeterias and listed among the major items sold by cafeterias providers. The items were chicken, soup, fish, vegetable and rice all summarized in Figures 1 to 5.

Analysis on Popular Items Prepared in Cafeterias

a. Chicken

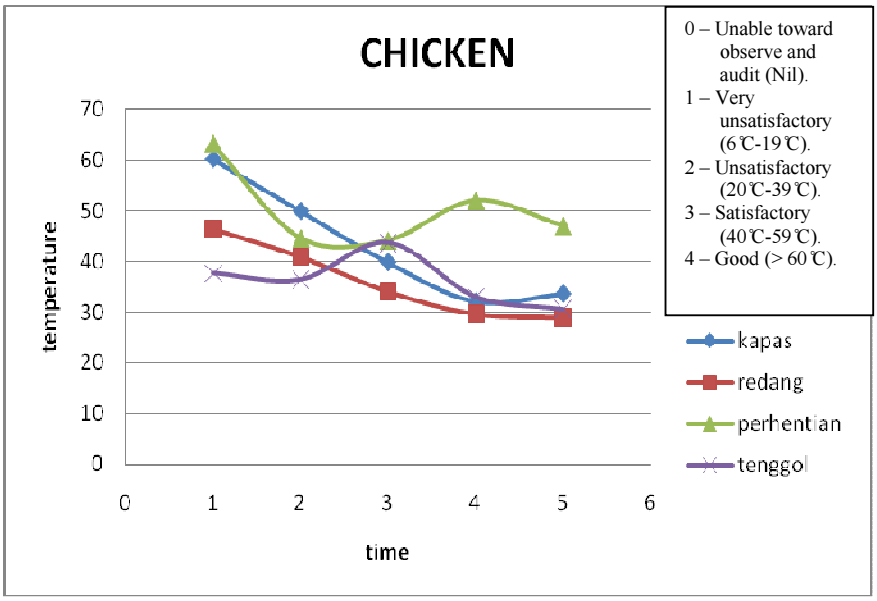

Figure 1: Chicken's temperature for all cafeterias

Figure 1 shows the fluctuation temperature for all cafeterias that out of compliances which based on the food safety practices [4]. This is where all the chickens which served and prepared by the cafeterias showed significant decrease in temperature reading at the fifth hour. However, the chickens that served and prepared by Perhentian cafeteria (44.1ºC-52ºC) indicates the increasing temperature at third and fourth hour which enables to slow down the microbial growth [12]. Chicken that be prepared by the other cafeterias indicates a tendency to be spoiled and later lead to food poisoning. Research which conducted by [13] proved that cooked food that be left at room temperature for a longer time, especially poultry is at risk of being contaminated by the Salmonella.

b. Soup

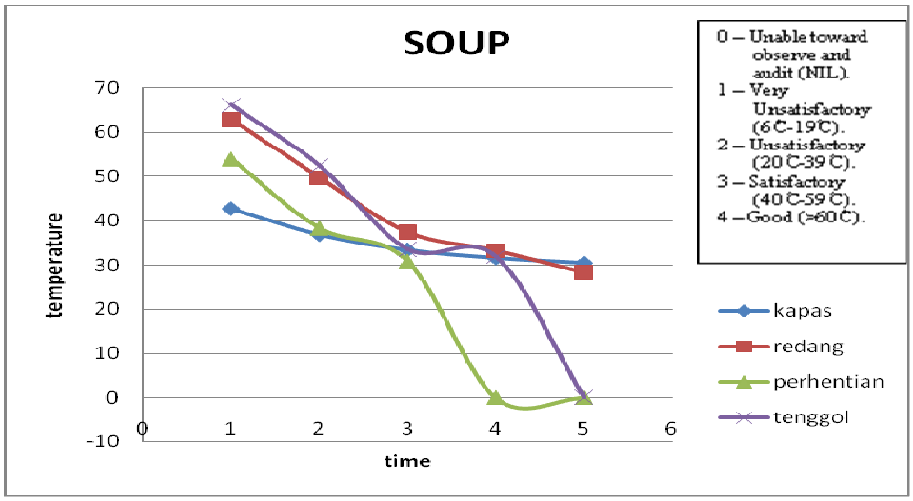

Figure 2: Soup's temperature for all cafeterias

Figure 2 indicates that only 2 cafeterias were within the compliance level during the first hour which are Redang and Tenggol cafeteria. After the first hour, it shows the temperature for Kapas and Redang cafeteria decreased to the dangerous

temperature zone. For Perhentian and Tenggol cafeteria, the soup was finished at third and fourth hour where this will help to reduce the chances of the food being contaminated. Several researchers agreed that any food that is conducive in increasing bacterial growth and toxin production, that when the processes would allow spore survival and is not subsequently heated before consumption can be associated with Clostridium Botulinum [14, 15].

