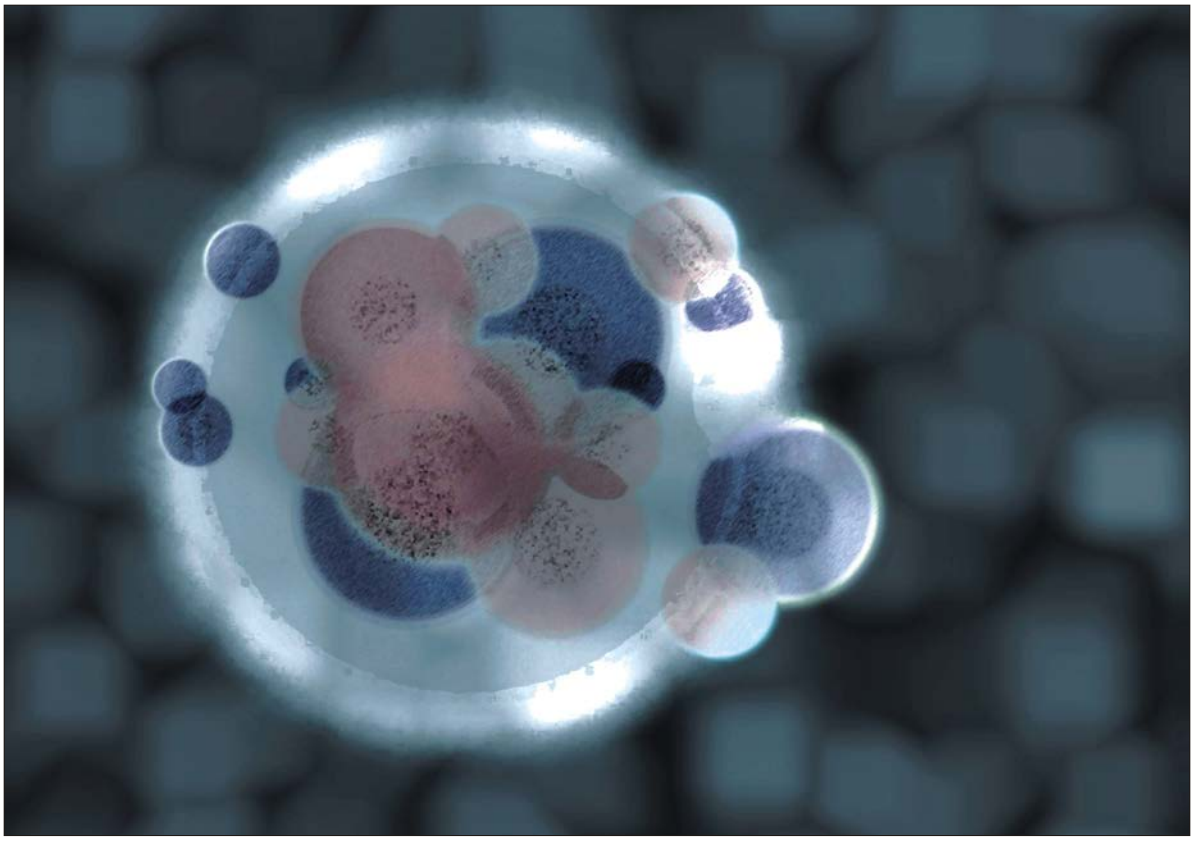

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Research Article
Traceability in the Meal Production Chain of Hospitalized Patients: Safety and Hygienic Quality

[1]Mohammed Abubaker Basalamah, [2]Mohammad Abd Elmoneim Elmadbouly and [2]Firas Sultan Azzeh

[1]Department of Pathology, Faculty of Medicine, Umm Al-Qura University, Holy Makkah, Saudi Arabia
[2]Department of Clinical Nutrition, Faculty of Applied Medical Sciences, Umm Al-Qura University, Holy Makkah, Saudi Arabia

