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SHORT COMMUNICATION KISA MAKALE

CHILLING RATE OF COOKED RICE AND RISK OF *Bacillus cereus GROWTH* IN RESTAURANT OPERATION

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Abstract:

The emetic syndrome of *B. cereus* food poisoning is often connected with consumption of rice. When cooked rice is cooled slowly and stored between 10°C to 50°C *B. cereus* spores germinate and reach numbers high enough to cause illness.

Cooked rice is often slowly chilled in most of the restaurants. In the absence of rapid cooling instruments such as blast chiller and cold room, cooked rice, as a common practice is kept at room temperature for cooling for a long time before putting into a refrigerator.

In this study, cooked rice in 10 cm deep in a pan was chilled in a blast chiller, cold room, refrigerator and at ambient and the cooling rates between the temperature zone of 50ºC to 10ºC were determined. Except the chilling in a blast chiller, in no other chilling methods the instructed/recommended four hours chilling time was achieved. Chilling of rice from 50ºC to 10ºC in a refrigerator took 12.5-13.5 hours. Chilling time came down to around 10 hours when thickness of rice in the pan was reduced to 5 cm. Chilling time was much longer (15.5-16.5 hours) when the rice was held at ambient until the centre temperature was 30 ºC before putting into the refrigerator. It is obvious that the commonly applied rice chilling in the restaurants is not safe. Some other practical ways other than reducing the thickness of rice should also be applied.

Keywords: Rice, Chilling, *Bacillus cereus*, Restaurant

Introduction

Meals prepared in food service sector must be chilled as quickly as possible unless they are going to be consumed shortly after cooking. Cooking kills off the harmful bacteria. However, spore forming bacteria survives in cooking. Two spore forming bacteria are particularly important for the safety of cooked meals. Spores of *Bacillus cereus* and *Clostridium perfirengens* survive in cooking and during the cooling process, spores may germinate enabling these two bacteria to multiply in the meals and produce toxins (Andersson et al. 1995; Drobniewski 1993).

Spores of *B. cereus* can be found widely in the nature, including samples of dust, dirt, cereal crops, water e.t.c, so it is a common contaminant of raw agricultural commodities. *B. cereus* produces two types of toxins-emetic and diarrhoeal-causing two types of illness. The diarrhoeal sickness is caused by toxins produced during the growth of the bacteria in the small intestine. The diarrhoeal enterotoxins can be produced in the temperature range of 10°C -48°C, with an optimum 32°C (Kramer & Gilbert 1989; Fermanian et al. 1997). Whereas, the emetic toxin is produced by *B. cereus* during the growth phase in the food when the temperature of food is in the range of 15°C to 40°C (Finlay et al. 2000; Granum 1994). Once formed, the heat stable toxin will not be inactivated during the subsequent cooking. Thus, illness occur by ingesting food contaminated with pre-formed toxin (FDA 2012; Choma et al. 2000).

Starch foods, such as rice, pasta or potatoes are commonly associated with emetic toxin outbreaks. Many of the emetic illnesses are due to improper holding of cooked rice at warm temperatures, offering conditions where the spores in the rice are able to germinate and produce toxin (Arnesen et al. 2008). In 95% of emetic cases fried or cooked rice is involved (Jansen & Moir 2003).

Toxin formation requires *B. cereus* concentrations to reach in excess of 10^5 cfu/g in the concerned foods. Some strains of *B. cereus* may cause food poisoning with an infective dose as low as 10^3-10^4 cfu/g (Kramer & Gilbert 1989; Becker et al. 1994). In rare cases of emetic and diarrhoeal illness have been reported involving 10^3-10^5 cfu/g *B. cereus* in food (McElroy et al. 1999). Laboratory studies on the formation of emetic toxin in boiled rice showed that in excess of 10^6 cfu/g of *B. cereus* required for toxin production to occur (Finlay et al. 2002). The conditions that favour the growth of *B. cereus* including cooking procedures that activate the pores followed by slow cooling and storage of food at 10-50ºC. Rice is commonly contaminated with spores of *B. cereus*. Holding rice at temperature between 10ºC to 50ºC will allow organisms to proliferate provided other growth conditions, such as pH, are favourable (ICMSF 1996; Johnson 1984).

In the European Union, there were 0.04 reported case of *B. cereus* foodborne illness per 100.000 population in 2012 (EFSA 2012). *B. cereus* was reported as a major causative agent of foodborne illness in the Netherlands in 2006, causing 5.4% of the food borne illness and in Norway in 2000 causing 32% of food borne outbreaks (Wijlands 2008). The most recent estimates by the CDC informs that *B. cereus* is becoming more problematic and accounting for nearly 63.000 cases annually in the United States (Scallan et al. 2011).

Control of *B. cereus* requires prompt refrigeration and cooling of foods to less than 10 ºC to minimize growth of toxin formation. The target of the control is then to secure that during cooling food does not stay in the temperature danger zone which is between 10°C to 50°C.

