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Article

Food Hygienic Quality of Chinese Style Fried Rice Available in Hotels, Restaurants and Take Away Outlets in the Colombo City

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Abstract

Sri Lanka is a famous tourist destination thus; ensuring food safety has garnered importance in public health. Chinese style fried rice are popular among consumers and the majority of them belong to the low-income category. Hence, the aim of this descriptive cross-sectional study was to detect food hygienic quality of Chinese style fried rice available in hotels, restaurants and take away outlets in the Colombo city.. Using systematic random and cluster sampling technique 25 eating houses were selected in the Colombo city limits in which prepared and available for sale. Two hundred Chinese style fried rice samples were collected comprising 35% of vegetable, 29 % of chicken, 18% of seafood, 9% egg, 5% of beef and 3.5% of mixed variety respectively. Aerobic Plate Count was carried out using USFDA Manual of Food Quality Control 1992. Detection and enumeration of coliforms, faecal coliforms and *E.coli* were carried out using SLS516:part3:1982 standard. In the present study Aerobic Plate counts of 39.50% samples were $> 10^5$ cfu/g. Furthermore, 24.50% of the total fried rice samples (200) tested contained ≥ 1.100 Coliforms/g of rice followed by 16% contained ≥ 1.100 Faecal Coliforms/g of rice. Alarmingly, *E.coli* was detected in 39.0 % of the fried rice samples tested and the highest percentages of varieties contaminated were egg, vegetable and mixed. The services of PHIs who render their services on food safety are strongly recommended to improve the microbial quality of ready-to-eat food available for sale in food establishments of the Colombo city.

Keywords: food hygienic quality; *E. coli*; coliforms; faecal coliforms

1. Introduction

Presence of coliforms, faecal coliforms and *E.coli* including some other food borne pathogen may reflect microbiological quality of foods relative to product shelf life or their safety from food borne pathogens. Hence, aforementioned bacteria are collectively known as "indicator organisms". In general, indicators are most often used to assess food sanitation [1]. Food poisoning outbreaks pose a major public health threat and assurance of safe food without food borne pathogens is one of the prime responsibilities of public health authorities.

In a recent study on fried rice samples [2] the results showed that Total Plate Count (TPC) had medium mean count ($6.30 \times 10^5 \pm 1.47 \times 10^5$ cfu/g), *S. aureus* and *B. cereus* had high mean counts ($7.70 \times 10^4 \pm 2.22 \times 10^5$ cfu/g and $3.85 \times 10^5 \pm 1.67 \times 10^6$ cfu/g respectively), while *Aeromonas* spp. had medium mean count ($7.13 \times 10^4 \pm 2.42 \times 10^5$ cfu/g). The mean counts of TPC in the samples collected from cafeteria were highest compare to other food premises.

In a study conducted to find out microbial safety status of rice dishes offered for sale it has been revealed that 42% of rice samples collected from local restaurants and 58% from branded restaurants have unsatisfactory safety status for *B. cereus*. 38% of rice samples collected from local restaurants and 62% from branded restaurants have unsatisfactory safety status for forming spores. Similarly, for

coliform 63 and 42% samples were found unsatisfactory from local and branded restaurants, respectively [3].

Investigations have been done to determine the microbiological quality of several food commodities including cooked rice. A follow up survey was conducted across Canada to evaluate the current status of "health food" sold in Canada in 1998. It has been revealed that of the total of 1239 samples 16.8-18.4% of samples exceeded Aerobic Colony Count (ACC) guide lines. 16.0-17.8% exceeded coliform guidelines and 9% exceeded *Bacillus cereus* guide lines [4].

Hatakka [5] investigated the microbiological quality of hot meals served by airlines of 33 countries globally. Of 1,012 hot meal samples analysed pathogenic bacteria were found in 3% of samples. *B.cereus* being the most common pathogen. Many of the samples exceeded the minimum acceptable (AFA) for *E.coli* (8.2%) and *B.cereus* (0.7%) respectively.