Abstract

Objective: The objective of study was to investigate the safety and microbial quality of each stage of the patients' meals production chain to determine the critical control points to reduce, eliminate or prevent the possibility of a food safety hazard in two public hospitals in Mecca. This study also evaluated the Good Manufacturing Practices (GMP) and sanitation procedures in the hospitals. **Methodology:** A predesigned checklist was used to assess the GMP, sanitation and hygiene practices. Bacteriological examination including estimation of total Aerobic Plate Count (APC), enumeration of mould and yeast count and *Staphylococcus aureus* (*S. aureus*), *Escherichia coli* (*E. coli*) and *Salmonella* spp. were done according to the standard methods. Mann-Whitney test for non-parametric data was performed to determine the statistical differences of results between the two hospitals. **Results:** The GMP and sanitation procedures showed comparable values between both hospitals. No significant differences in the microbiological examinations were observed in the stages of receiving and storage of ingredients, preparation, cooking and collecting foods at the line between the two hospitals. Serving the meals to patients' stage showed significantly ($p = 0.036$) higher APC value in hospital 1 than hospital 2. *Staphylococcus aureus* and *E. coli* bacteria were not detected during the delivery of meals to patients but *Salmonella* spp. were found at this stage in cold served vegetable salad and coleslaw salad that contained mayonnaise. **Conclusion:** Hospital food workers should be trained to carefully handle food items that could possibly be contaminated with pathogenic microbes.

Key words: Pathogenic microbes, aerobic plate count, good manufacturing practices, yeast count, traceability

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Corresponding Author: Firas Sultan Azzeh, Department of Clinical Nutrition, Faculty of Applied Medical Sciences, Umm Al-Qura University, P.O. Box 7067, (21955) Makkah, Saudi Arabia Tel: +966-540833661 Fax: +966-25720000-4227

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Safety of hospitalized patients' meals is considered a very important issue because patients are at higher risk of getting infections that may hinder their recovery or cause grievous problems[1]. Implementing a good food safety program, such as Hazard Analysis and Critical Control Points (HACCP), in food service establishments could decrease the probability of any kind of contamination during processing and preparation of the meals and its delivery[2]. Unfortunately, many hospitals do not implement food safety measures efficiently in food service area; in a consequence, many outbreaks from contaminated foods have occurred in many countries[3-5].

Good Manufacturing Practices (GMP) of food service establishment is designed as a prerequisite program for HACCP and other quality or safety systems to protect foods from contamination and prevent cross-contamination between foods[6]. Knowledge about food safety and GMP among food workers in hospitals in developing countries is only fair[7,8]. Microbial contamination may occur at any stage of the production chain; receiving raw materials, cleaning, cooling, freezing, mincing, cutting, cooking, collecting foods at the line and during serving meals to patients[9]. To determine the possible stage(s) that foods may get contaminated, food safety during all previous stages should be evaluated and monitored. Therefore, the objective of study was designed to determine the microbial quality of each stage of the patients' meals during the production chain as well as to evaluate the GMP and sanitation procedures in two public hospitals in Mecca, Saudi Arabia.

MATERIALS AND METHODS

Study design and setting: This research was carried out in two general hospitals in Mecca from May, 2014-November, 2014, which contributes in finding and determining the possible stage of production chain that causing microbial contaminations to hospitalized patients' meal to improve the safety of such meals. The study had the ethical approval from both the Research Ethics Committees in Faculty of Applied Medical Sciences, University of Umm Al Qura and the Research Ethics Committees in Mecca Health Affairs Directorate. Sanitation and hygiene practices as well as microbial examinations of patients' meals were evaluated along all stages of the production chain including: Receiving and storage ofingredients, preparation, cooking, collecting foods at the line and serving the meal to patients.

Methods: The GMP, sanitation and hygiene practices were assessed using a predesigned checklist included 80 items representing 11 parameters are as follows: Personal hygiene, food preparation, hot holding, cold holding, refrigerator and freezer, food storage, cleaning and sanitizing, utensils and equipment, garbage storage and disposal and pest control. Each item complying with hygienic requirements was given ten points. On the other hand, the microbial examinations were assessed from all production chain stages of patient meal. One hundred and eighty samples of patients' meals from both hospitals were examined. A sample of about 100 g or 100 mL from each food item was aseptically collected in a sterile plastic container. The samples then were transported as soon as possible to the laboratory using an insulated ice box containing an ice pack. Ten-fold serial dilutions from each sample were prepared and subjected to the bacteriological examination including estimation total Aerobic Plate Count (APC), enumeration of mould and yeast count and detection for absence or presence of *S. aureus*, *E. coli* and *Salmonella* spp. according to the standard methods discussed by George *et al.*[10] and Roberts and Greenwood[11].