Restaurants are considered to be the small operations in the food service sector. Rice which is a very common meal prepared in the restaurants is often not consumed just after cooking but kept for some time for the later use.

In some regulations time limits have been set for chilling of cooked foods. FDA code in USA and FSANZ (Food Standards Australia and New Zealand) request cooling from 57ºC to 21ºC in two hours and from 21ºC to 5 ºC in 4 hours (FDA 1997 and FSANZ 2016). In IFSA, World Food Safety Guidelines for Airline Catering the requested chilling time from 60°C to 10°C is 4 hours (IFSA 2016).

Chilling of rice in a restaurant operation is often not rapid. Use of blast chillers for rapid chilling is rare as majority of restaurants cannot afford such expensive investment. Some restaurants may have cold rooms but for the majority of restaurants the refrigerators which are normally used for cold holding are the single equipment's used for food chilling.

In this study, cooked rice was cooled using different methods in a restaurant environment and the cooling rates were determined. The aim was to determine the time period that the food temperature remained within the *B. cereus* germination temperature range in each cooling method.

Materials and Methods

The study was conducted in the operation kitchen of Turkish DO&CO, Airline Catering Unit, Istanbul, Turkey. Rice was first washed in a kettle and cooked in a tilting pan. During cooking rice temperature reached to 95ºC in the center. After cooking, rice was transferred into five stainless steel pans. Dimension of a pan was 52x11x32 cm. Thickness of rice in the pans was 10 cm except in the fourth pan in which the thickness of rice was 5 cm. Pans were covered with strech film. Small holes were pierced on the strech film in order to let the vapour of cooked rice to release.

Rice in five different pans was kept at room temperature around 22-24°C until the centre temperature of rice came down to 50°C.

First pan with rice was then placed into a blast chiller (Air-o-chill, Electrolux). The temperature of blowing air in the blast chiller varied between -7ºC to -10ºC.

Second pan was placed into a cold room when the centre temperature of rice was 50°C. Dimension o f the cold room was 220X240X200cm. The inside temperature of cold room was between 2°C to 5°C. The third and fourth pans were placed into a home-type vertical refrigerator when the centre temperature of rice was 50ºC. The difference between the third and fourth pans was that the rice thickness in the fourth pan was 5 cm. The inside temperature of refrigerator was in between 2-5ºC.

The fifth pan was kept at ambient temperature (22-24°C) until the rice centre temperature was 30ºC.

The pan was then put into the refrigerator and chilling from 30ºC to 10ºC was continued in the refrigerator.

During the chilling, the centre temperature of rice in the pans was recorded from 50ºC to 10ºC at every 30 minutes. Data logger (Kimo- KTT30) was used to monitor the temperature during cooling.

The air flow in the cold room and refrigerator was monitored with an air velocity meter (Veocicalc 9515, TSI).

The set of experiment explained above was repeated three times to verify the validity of the experiments.

Results and Discussion

Center temperature of cooked rice was 95°C when the rice was transferred to pans. After transferring into the pans, rice in pans was kept at room temperature at around 22- 24°C until the centre temperature of rice dropped to 50°C. Dropping of rice centre temperature from 95°C to 50°C took 170-180 minutes for the rice in 10 cm deep and 130-140 minutes for the rice in 5 cm deep in the pan. The temperature range between 95°C to 50°C is not considered unsafe as *B. cereus* spore's germination does not occur above 50°C.

Chilling rates of rice cooled from 50°C to 10°C in different methods are shown in Figure 1.

Cooling rate was much faster in the blast chiller. Rice centre temperature dropped from 50°C to 10°C in two 130-140 minutes.

The time for the rice to cool from 50°C to 10°C was 8.5-9.5 hours in the cold room. In the refrigerator, rice temperature came down from 50°C to 10°C 12.5-13.5 hours.

Although the inside temperature was 2-5°C in both the cold room and the refrigerator, the cooling was faster in the cold room. The reason of faster cooling in the cold room was due to the higher air flow generated by the evaporator fan. Air flow in front of the evaporator fan was monitored to be 1.95-2.30 m/sec. Whereas, in the refrigerator there was almost no air flow.

When thickness of rice in pan was reduced from 10 cm to 5 cm, the cooling rate was faster. Temperature of rice in 5 cm deep came down to 10°C two hours before than the rice in 10 cm deep in the refrigerator. The cooling time was 10.5-11.5 hours.

Cooling rate of rice was very slow when rice was kept at ambient temperature until the centre temperature was 30°C and then was put into the refrigerator. In this experiment, it was shown that cooling took 15.5-16.5 hours until the final temperature of rice came to 10°C in the refrigerator.

Cooling experiments showed that except the chilling in the blast chiller, in no other chilling methods the recommended 4 hours chilling rule was achieved.