c. Fish

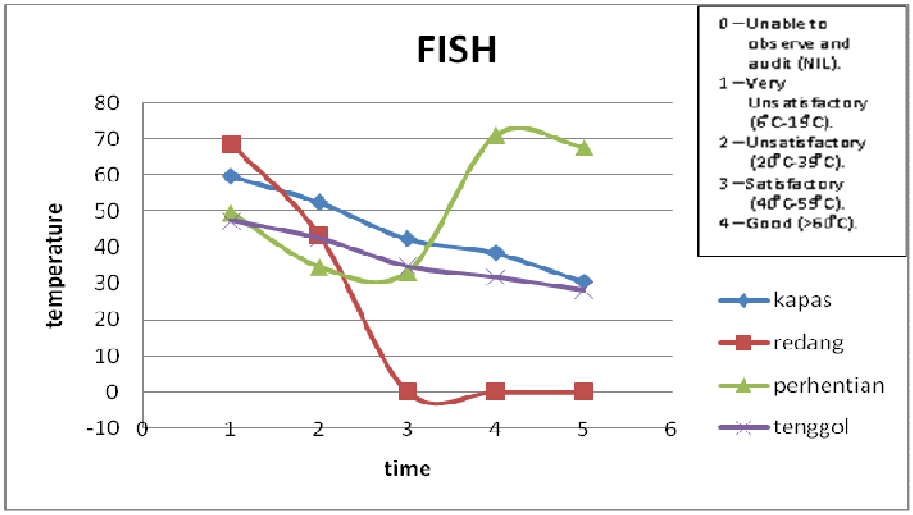

Figure 3: Fish's temperature for all cafeterias

Figure 3 illustrates only Perhentian and Redang cafeteria were identified to be complied with the Food Safety Practices after the fish were displayed more than four hours at the tray line [4]. The Perhentian cafeteria indicates increasing temperature from the second hour to fifth hour (33.2ºC-71ºC) due to reheating and refilling with some newer fish. Meanwhile, the fish in Redang cafeteria were sold out at the third hour. V. parahaemolyticus can be found on seafood, and requires a salty environment similar to seawater for growth [16]. Food poisoning that caused by this bacterium is usually a result of insufficient cooking time and or contamination of the cooked product due to a raw ingredient followed by improper holding temperature. This is a major problem in Japan in which most seafood is consumed raw.

