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Personal Hygiene Practices of Food Handlers and the Bacteriological Quality (*Escherichia coli*) of the Vegetable Salad in Private Hospitals' in Mombasa County

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Abstract

Consumption of fresh vegetable salad has increased all around the world. Many consumers strive to eat healthy diets to protect themselves from illnesses such as cancer, cardiovascular disease, and obesity. Besides the health benefits, vegetable salad has been associated with outbreaks of food borne disease in many countries. Various health problems can arise from the consumption of contaminated prepared salad if hygiene practices are not adhered to. The study assessed the relationship between the personal hygiene of the food handlers and the bacteriological quality of the vegetable salad in registered private hospitals' in Mombasa County. Laboratory tests were carried out to isolate and identify *Escherichia coli strains* from 180 prepared homogenate samples from carrots, tomatoes, and lettuce using standard media, biochemical tests and serology where applicable. Cultures were only considered positive when unsatisfactory limits were met, that is, $E.\ coli \geq 10^{2}\ cfu/g$. An observation method was used to assess the personal hygiene practices of 135 food handlers in private hospitals. *Escherichia coli* organism was predominantly present in the vegetable salad cultures. *Escherichia coli* in tomato samples; before washing 11.7 (%); preparation stage 8.3 (%) and service stage 13.3 (%). In lettuce samples, *Escherichia coli* isolated: before washing 31.7 (%); preparation stage 8.3 (%) and service stage 13.3(%). While in carrot samples: before washing 25 (%); preparation stage 10 (%) and service stage 18.3(%). Results of the Multiple linear regression analysis indicated an overall significant causal relationship between the personal hygiene of the food handlers {Personal Protective Equipment use (scale 5-1), Good grooming (scale 5-1), good practice (scale 5-1), Hand Hygiene (scale 5-1), physical examination (scale 5-1)} and the bacteriological quality of the vegetable salad in private hospitals in Mombasa County. The study recommends that the Ministry of Health, in particular the public health department should identify a monitoring and surveillance team to carry out spot checks on food production areas

and assess their capacity in terms of personnel, facilities and equipment. There is need to carry out regular analysis of hand swabs from the food handlers.

Keywords: *Personal Hygiene, Food Handlers, Bacteriological Quality, Escherichia coli & Vegetable Salad.*

1.1 Background of the Study

Personal hygiene is an indispensable part of food quality and safety for all vegetable salad handlers (Garayoa, Abundancia, Leturia & Vitas, 2017). Therefore, good personal hygiene, working habits and physical health of food handlers is essential (Kariuki, Ng'ang'a & Wanzala, 2017)

During the preparation of vegetable salads, the correct selection and use of appropriate tools and equipment for each assigned task is critical to the quality of vegetables (Akusu, Kabari, & Wemedo, 2016). Hygienic cleaning methods and tools can protect human health and safety, therefore cleaning is essential in maintaining efficient, clean and compliant facilities (Githiri, Kimiywe & Okemo, 2013). Proper cleaning also helps control internal hygiene and mitigates cross-contamination at every stage. It is also important to ensure that proper tools are used in addition to thorough cleaning and correct storage methods.

Food safety and food-borne disease issues have also proven to be critical in some hospital food-borne disease outbreaks. (Buccheri, *et al*., 2007). Patients could be more vulnerable to diseases and extra care should be taken. Emphasis should therefore be put on the production of safe food for hospitalized patients as contaminated food can have a detrimental effect on their recovery (Derea, Salem, Fawzi & Azeem, 2008). Compliance with the Codex Alimentarius standards is also required.