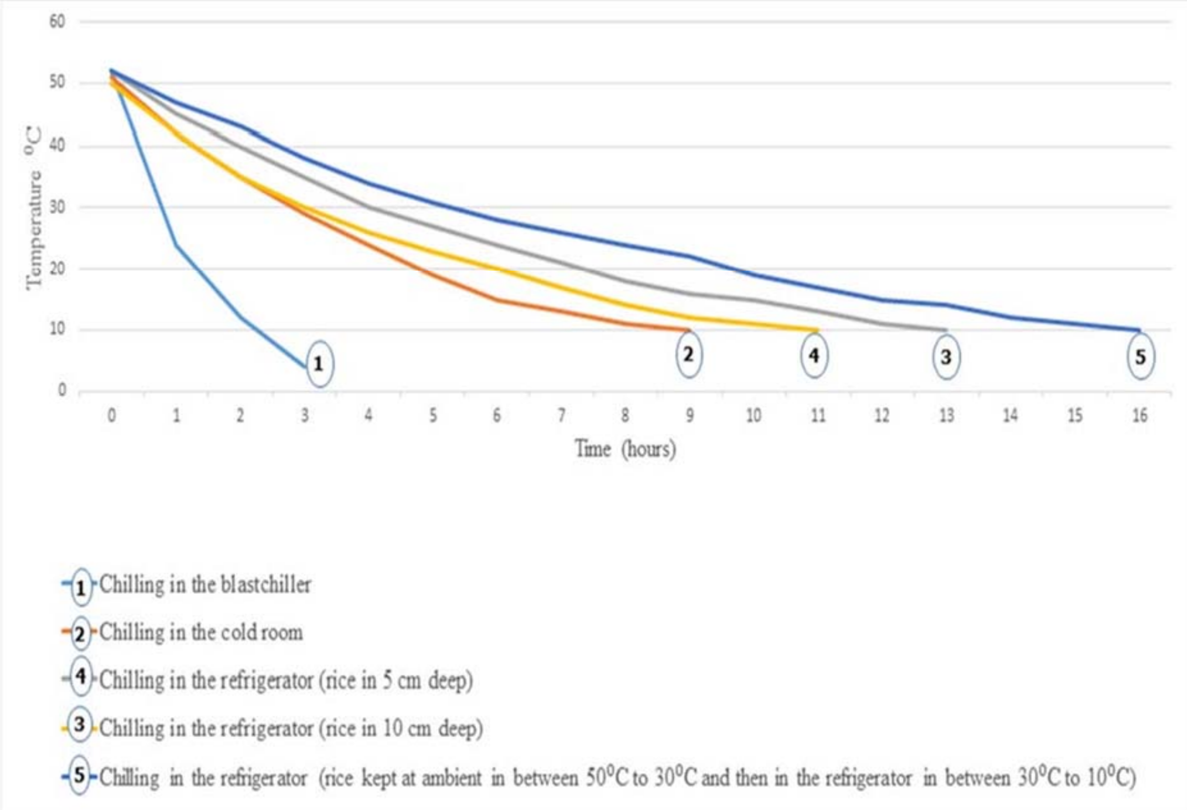

Figure 1. Chilling rate of cooked rice

Chilling rate can be increased if the thickness of food is reduced. This is an easily and practical way of fast food chilling in the restaurants and should be an essential food safety point in the restaurant food safety system. It is also very noticeable that cooling time takes longer when an employee in a restaurant keep the cooked rice long time at ambient (until the centre temperature comes down to around 30°C) before placing it into the refrigerator. This practice brings the risk of *B. cereus* proliferation and therefore must be prevented through training and supervision in the restaurants.

It is well documented that most food borne outbreaks related to *B. cereus* contamination is a result of time and temperature abuse that promoted the growth of initially low levels of *B. cereus* to increase to infectious amounts (ICMSF 1996). In addition to the temperature, pH and water activity are the two other factors affecting the *B. cereus* growth. Rice is a very suitable media for the growth of *B. cereus* as its pH and water activity values encourage the multiplication of this bacteria when the temperature of rice is kept in between 10°C to 50°C degrees. Average pH and water activity values of cooked rice is 6.3-6.5 and 0.93-0.95 respectively and this fit well with the optimum growth conditions of *B. cereus* with pH 6.0-7.0 and water activity 0.93-0.99 (Schoeni & Wong, 2005; Leguerinel & Mafart, 2001). The emetic syndrome of *B. cereus* food poisoning is often connected with consumption of rice in Chinese restaurants (Kramer & Gilbert 1989). The common practice in these restaurants is that the boiled rice is stored overnight usually at room temperature and *B. cereus* is then able to multiply. Once formed, the emetic toxin in rice is heat stable and cannot be inactivated during the subsequent reheating (Agata et al. 2002; Kotiranta et al. 2000). Thus, makes the chilling of cooked rice as an important food safety point.

Conclusion

It can be concluded from the experiments that in most of the restaurants the rice cooling application is not safe. Restaurants must use some practical ways to speed up the cooling of rice after cooking. These practical ways may include soaking rice pan into water bath, reduce the rice thickness in pan down to 2-3 cm, continuous stirring of rice while cooling and placing rice pan in front of blowing air. Use of these practices must be encouraged and requested by the legal food control authorities.

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