Statistical analysis: Data were analyzed using SPSS, version 20 (IBM Corp., Armonk, New York, USA). Mann-Whitney test for non-parametric data was performed to determine the statistical differences of results between the two hospitals. p-value less than 0.05 was considered statistically significant. Data were expressed in form of Mean±SD.

RESULTS

Table 1 shows the GMP and sanitation procedures' scores and percentages in the two hospitals. Results of the studied parameters displayed comparable values between both hospitals and no significant differences were observed in the total score between them (77.5 vs. 78.9%).

Table 2 demonstrates the comparison in colony forming unit per gram (CFU g^{-1}) of APC as well as moulds and yeasts counts in the selected foods during all stages of the production chain of patient meal in the two hospitals. No significant differences in the microbiological examinations were observed in the stages of receiving and storage of ingredients, preparation, cooking and collecting foods at the line between the two hospitals. Serving the meals to patients' stage showed significantly ($p = 0.036$) higher APC value in hospital 1 than hospital 2. It was observed that APC as well as moulds and yeast counts were higher at the first two stages of the production chain for both hospitals, then decreased at the cooking stage.

Table 1: Evaluation of GMP and sanitation procedures in the two hospitals

Parameter	Total score for each parameter	Hospital 1		Hospital 2	
		Score	%	Score	%
Personal hygiene	140	90	64.3	100	71.4
Food preparation	120	90	75.0	90	75.0
Hot holding	50	40	80.0	50	100.0
Cold holding	20	20	100.0	20	100.0
Refrigeration and freezing	90	70	77.8	70	77.8
Food storage	150	100	66.7	80	53.3
Cleaning and sanitizing	40	40	100.0	40	100.0
Utensils and equipments	120	100	83.3	110	91.7
Garbage storage and disposal	40	40	100.0	40	100.0
Pest control	30	30	100.0	30	100.0
Total	80	62	77.5	63	78.9

Table 2: Comparison of APC as well as moulds and yeasts counts in foods during the production and serving stages of patient meals in the two hospitals

Stage	Hospital	APC (CFU g^{-1}) Mean±SD	Moulds and yeasts (CFU g^{-1}) Mean±SD
Receiving and storage of ingredients	Hospital 1	$9.3\times10^{5}\pm0.9\times10^{6}$	$6.1\times10^{3}\pm3.6\times10^{4}$
	Hospital 2	$4.2\times10^{3}\pm0.9\times10^{4}$	$1.3\times10^{2}\pm3.5\times10^{2}$
	p-value	0.326	0.387
Preparation	Hospital 1	$8.3\times10^{4}\pm1.4\times10^{5}$	$<1\times10^{1}$
	Hospital 2	$2.2\times10^{5}\pm0.9\times10^{6}$	$1.5\times10^{3}\pm0.2\times10^{3}$
	p-value	0.482	0.466
Cooking	Hospital 1	$1.5\times10^{3}\pm0.6\times10^{3}$	$<1\times10^{1}$
	Hospital 2	$8.2\times10^{2}\pm2.6\times10^{3}$	$<1\times10^{1}$
	p-value	0.559	-
Meals at the line	Hospital 1	$2.5\times10^{3}\pm0.9\times10^{3}$	$1.6\times10^{1}\pm0.2\times10^{1}$
	Hospital 2	$1.5\times10^{3}\pm0.1\times10^{3}$	$2.9\times10^{1}\pm6\times10^{1}$
	p-value	0.751	0.483
Serving the meals to patients	Hospital 1	$3.5\times10^{3}\pm0.5\times10^{3}$	$<1\times10^{1}$
	Hospital 2	$1.6\times10^{2}\pm0.8\times10^{2}$	$<1\times10^{1}$
	p-value	0.036	-

Table 3: Detection of some food pathogens during the production and serving stages of patient meals in the two hospitals