Diarrhoea is rated among the highest causes of outpatient morbidity (CDC Annual Report, 2018). Food borne diseases especially those caused by pathogens continue to prevail with incidences being reported each year in National morbidity and mortality reports (Ministry of Health [MOH], 2000). Public hospitals in different parts of the country recorded 343 *Escherichia coli* food contamination cases that led to 14 deaths. In Kenya, diarrhoeal reported cases were 3,967 with 76 deaths with in 20 counties (43%) out of the 47 counties (CDC Kenya, 2017

Vegetables are exposed to soil, dust and contaminated water during harvest or post-harvest processing and this can lead to microbial contamination of vegetables (Hardoim *et al*., 2015). Vegetables can contain many types of microorganisms, such as *Escherichia coli* (Kariuki *et al*., 2017). These pathogens have been identified as the most common ones found in raw vegetable salad due to poor food handling practices (Mritunjay & Kumar, 2017). The vegetable salads handlers must therefore practice high standards of personal hygiene to ensure that that the vegetables are not contaminated with pathogenic microorganisms

Research on foodborne illness risk factors has shown that the majority of outbreaks associated with food service establishments can be attributed to improper food preparation operations by food handlers (Hertzman & Barrash, 2007). Studies around the world have also linked vegetable salads to food-borne disease outbreaks (Correia *et al*., 2017). Pathogens such as *E. coli O157:H7* has been isolated from various fresh produce such as lettuce, tomatoes and carrots (Dhiraputra *et al*., 2005a). So far, there is little evidence of studies on vegetable salad consumed in hospitals, more so, private hospitals in Kenya, and especially in Mombasa County.

These private hospitals are a major referral for both local and international tourists visiting the region whose care may have an impact on the destination. However, a study of cooked food in a Kenyan public hospital showed that the food that food handlers provided to patients was contaminated (Githiri Okemo & Kimiywe, 2010). This could have been due to lack of training in food hygiene practices. Because the vegetable salad is eaten raw, the bacteriological quality of the salad served to patients in the hospitals could be compromised during preparation, storage, and service if the correct temperatures and handling practices are not observed. The probability of contamination of the vegetable salad served in hospitals in Mombasa County may also be heightened due to the high temperatures in the region (average 32°C). Most of the vegetables consumed in Mombasa County are also transported from other counties hence; the quality of the vegetables could also be compromised if the transportation trucks do not meet the food safety standards. In line with the above this study sought to assess the personal hygiene of the food handlers and the bacteriological quality of the vegetable salad served in the private hospitals in Mombasa County, Kenya.

1.2 Objective of the Study

To establish the relationship between the personal hygiene of the food handlers and the bacteriological quality of the vegetable salad in private hospitals' in Mombasa County.

1.3 Null Hypotheses

H_0: There is no significant relationship between the food handlers' personal hygiene and the bacteriological quality of the vegetable salad in private hospitals in Mombasa County.

2.0 Literature Review

2.1 *Escherichia coli (E.coli)*

Escherichia coli (E. coli) was discovered after Theodor Escherich was isolated it from the faeces of new-borns in 1885 (Aryal, 2020). *Escherichia coli* is a gram-negative bacterium that parasitizes the gastrointestinal tract. However, most strains do not cause disease. (National Centre for Emerging and Zoonotic Infectious Diseases (NCEZID), 2019)

E. coli, originally known as Bacterium coli is widely distributed in the intestine of humans and warm-blooded animals (Feng, Weagant, Grant & Burkhardt, 2002). It is the main facultative anaerobic bacteria of the intestine and is part of the intestinal flora necessary to maintain the physiological function of a healthy host. Although most strains of *E. coli* are not considered pathogens, they can be opportunistic pathogens that cause infections in immunosuppressed hosts.

There are also pathogenic strains of *E. coli*, such as *E. coli* 0157: H7, which when ingested can cause gastrointestinal diseases in healthy people. *E coli* is an indicator of faecal contamination because it is abundant in human and animal faeces. (Feng *et al*., 2002). The presence of *E. coli* in food samples indicates the presence of faecal contamination and improper hygiene practices in food handlers. However, they generally do not cause foodborne illness in humans (Bakobie *et al*, 2017).

According to the Winnipeg Regional Health Department (2005), this bacterium is acquired by eating foods that contain it. If an infected person does not wash their hands after going to the toilet, human-to-human transmission will occur. Contamination of the environment, counter tops and dish cloths may also be a source of infection.