Investigation of level of bacterial contamination of ready to eat food (including cooked rice) products in retail shops and food factories in Japan has been carried out. The isolation rates for coliforms were 6.1-50% for intact vegetables and 50-66.7% for fresh products. *E.coli* was detected only in fresh products *B.cereus* was isolated from 20.1%(17 of 81)of the intact vegetables and 9.2%(8 of 87) of the fresh products [6].

The microbiological quality of cooked rice from restaurants and take away premises in the United Kingdom has been investigated by Nicholas et al [7]. 4,162 samples of cooked rice were examined including ready to eat rice purchased at point of sale and rice that was stored precooked for reheating on demand. It has been revealed that the prevalence of *Bacillus* species, *B.cereus* and *E.coli* was significantly greater in precooked stored rice than in point of sale cooked rice ($p < 0.05$). *Bacillus* species $\geq 10^4$ cfu/g were present in 7%, 2% and 9% of precooked stored samples respectively, compared to 2%, 0.5% and 1% respectively in point of sale samples. Moreover, 94% of point of sale cooked rice samples were of acceptable microbiological quality.

Microbiological study of ready to eat foods with added spices and spice ingredients has been carried out in the UK [8]. Total of 1946 samples were analysed and 66% were of satisfactory/acceptable quality. It has been revealed that 32% were of unsatisfactory and 2% were of unacceptable quality. Unsatisfactory results were mostly due to high Aerobic Plate Counts of up to $\geq 10^7$ cfu/g, Enterobacteriaceae $\geq 10^4$ cfu/g, *E.coli* $\geq 10^2$ cfu/g and *Bacillus* species $\geq 10^4$. Moreover *B.cereus* was present in 19% of samples [8].

In order to address the research gap of lack of investigations into microbial quality of Chinese style fried rice, a popular main meal variety of Sri Lankans present study was undertaken. Accordingly, this study aims to assess the food hygienic quality of Chinese style fried rice available in hotels, restaurants and take away outlets in Colombo city.

2. Methodology

2.1. Sample Size Calculation

Sample size was calculated using the standard Lwanga and Lemeshow formula for this descriptive cross sectional study [9].

2.2. Sampling Method

Systematic random and cluster sampling technique was used as described in details [10]

2.3. Ethical Approval

Ethical approval was obtained from ethical clearance committee, MRI, Colombo 08

2.4. Collection of Samples

200 Chinese style fried rice samples were collected as described previously [10,11].

2.5. Transport and Storage of Samples

Samples were transported without freezing and upon receipt in the laboratory they were stored at 4°C and analysis was begun as soon as possible.

2.6. Food Hygienic Quality of Chinese Style Fried Rice Was Assessed by Performing Aerobic Plate Count, Coliform Count, Faecal Coliform Count and E.coli Count

2.6.1. Aerobic Plate Count (10, 12)

The total aerobic plate count is useful for indicating the overall microbiological quality of a product and thus is useful for indicating the sanitary conditions under which the food was produced and or processed

Media

Plate Count Agar

0.1% peptone water

Method

Decimal dilutions were prepared from 10^{-1} to 10^{-6} . 1ml of each dilution was pipetted into separate duplicate, appropriately marked petri dishes. 20 ml of plate count agar (cooled (at 44- 40°C) was added to each plate, within 15 minutes of preparation of original dilution. Sample dilutions and agar medium were mixed thoroughly and uniformly. Agar plates allowed to solidify, plates were inverted and incubated at 35°C for 48hrs. After incubation duplicate plates having 25- 250 colonies were counted using the standard calculation [10,12].

2.6.2. Examination of Coliforms, Faecal Coliforms and E.coli in Chinese Style Fried Rice by the Most Probable Number(MPN) Method [12]

The MPN method use of a statistical technique for estimating the most probable number of bacteria per specific unit of material under test. In this method three serial dilutions were used and three tubes of medium were inoculated from each dilution.

2.6.2.1. Examination for Presumptive Coliforms

Media

0.1% peptone water

Mac Conkey Broth

Method

Three serial dilutions (10^{-1} to 10^{-3}) were prepared as described previously [11]. 10ml of each of the 10^{-1} dilution was pipetted into each of 3 separate tubes double strength Mac Conkey tubes. Each of 3 tubes of single strength of Mac Conkey broth (containing inverted Durham tubes) was inoculated with 1ml of the food homogenate (10^{-1}). Inoculated each of 3 tubes of single strength of Mac Conkey broth (containing inverted Durham tubes) with 1ml of the food homogenate (10^{-2}). All the Mac Conkey tubes were mixed by gentle rotation and incubated at 37°C for 48hrs.