Stages	Hospital	*Escherichia coli*	*Staphylococcus aureus*	*Salmonella* spp.
Receiving and storage of ingredients	Hospital 1	+ve	-ve	+ve
	Hospital 2	+ve	+ve	-ve
Preparation	Hospital 1	-ve	-ve	-ve
	Hospital 2	+ve	-ve	+ve
Cooking	Hospital 1	-ve	-ve	-ve
	Hospital 2	-ve	-ve	-ve
Meals at the line	Hospital 1	-ve	-ve	-ve
	Hospital 2	-ve	-ve	+ve
Serving the meals to patients	Hospital 1	-ve	-ve	-ve
	Hospital 2	-ve	-ve	+ve

Table 4: Comparison of the APC and *Salmonella* spp. counts between the two hospitals for hot and cold served foods from the last stage of the production chain

Hospitals	*Salmonella* spp. APC (CFU g^{-1}) Mean±SD			*Salmonella* spp. (CFU g^{-1}) Mean±SD		
	Cold served foods	Hot served foods	p-value	Cold served foods	Hot served foods	p-value
1	$7.7\times10^{3}\pm1\times10^{4}$	$4.4\times10^{2}\pm1.3\times10^{3}$	0.042	-ve	-ve	-
2	$2.4\times10^{2}\pm5.8\times10^{2}$	$<1\times10^{1}$	0.279	$3.3\times10^{3}\pm1.5\times10^{3}$	-ve	0.01

The presence or absence of *S. aureus*, *E. coli* and *Salmonella* spp. bacteria during the production and delivery stages of patient meal in the two hospitals was shown in Table 3. *Staphylococcus aureus* and *E. coli* bacteria were detected at the first two stages of the production chain but neither of these bacteria were detected after cooking of foods. On the other hand, *Salmonella* spp. were detected at all stages of the production stage except the cooking stage.

Table 4 presents a comparison of the APC and *Salmonella* spp. counts between the two hospitals for hot and cold served foods from the last stage of the production chain. In hospital 1, cold served foods had significantly ($p = 0.042$)

higher APC count than hot served foods and no *Salmonella* spp. were detected. However, hospital 2 showed higher APC counts for cold served foods than hot served foods but not statistically significant and *Salmonella* spp. count was significantly ($p<0.05$) higher in cold served foods than hot served foods. The cold served foods that showed the presence of *Salmonella* spp. were vegetable salad and coleslaw salad that contained mayonnaise.

DISCUSSION

This study aimed to determine the possible stages of the production chain that caused contamination to the patient meal and act as critical point at which control can be exercised to reduce, eliminate or prevent the possibility of a food safety hazard in two hospitals in Mecca region. The GMP and sanitation procedures between the two hospitals were implemented similarly. During the production chain of patient meal, cooking stage decreased the APC as well as moulds and yeast counts considerably but APC were detected during delivery of the meals to patients in one of the hospitals. At cooking and delivery stages, *S. aureus* and *E. coli* bacteria were not detected due to the cooking temperature. Although *Salmonella* spp. not detected in cooked and hot served foods, cold served foods showed presence of *Salmonella* spp. in vegetable salad and coleslaw salad that contained mayonnaise.

A possible contamination was detected during serving the meals to patients. Contaminations at this stage could happen by leaving prepared foods at an unsafe temperature for a long time at the pre-distribution stage, sick workers staying at work, food workers and handlers do not wash their hands carefully, foods contacted to contaminated surfaces, undercooked foods, using unclean trolleys, delaying the distribution of meals to hospital wards or unhygienic conditions at the hospital ward[12,13]. Several measures could be adopted to prevent or minimize food contamination, those are: Cold consumed food should be eaten within 30 min of removal from the storage area, the temperature of hot and cold served foods to patients should be kept above 63°C and below 8°C, respectively, maintaining clean and hygienic utensils and equipments and training food workers for proper GMP implementation all the time[14,15]. In addition, international standards recommend that the temperature throughout the cooked food should be held at 70°C for at least 2 min to destroy all pathogenic non-spore-forming bacteria[15].