World Health Organization *E.coli* fact sheet (2018) states that people infected by *E. coli* can develop a range of symptoms. Symptoms usually appear about five days after exposure; the range is 2 to 10 days. Some infected people may have mild diarrhoea or no symptoms. Most confirmed cases will have severe diarrhoea and abdominal cramps, vomiting, and blood in the stool. There is usually little or no fever. Most people get better in 5 to 7 days. Some infections are very mild, but some infections are serious and even life-threatening.

E. coli infection can be prevented by practicing proper personal hygiene. Hands should be washed carefully with soap after using the toilet. Working table tops and dish cloths should be properly cleaned especially after preparation of raw beef (WHO Fact Sheet 2018).

2.2 Personal Hygiene Practices of Food handlers and bacteriological quality of vegetable salad

Lack of personal hygiene among food handlers is one of the most common practices that cause foodborne illness (Sylvia, RoseAnn & John, 2015). Food handling areas must be restricted and no person known or suspected to have or carry a disease should be allowed to enter. This helps lower the likelihood of the transition of the pathogens to the vegetables. Vegetable salads are a microbiological risk food because they are eaten raw (Suslow et al., 2003). Strict hygiene measures must be taken from the field to the table, because compared with cooked food, no single step can guarantee the complete removal of potential pathogenic microorganisms in its ingredients (Suslow *et al*., 2003).

Good personal hygiene can also prevent the spread of microorganisms that cause food spoilage (Kariuki *et al*., 2017). In addition, the use of suitable protective clothing can help minimize vegetable contamination (Odetokun & Adetunji, 2016). Improper handling by food handlers and neglect of sanitation measures may allow pathogenic bacteria to come into contact with food (Baş, Ersun and Kıvanç, 2006). In addition, in some cases, microbial food safety has not been routinely implemented due to lack of infrastructure and effective food safety regulations and standards.

Ali and Immanuel (2017) conducted a case study on two kitchens hostels for women at the Sam Higginbottom University of Agricultural Science and Technology (SHUATS) in Allahabad, India. Hygiene practices and microbiological quality of food in institutional food service establishments were evaluated. A questionnaire on knowledge, attitudes and practices in food safety was carried out among 25 food handlers who worked in two kitchens. 18 (72%) came from the old women hostel kitchen and 7 (28%) came from the new kitchen. 72 cooked food samples (36 per kitchen) were analysed for evidence of contamination (total aerobic mesophilic bacteria, coliforms and *E. coli*). Total aerobic colony counts (APC), coliforms, and unacceptably high levels of *E. coli* were found in all cooked food samples. Other survey results showed that most food handlers did not show good food handling practises or adequate personal hygiene. This was due to their poor knowledge and attitude towards food safety. It was recommended to strictly supervise and implement food safety regulations, and regularly train on personal hygiene and good food handling practices.
From the above study, it is evident that lack of knowledge about food safety can lead to poor food handling and poor personal hygiene.

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3.0 Research Methodology

3.1 Research Design

The study was conducted in Mombasa County, which is one of the 47 counties of Kenya. It is also an urban city-county with both local and immigrant communities with a population of 939,370 (KNBS, 2012).

An informal experimental design was used to measure the bacteriological quality of the vegetable salad which comprised of 180 samples from carrots, lettuce and tomatoes. An observation method was used to assess the personal hygiene practices of 135 food handlers in 5 registered private hospitals in Mombasa County. Observation was done from the time the vegetable items were received/delivered from the approved suppliers to the time it was served to the patients. Vegetable salad samples were collected, tested, observed, and documented. An observation check-list was used to collect information about the food handler's hygiene practices in the private hospitals

3.2 Data Collection Techniques and Procedure

Clean protective clothing approved by the hospitals was used and correct personal hygiene observed. Observation was done from the time the vegetable items were received/delivered from the approved suppliers to the time it was served to the patients. An observation check-list was used to collect information about the food handler's hygiene practices in the private hospitals. Vegetable samples were collected on the same day as the participant observation. Vegetable salad samples were collected, tested, observed, and documented.