Results

All tubes producing acid and gas were considered positive for the presence of presumptive coliforms. Acid production was indicated by changing purple colour to yellow colour. Gas was accumulated in the durham's tube.

2.6.2.2. Confirmation of Coliforms

Media

Brilliant green Bile (BGB) broth

Method

A loopful from each positives in 2.6.2.1 was subcultured to 10 ml quantities of BGB broth. Incubated at $37\pm 1^{\circ}\text{C}$ for 24-48 hrs.

Results

Any tube showing gas production and turbidity was considered as positive for confirmed coliforms.

2.6.2.3. Examination for Faecal Coliforms

Media

BGB broth

Method

A loopful from each of the positive tube in 2.6.2.2 was inoculated into 10ml quantities of BGB broth pre-warmed to $44\pm 0.1^{\circ}\text{C}$. Incubated at $44\pm 0.1^{\circ}\text{C}$ for 48hrs.

2.6.2.4. Examination for *Escherichia coli*

Media

BGB broth

Eosin Methylene Blue (EMB) agar

Peptone water

Kovacs reagent

Method

A loopful from each positive tube in 2.6.2.3 was streaked on EMB agar and incubated at $36\pm 1^{\circ}\text{C}$ for 24hrs.

Colonies with almost black centers and greenish metallic sheen were considered as the positive result for *E. coli*. Absence of such colonies was considered as the negative result. One positive colony from each plate was inoculated into separate tubes of peptone water and incubated at $44\pm 0.1^{\circ}\text{C}$ for 24-48hrs. Tested for the production of indole by adding Kovacs reagent.

Results

Positive for indole production indicated by red ring at the surface was considered as the positive result for *E. coli*.

The number of positive tubes in each step were counted. Number of coliforms, faecal coliforms and *E. coli* per ml or gram was determined using MPN table (SLS 516; part 3, 1982 as described previously [10]).

2.7. Data Processing and Statistical Analysis

Data processing and analysis were done using SPSS 26 statistical software Programme. Descriptive statistics were used as described previously [10].

3. Results

Food hygienic quality of Chinese style fried rice samples available in hotels restaurants and take away outlets in Colombo city is presented as follows.

3.1. Aerobic Plate Count

Table 14 shows Aerobic Plate counts of 39.50% samples were $> 10^5$ cfu/g. Mixed variety was shown the highest level of contamination 79.40% indicated by Aerobic Plate Count $> 10^5$ cfu/g.

Table 1. Aerobic Plate counts (APC) in different varieties of Chinese style fried rice.

Variety of fried rice	APC				Total number	
	$\leq 10^5/g$		$>10^5/g$			
	No	%	No	%	No	%
Vegetable	50	(71.40)	20	(28.60)	70	(100.0)
Chicken	31	(52.54)	28	(47.46)	59	(100.0)
Sea food	20	(55.56)	16	(44.44)	36	(100.0)
Egg	10	(55.60)	08	(44.40)	18	(100.0)
Beef	08	(80.00)	02	(20.0)	10	(100.0)
Mixed	02	(28.60)	05	(71.40)	07	(100.0)
Total	121	(60.50)	79	(39.50)	200	(100.0)

3.2. Estimation of Coliforms

According to Table 2, 24.0% of the total fried rice samples tested contained coliforms $>1,100/g$ of rice. Of all varieties, the highest percentage 27% of seafood samples contaminated with coliforms $>1,100/g$.

Table 2. Estimation of Coliforms, in different varieties of Chinese style fried rice.