Many food borne outbreaks in hospitals and health care settings have been reported causing deaths to patients. However, immune-compromise individuals are to be the most affected and deaths in hospital food borne outbreak, which are preventable by implementing proper food safety measures[16]. *E. coli* bacteria caused outbreaks in healthcare settings in Scotland[17], Canada[18] and USA[19] with 2 and 3 deaths in Canada and USA, respectively. Outbreaks from *Salmonella* spp. in hospitals also were noticed with 5 deaths in Netherlands[20] and 18 deaths in Australia[21]. The probable food carrier of these outbreaks from *E. coli* could be from undercooked foods, cross-contamination from raw to cooked foods, unpasteurized dairy products and fruit juices and raw vegetables and legumes[22]. While, the possible associated foods for *Salmonella* spp. outbreaks in hospitals were mainly from animal products as egg, poultry, meat, seafood as well as raw legumes, vegetables and fruits and unpasteurized juices[22]. The main carrier for *S. aureus* is the food handlers and contaminated utensils and equipments[23]. Study results showed that cooking decreased APC, moulds and yeast, *S. aureus*, *E. coli* and *Salmonella* spp. bacteria in foods noticeably. Moreover, *Salmonella* spp. or other bacteria were not detected in the hot served foods. On the other hand, *Salmonella* spp. bacteria were found in vegetable salad and coleslaw salad that contained mayonnaise. These dishes were delivered cold or at room temperature, which could be suitable carriers for pathogenic non-spore-forming bacteria such as *Salmonella.* So, appropriate corrective actions should be applied to prevent possible outbreak from these foods, changing the supplier of mayonnaise or raw egg and raw vegetables to more trusted and reliable companies, having a certificate of conformity to international and local standard specifications and performing continuous monitoring for the safety of these products. Furthermore, the cooking step as a most important stage in microbial reduction, should be monitored thoroughly by a validated thermometer to prevent the growth of any pathogenic microbes from undercooked foods.

CONCLUSION

Traceability in the meal production chain of hospitalized patients in two hospitals in Mecca showed that the microbial load was high in receiving and storage of foods and during the preparation stages, then cooking step decreased the microbial count remarkably. During serving the meals to patient, *Salmonella* spp. were found in vegetable salad and coleslaw salad that contained mayonnaise. Hospital workers should be trained to implement GMP precisely and they have to know the most important foods that could be contaminated with pathogenic microbes to be handled carefully.

SIGNIFICANCE STATEMENTS

This study determined the possible stage of the patient meal production chain that caused contamination to food items in two hospitals in Mecca region. The results indicated that no significant differences in the microbiological examinations were observed in the stages of receiving and storage of ingredients, preparation, cooking and collecting foods at the line between the two hospitals. Serving the meals to patients' stage showed remarkably higher APC values. Thus, this research could lead to a new theory on the importance of possible detection and the presence of higher microbial contamination during delivery the meals to patients and therefore, hygienic practices could be implemented to prevent any contamination at this stage.