Samples were collected at each stage of the food chain that is before washing, during preparation and service stage. Samples from the vegetable items (carrots, tomatoes, and lettuce) were collected before washing from the individual containers using sterile gloves to avoid any cross-contamination. After washing/slicing /shredding, each vegetable item was mixed and a sample of not more than 25 grams collected using the food handlers' equipment. Each vegetable item was held in individual bowls before plating. Vegetable samples were collected using a sterile scoop. All the prepared vegetable salad was arranged in individual plates. The collected samples were put in labelled sterile leak-proof containers and coded appropriately according to location, date, and sample number. The samples were immediately put into a cooler box that had been sterilized using 70% ethanol and, containing ice cubes with temperatures not exceeding 8°C. This was to prevent bacterial multiplication during sample transportation to the laboratory. Upon arrival, the samples were immediately transferred to a refrigerator at a temperature not higher than 4°C and microbiological analysis was started within 24 hours after the samples collection.

Vegetable salad samples were tested and the bacteria identified using the morphological characteristic, colony characteristic, and biochemical test. The acceptable microbial load chart as propounded by Centre for food safety (2014) was used to report the findings (Table 1)

Table 1: Acceptable Microbial Load Chart

Criterion	Satisfactory	Borderline	Unsatisfactory: potentially injurious to health and/or unfit for human consumption
Escherichia coli	n.d. in 25g	N/A	Detected in 25g

Result (colony-forming unit (cfu)/g)

Key: n.d. = not detected; N/A = not applicable

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3.3 Data Analysis

Regression analysis was used to test the relationship between personal hygiene of the food handlers and the bacteriological quality of vegetable salad. Shapiro – wilk test was used to test if the data was normally distributed, when the test value was greater than 0.05, the data was considered to be normally distributed, on the other hand, if it was below 0.05, the data was considered significantly deviated from the normal distribution.

4.0 Results and Findings

Table 2: Results of the isolation and identification of *Escherichia coli* from the fresh vegetable salad in private hospitals in Mombasa County

VEGETABLE SALAD	BACTERIA	TESTING STAGES	BACTERIA POSITIVE CULTURE RESULTS																		BACTERIA POSITIVE (%)	
			Hospital 1				Hospital 2				Hospital 3				Hospital 4				Hospital 5				Per Testing Stage	Overall
			Month 1		Month 2		Month 1		Month 2		Month 1		Month 2		Month 1		Month 2		Month 1		Month 2			
			V1	V2	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2		
Tomato	*Escherichia coli*	**Before *(S1)***	0	1	0	0	0	0	0	1	1	1	0	0	1	0	0	0	1	0	0	1	11.7%	**33.3%**
		Preparation *(S2)*	0	0	1	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	8.3%	
		Service *(S3)*	0	1	0	0	0	0	1	0	0	0	1	0	1	0	1	0	1	1	0	1	13.3%	
		Preparation *(S2)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	
		Service *(S3)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	
Lettuce	*Escherichia coli*	**Before *(S1)***	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	31.7%	**53.3%**
		Preparation *(S2)*	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	8.3%	
		Service *(S3)*	0	1	0	1	1	1	0	1	0	0	1	0	0	1	0	0	0	0	0	1	13.3%	
		Preparation *(S2)*	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3.3%	
		Service *(S3)*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1.7%	
Carrots	*Escherichia coli*	**Before (*S1)***	1	1	1	0	1	1	0	1	1	1	1	0	1	1	1	0	1	1	0	1	25%	**53.3%**
		Preparation *(S2)*	0	0	0	0	6	1	0	1	0	0	1	0	0	0	1	0	0	1	1	0	10%	
		Service *(S3)*	1	1	1	1	0	0	1	0	0	0	1	0	1	0	1	1	0	1	0	1	18.3%	
		Preparation *(S2)*	1	0	0	0	1	0	1	0	0	1	0	0	0	1	0	1	0	1	0	0	11.7%	
		Service *(S3)*	1	1	0	0	1	1	0	1	1	0	0	1	0	1	0	1	0	1	0	1	18.3%	