Variety of fried rice	Range of Coliforms				Total number	
	$\leq 1,100/g$		$>1,100/g$			
	No	%	No	%	No	%
Vegetable	53	(75.70)	17	(24.30)	70	(100.0)
Chicken	44	(74.58)	15	(25.42)	59	(100.0)
Sea food	26	(73.00)	10	(27.00)	36	(100.0)
Egg	15	(83.33)	03	(16.67)	18	(100.0)
Beef	08	(80.00)	02	(20.0)	10	(100.0)
Mixed	06	(85.71)	01	(14.29)	07	(100.0)
Total	152	(76.00)	48	(24.00)	200	(100.0)

3.3. Faecal Coliform Count

As depicted in Table 3, 16% of total fried rice samples tested contained > 1, 100 faecal coliforms/g of fried rice. Beef variety was shown the highest percentage of contamination, 20% with faecal coliforms > 1100/g.

Table 3.

Variety of fried rice	Range of Faecal Coliforms				Total number	
	≤ 1,100/g		>1,100/g			
	No	%	No	%	No	%
Vegetable	59	(84.29)	11	(15.71)	70	(100.0)
Chicken	49	(83.05)	15	(16.95)	59	(100.0)
Sea food	29	(80.56)	07	(19.44)	36	(100.0)
Egg	17	(94.44)	01	(5.56)	18	(100.0)
Beef	08	(80.00)	02	(20.0)	10	(100.0)
Mixed	06	(85.71)	01	(14.29)	07	(100.0)
Total	168	(84.00)	32	(16.00)	200	(100.0)

3.4. E.coli Count

According to Table 4, *E.coli* was detected in 39.0% of fried rice samples tested and the highest percentage of positive samples were found in egg, 44.40% followed by vegetables 44.30% and mixed 42.90%.

Table 4. Estimation of *E.coli* in different varieties of Chinese style fried rice.

Variety of fried rice	Range of <i>E.coli</i>				Total number	
	<3/ not detected		≥3/detected			
	No	%	No	%	No	%
Vegetable	39	(55.70)	31	(44.30)	70	(100.0)
Chicken	40	(67.80)	19	(32.20)	59	(100.0)
Sea food	21	(58.33)	15	(41.67)	36	(100.0)
Egg	10	(55.60)	08	(44.40)	18	(100.0)

Beef	08	(80.00)	02	(20.0)	10	(100.0)
Mixed	04	(57.10)	03	(42.90)	07	(100.0)
Total	122	(61.00)	78	(39.00)	200	(100.0)

4. Discussion

This study revealed that Aerobic Plate Count of 39.50% (Table1) of fried rice samples were $>10^5$ which can be considered unsatisfactory according to 12th schedule of Singapore Microbiological standard for food (2002) as described previously [10], where there is no Sri Lankan standard. This finding is consistent with Bakar [2], who found the TPC had medium mean count ($6.30 \times 10^5 \pm 1.47 \times 10^5$ cfu/g) in a study conducted to find out the microbiological quality of ready-to-eat (RTE) fried rice dishes sold at different type of food premises in Kuantan city, Pahang. Our study on par with that of Warburton [4] who investigated current microbiological status of health food to sold in Canada

Moreover, findings of present study confirm with that of Little et al [8] because they reported 32% of ready to eat food with added spices or spice ingredients in UK were of unsatisfactory quality mostly due to the high Aerobic Colony Counts up $>10^7$ cfu/g.

In 24% of fried rice samples tested, high levels ($> 1,100$) of contamination of Coliforms were observed in the present study (Table2). Our finding confirms the previous finding of coliforms and *B.cereus* were found in tortillas before and after cooking [13]. Although, there is no Sri Lanka standard for fried rice, afore mentioned value was taken as the significant value of Coliforms as described previously [10]. Findings of present study is little higher than that of a study done in Canada [4], where the 16.0-17.8% health foods were exceeded Coliform guidelines. Generally Coliforms belong to the four genera *Escherichia*, *Citrobacter*, *Klebsiella* and *Enterobacter*. Generally Coliforms are heat sensitive having the D value of *E. coli* at 60°C in 45 seconds(1). Therefore, presence of Coliforms in fried rice indicates that they have derived from ingredients such as vegetables, meat, spices or due to contamination from sources such as utensils, hands, water, flies and other equipment. Excessive levels of Coliforms in cooked rice shows that basic hygiene measures have not been adhered during preparation.