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REFERENCES

1. El-Derea, H., E. Salem, M. Fawzi and M.A. Azeem, 2008. Safety of patient meals in 2 hospitals in Alexandria, Egypt before and after training of food handlers. Eastern Mediterr. Health J., 14: 941-952.
2. Buccheri, C., A. Casuccio, S. Giammanco, M. Giammanco, M. La Guardia and C. Mammina, 2007. Food safety in hospital: Knowledge, attitudes and practices of nursing staff of two hospitals in Sicily, Italy. BMC Health Serv. Res., Vol. 7. 10.1186/1472-6963-7-45.
3. Gould, D., E. Kraa, C.B. Dalton, R. Givney, J. Gregory, R.J. Stafford and M.D. Kirk, 2004. Foodborne disease outbreaks in Australia, 1995 to 2000. Communicable Dis. Intell. Q. Rep., 28: 211-224.
4. Van Duynhoven, Y.T.H.P., C.M. De Jager, L.M. Kortbeek, H. Vennema and M.P.G. Koopmans *et al*., 2005. A one-year intensified study of outbreaks of gastroenteritis in the Netherlands. Epidemiol. Infect., 133: 9-21.
5. Rumble, C., S. Addiman, S. Balasegaram, K. Chima, D. Ready, J. Heard and E. Alexander, 2017. Role of food handlers in norovirus outbreaks in London and South East England, 2013 to 2015. J. Food Prot., 80: 257-264.
6. Kim-Soon, N., L.H. Chin and A.R. Ahmad, 2017. Quality assurance practices of the food manufacturers in Malaysia. Adv. Sci. Lett., 23: 317-321.
7. Al-Mohaithef, M., 2014. Food hygiene in hospitals: Evaluating food safety knowledge, attitudes and practices of foodservice staff and prerequisite programs in Riyadh's hospitals, Saudi Arabia. Ph.D. Thesis, University of Birmingham, UK.
8. Osaili, T.M., B.A. Obeidat, W.A. Hajeer and A.A. Al-Nabulsi, 2017. Food safety knowledge among food service staff in hospitals in Jordan. Food Control, 78: 279-285.
9. Hartwell, H. and J.S. Edwards, 2001. A preliminary assessment of two hospital food service systems using parameters of food safety and consumer opinion. J. R. Soc. Promot. Health, 12: 236-242.
10. George, J.J., I.M. Robert and B. Ruth, 2001. FDA's Bacteriological Analytical Manual. AOAC International, Arlington, Virginia, USA.
11. Roberts, D. and M. Greenwood, 2003. Practical Food Microbiology. 3rd Edn., Blackwell Publishing Ltd., USA., ISBN-13: 9781405100755, Pages: 294.
12. Tessema, A.G., K.A. Gelaye and D.H. Chercos, 2014. Factors affecting food handling practices among food handlers of Dangila town food and drink establishments, North West Ethiopia. BMC Public Health, Vol. 14. 10.1186/1471-2458-14-571.
13. Adikari, A.M.N.T., M.S.F. Rizana and T.P. Amarasekara, 2016. Food safety practices in a teaching hospital in Sri Lanka. Procedia Food Sci., 6: 65-67.
14. Engelund, E.H., A. Lassen and B.E. Mikkelsen, 2007. The modernization of hospital food service-findings from a longitudinal study of technology trends in Danish hospitals. Nutr. Food Sci., 37: 90-99.
15. Lund, B.M. and S.J. O'Brien, 2009. Microbiological safety of food in hospitals and other healthcare settings. J. Hospital Infect., 73: 109-120.
16. Meakins, S.M., G.K. Adak, B.A. Lopman and S.J. O'Brien, 2003. General outbreaks of infectious intestinal disease (IID) in hospitals, England and Wales, 1992-2000. J. Hosp. Infect., 53: 1-5.
17. O'Brien, S.J., P.S. Murdoch, A.H. Riley, I. King and M. Barr *et al*., 2001. A foodborne outbreak of Vero cytotoxin-producing *Escherichia coli* O157: H-phage type 8 in hospital. J. Hospital Infect., 49: 167-172.
18. Bolduc, D., L.F. Srour, L. Sweet, A. Neatby, E. Galanis, S. Isaacs and G. Lim, 2004. Severe outbreak of *Escherichia coli* O157:H7 in health care institutions in Charlottetown, Prince Edward Island, Fall, 2002. Can. Commun. Dis. Rep., 30: 81-88.
19. Reiss, G., P. Kunz, D. Koin and E.B. Keefe, 2006. *Escherichia coli* O157:H7 infection in nursing homes: Review of literature and report of recent outbreak. J. Am. Geriatr. Soc., 54: 680-684.

20. M.J. Bruins, T.M.A. Fernandes, G.J.H.M. Ruijs, M.J.H.M. Wolfhagen, J.M van Rijn-van Berkel, B.E. Schenk and Y.T.H.P. van Duynhoven, 2003. Detection of a nosocomial outbreak of salmonellosis may be delayed by application of a protocol for rejection of stool cultures. J. Hosp. Infect., 54: 93-98.
21. Cowell, D., S. Cameron, I.G. Tribe and P. Cameron, 2002. An outbreak of *Salmonella typhimurium* phage type 135 infection linked to the consumption of raw shell eggs in an aged care facility. Communicable Dis. Intell. Q. Rep., 26: 38-39.
22. Lund, B.M., 2008. Properties of Microorganisms that Cause Foodborne Disease. In: The Microbiological Safety of Food in Healthcare Settings, Lund, B.M. and P.R. Hunter (Eds.). John Wiley and Sons, New York, ISBN: 9780470698020, pp: 212-233.
23. Soares, M.J.S., N.H. Tokumaru-Miyazaki, A.L.S. Noleto and A.M.S. Figueired, 1997. Enterotoxin production by *Staphylococcus aureus* clones and detection of Brazilian epidemic MRSA clone (III::B:A) among isolates from food handlers. J. Med. Microbiol., 46: 214-221.