1. Results were considered positive when; *Escherichia coli (E.coli)* $\geq 10^2$ cfu /g
2. S1, S2 and S3=Sample 1, Sample 2 and Sample 3 respectively.
3. V1 and V2 = Visit 1 and Visit 2 respectively.
4. 1=Positive culture; and 0= Negative results

Table 2 shows the results of the isolation and identification of *Escherichia coli* from the fresh vegetable salad in private hospitals in Mombasa County. A total of 180 samples were tested from tomatoes, lettuce and carrots Cultures were only considered positive when unsatisfactory limits were met, that is, *E. coli* $\geq 10^2$ cfu /g as per the Microbiological Guidelines for Food, For ready-to-eat food in general and specific food items, Centre for food safety, (2014). *Escherichia coli* was isolated from all the testing stages in all the vegetable salads. *Escherichia coli* in tomato: before washing was 11.7 (%); preparation stage 8.3 (%) and service stage 13.3

(%). The findings show that some of the samples tested were contaminated. Other studies have depicted that, despite the health benefits of fresh vegetables, their consumption has also been associated with risk for consumers (Weldezgina & Muleta, 2016). On the other hand, *Escherichia coli*, isolated in lettuce were: before washing 31.7 (%); preparation stage 8.3 (%) and service stage 13.3(%).
Finally, in carrots: *Escherichia coli*; before washing 25 (%); preparation stage 10 (%) and service stage 18.3 (%). In all the stages, the first stage, (before washing) had the highest number of bacteria isolated with: Tomato 11.7 (%), 31.7 (%) in lettuce and 21.7 (%) in carrots. Fresh vegetable samples before cleaning were found to be contaminated with viable aerobic bacteria, Dhiraputra et al., (2005b). Karuiki et al., (2017) also, indicated that vegetables can harbour a large variety of micro-organisms such as *Escherichia coli.*

Culture results indicated that the three vegetable salads (Tomato, Lettuce and Carrots) in all of the five hospitals sampled had *Escherichia coli. Escherichia coli* was isolated in 33.3(%) of the tomato samples; 53.3(%) in lettuce and 53.3(%) in carrots. From this study, carrots and lettuce had the highest positive cultures of *Escherichia coli* 53.3(%) while tomatoes had 33.3%. Similar findings were noted in a study conducted in Port Harcourt metropolis, Nigeria (Nma, et al., 2013), on the prevalence of *Escherichia Coli* and *Salmonella* spp. and in commonly consumed lettuce and cabbage vegetables sold in Port Harcourt metropolis, Nigeria. Out of the 14 samples, 12 (85.7%) to *Escherichia coli* and 6(42.9%) tested positive to *Salmonella* spp.

These findings concur with those of Mritunjay and Kumar (2017), where *Escherichia coli* pathogens were common in raw vegetable salad due to poor food handling practices. In addition, carrots had a higher mean count of coliforms in the study. Other studies have also revealed the potential hazard of ready-to-eat salads even after being washed three times (Kuddus et al., 2016.)
Findings of Berrada et al., (2016) stated that a high number of salads of all categories classified as unsatisfactory were contaminated with *E. coli*. Vegetable salad sampled from the restaurants located within Okadatown, Edo state, also harboured a high microbial load (Osamwonyi et al., 2013). There were similar findings in a study that evaluated the microbiological quality of salads (*Kachumbari*) served around Egerton University, Kenya. Approximately 80% of the samples tested positive for *E. coli* (Kibitok & Nduko, 2016). According to some studies (Callejón et al., 2015), *Escherichia coli* was found to be the second most common pathogen identified in a similar research in the United States. However, this disagrees with this research finding which identified *Escherichia coli* as the most predominant bacteria common in vegetable salad cultures. Microbial levels detected in ready-to-eat foods examined in a study by Rodríguez-Caturla et al., (2012) indicated the absence of pathogens in the vegetable samples analysed**.**

Overall, this study concurs with the findings of Weldezgina and Muleta (2016) that, despite the health benefits of fresh vegetables, their consumption has also been associated with risk for consumers. If vegetable salad is not prepared hygienically, it can become a vehicle for the transmission of pathogenic micro-organisms associated with human diseases as also mentioned in other studies (Said, 2012).