According to Table 3, 32% of fried rice samples analyzed were contaminated with high count ($>1,100/g$) of faecal coliforms. It has been revealed that cooked food products including rice, if subjected to time-temperature abuse, contained high amounts of not only *Bacillus cereus* but also coliforms. Therefore, findings of present study support afore mentioned observation [10].

E. coli was detected in 39% of fried rice samples analyzed (Table 4) in the present study. This finding confirms with that of Nicholas et al [7] reported 9% of precooked stored rice samples contaminated with *E. coli* $> 10^2$ cfu/g. Findings of present study is clearly four fold greater than that of a study done in Finland by Hattaka [5], where 8.2% hot meals served by airline exceeded the minimum acceptable microbiological standards by the Association of European Airlines (AEA). *E.coli* indicates presence of faecal contamination in a food product and possible presence of foodborne pathogens such as *Salmonella*. Presence of *E.coli* in in such a high number of fried rice samples indicates that this commodity presents of health hazard to the consumer to pathogens other than *B.cereus* too.

Although there is no SLSI standard for fried rice *E.coli* is not tolerated in any kind of ready to eat food product. Therefore, it is evident that in the most establishments fried rice have been prepared under very poor hygienic conditions. Educating food handlers regarding these alarming findings is utmost importance.

5. Conclusion

In the present study Aerobic Plate counts of 39.50% samples were $> 10^5$ cfu/g. Furthermore, 24.50% of the total fried rice samples (200) tested contained ≥ 1.100 Coliforms/g of rice followed by

16% contained ≥ 1.100 Faecal Coliforms/g of rice. Alarming, *E.coli* was detected in 37.50% of the fried rice samples tested and the highest percentages of varieties contaminated were egg, vegetable and mixed.

6. Recommendations

Safe fried rice consumption for the 21st century without foodborne pathogens is possible. This scientific evidence should be transformed into meticulous compliance with food safety measures by owners, employees and consumers of food outlets. The services of PHIs who render their services on food safety are strongly recommended to improve the microbial quality of ready-to-eat food available for sale in food establishments of the Colombo city.

References

1. Jay JM, Loessner MJ, Golden DA. Modern food microbiology: Springer; 2005.
2. Bakar IA. Microbiological quality evaluation of fried rice sold at food premises in Kuantan city, Pahang. International Journal of Allied Health Sciences. 2018;2(1):285-91.
3. Noor N, Sabah A. A SURVEY STUDY TO ISOLATE SOME PATHOGENIC BACTERIA FOR COOKED RICE AT BAGHDAD CITY.
4. Warburton DW, Harrison B, Crawford C, Foster R, Fox C, Gour L, et al. Current microbiological status of health foods' sold in Canada. International journal of food microbiology. 1998;42(1-2):1-7.
5. Hatakka M. Microbiological quality of hot meals served by airlines. Journal of food protection. 1998;61(8):1052-6.
6. Kaneko K-I, Hayashidani H, Ohtomo Y, Kosuge J, Kato M, Takahashi K, et al. Bacterial contamination of ready-to-eat foods and fresh products in retail shops and food factories. Journal of food protection. 1999;62(6):644-9.
7. Nichols G, Little C, Mithani V, De Louvois J. The microbiological quality of cooked rice from restaurants and take-away premises in the United Kingdom. Journal of Food protection. 1999;62(8):877-82.
8. Little C, Omotoye R, Mitchell R. The microbiological quality of ready-to-eat foods with added spices. International journal of environmental health research. 2003;13(1):31-42.
9. Lwanga SK, Lemeshow S. Sample size determination in health studies. Geneva: World Health Organization. 1991;1.
10. Perera M. Prevalence of *B. cereus* in "Chinese style" fried rice available in hotels, restaurants and take away outlets in Colombo city 2003.
11. Perera ML, Ranasinghe GR. Prevalence of *Bacillus cereus* and associated risk factors in Chinese-style fried rice available in the city of Colombo, Sri Lanka. Foodborne pathogens and disease. 2012;9(2):125-31.
12. Manual BA. BAM. Food and Drug Administration. 2001.
13. Capparelli E, Mata L. Microflora of maize prepared as tortillas. Applied microbiology. 1975;29(6):802-6.

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