d. Vegetable

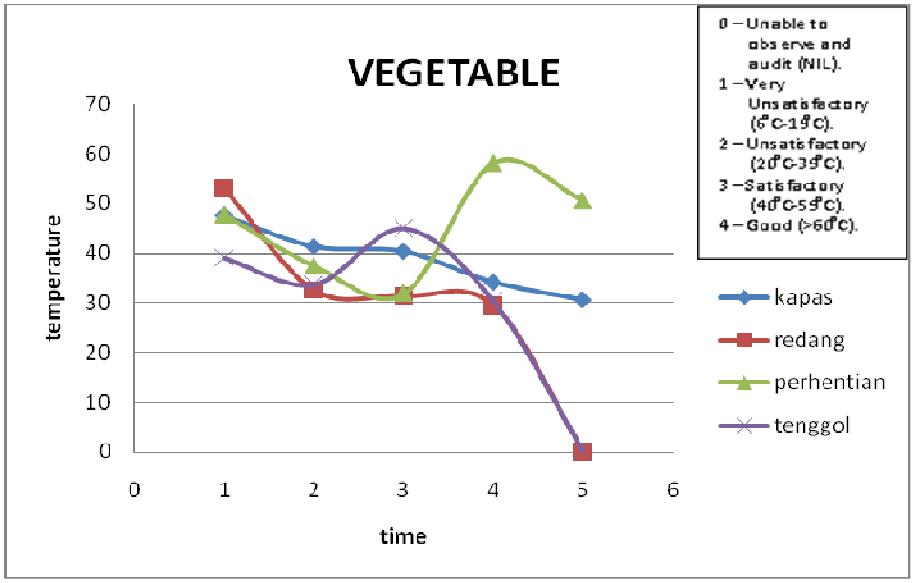

Figure 4: Vegetable's temperature for all cafeterias

Figure 4 shows that all cafeterias were out of compliances based on food safety practices [4]. This is due to all vegetables served and prepared by the cafeterias show decrease in temperature reading until fifth hour, except Tenggol cafeteria (sold out at fifth hour). However, the vegetables that are served and prepared by Perhentian cafeteria (31.9ºC-58.2ºC) indicated increasing temperature at the second and third hour due to replenishment with some new ones, which enables to slow down the microbial growth [12]. The temperature at the fifth hour for Kapas and Redang cafeteria were below dangerous temperature zone, and thus enable microbial organism to grow and contaminate the food. Improper temperature and holding time will lead the vegetables to

be contaminated with various bacteria pathogens including Salmonella, Shigella, E. coli, O157:H7, Listeria Monocytogenes and Campylobacter [14].

e. Rice

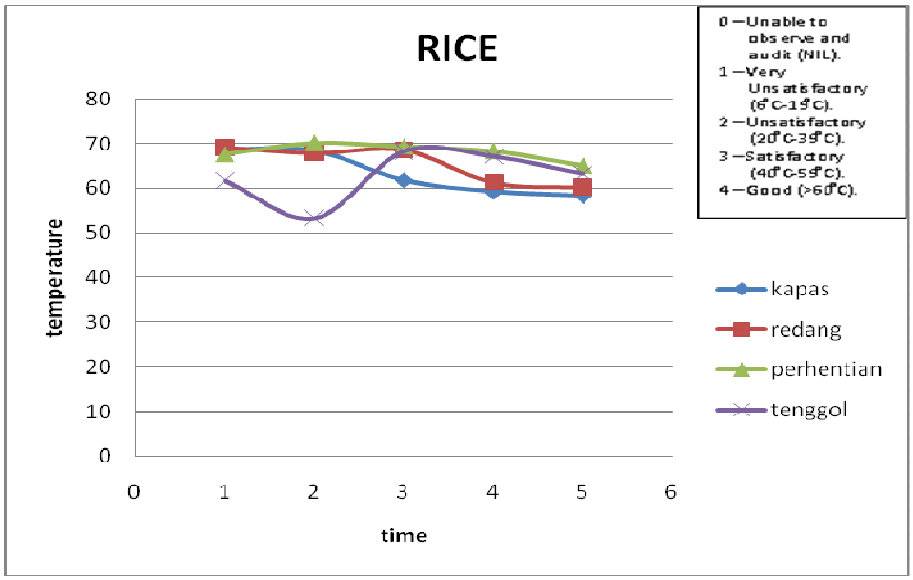

Figure 5: Rice's temperature for all cafeterias

Figure 5 indicates that all of the rice which prepared and served by the cafeterias were at compliance level, as all of the cafeterias stated temperature above 60ºC until the fifth hour the rice being displayed at the tray line [4]. The rice temperature above danger zone will retard the bacteria growth that can cause food poisoning. Improper cooking and holding temperature of rice will lead to Bacillus Cereus contamination that can cause emetic food poisoning, which is often associated with starchy food such as rice and pasta [6].

CONCLUSION

In conclusion, food temperature and food time holding practices that be implemented in UiTM Dungun Terengganu was shown only at one cafeteria (Perhentian) which complied the food safety practices and assessment [4] with average means of > 3.2. The other cafeterias were out of compliance namely Kapas, Redang and Tenggol cafeteria. Improper food temperature and longer time foods are being displayed at a tray line without proper holding equipment are the most influencing factors that lead to the other cafeterias received average means less than 3.2, and automatically classified as out of compliance.

Since this study only focuses on one risk factor at cafeteria in UiTM Dungun Terengganu, therefore future research are in need to investigate the scenario of other cafeterias in various UiTM branches. It is interesting to find out whether the pattern of scores for other cafeterias in each branch campuses of UiTM in Malaysia is the same. Probably, the other 4 risk factors can be maintained to outlook the overall scenario of the cafeterias' activities, procedures and compliance to food safety standards and practices. Moreover, lab tests on microorganism presence as well as microbiological tests can be established to explore the relationship between both audit process outcomes and lab test results. An extensive analysis in data gathering methods is critically needed and more precise risk assessment thus can be inaugurated. Overall, it helps the government to reduce the worrying rate of foodborne illness (food poisoning) in the country.

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