4.1 The causal relationship between the personal hygiene of the food handlers and the bacteriological quality of the vegetable salad.
Multiple regression analysis was used to test the causal relationship between the personal hygiene of the food handlers' independent variables: Personal Protective Equipment use (scale

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5-1), Good grooming (scale 5-1), Good Practice (scale 5-1), Hand Hygiene (scale 5-1), Physical Examination (scale 5-1) and the dependent variable *Escherichia coli.*

Table 3 shows the results of the causal relationship between the personal hygiene of the food handlers and the bacteriological quality (*Escherichia coli*) of vegetable salad in private hospitals' in Mombasa County. Shapiro-Wilk test for normal distribution indicated that the independent variables were not normally distributed {reject normality (P=0.0066)}.

Table 3: Results of the causal relationship between the personal hygiene of the food handlers and the bacteriological quality (*E. coli* level) of vegetable salad

Regression Equation				**Least squares multiple regression**			**Analysis of Variance**		**Test for Normal distribution** (Shapiro-Wilk test)
Independent variables	Coefficient	T	P	N	Coefficient of determination R^2	Multiple correlation coefficient	F-ratio	Significance level	
(Constant)	98.0598			135	0.5835	0.7638	36.1383	**P<0.0001**	Reject Normality (P=0.0066)
Good grooming Scale 5-1	-10.0519	-4.986	**<0.0001**						
Good Practice Scale 5-1	-3.5698	-1.246	0.2150						
Hand Hygiene Scale 5-1	0.9562	0.461	0.6456						
Physical Exam scale 5-1	-0.5832	-0.241	0.8099						
PPE use Scale 5 -1	-5.9747	-1.969	0.0511						

Multiple regression, dependent Y is E. coli ≥10 ^{2} cfu /g Positive and in X are five personal hygiene independent variables in Scale 5-1.

4.2 Discussion of the findings

The results of multiple linear regression analysis was used to explain the causal relationship between the personal hygiene of the food handlers and the bacteriological quality (*Escherichia coli* level) of vegetable salad in private hospitals' in Mombasa County. The overall model explained 58% of the variation in the dependent variable (*Escherichia coli).* This was significantly useful in explaining the personal hygiene of the food handlers and the quality of the vegetable salad (*Escherichia coli* level) in private hospitals', with Analysis of Variance (ANOVA) indicating Significance Level F= 36.4253, P<0.0001.

Only one independent variable, Good grooming (scale 5-1) t = -4.986, P < 0.0001 showed significant effect on quality of vegetable (*Escherichia coli* level), on the other hand Good Practice (scale 5-1) t =-1.246, P < 0.2150; Hand Hygiene (scale 5-1) t =0.461, P < 0.6456; Physical Examination (scale 5-1) t = -0.241, P < 0.8099 and Personal Protective Equipment use (scale 5-1) t = -1.969, P < 0.0511, showed no significant effect. Some studies have found that the presence of *E. coli* in food samples indicates the presence of faecal contamination and improper hygiene practices of food handlers (Abakari *et al*., 2018). In another study, the majority of food handlers did not practice proper personal hygiene and good food handling habits because they had little knowledge and attitudes about food safety. The total aerobic

bacteria count (APC), coliform and *E. coli* levels of all analysed cooked food samples were above the acceptable level (Ali & Immanuel, 2017).

5.1 Conclusion

The study concluded that there were overall significant causal relationship between the personal hygiene of the food handlers and bacteriological quality of the vegetable salad in private hospitals' in Mombasa County.

6.1 Recommendations

The study recommends that the Ministry of Health, in particular the public health department should identify a monitoring and surveillance team to carry out spot checks on food production areas and assess their capacity in terms of personnel, facilities and equipment. Further, Hospitals should carry out routine sampling of the ready to eat foods especially the vegetable salads. The results help identify micro-organisms related with the vegetables and corrective action made. Finally, there is need to carry out regular analysis of hand swabs from the food handlers. The results obtained can help raise awareness, adopt better control strategies to prevent outbreaks of foodborne diseases and promote food safety.

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