SUST
Journal of Agricultural and Veterinary Sciences
Journal homepage:
http:// journals.sustech.edu

Assessment of the Quality of Food Services for Oranges Fruits Provided in Hospitals at Khartoum and Omdurman States

M. A. Mustafa[1], Khadir E. K. Abdelhakam[2], Fatin H.O. Farahat[3], Shafag H. M. Suliman[4] and Nada M.ElKhir[5]

1 Department of Nutrition and Food Technology, Faculty of Science and Technology, Omdurman Islamic University, Omdurman, Sudan
2,3 Department of Food Science and Technology, Faculty of Agriculture, Omdurman Islamic University, Omdurman, Sudan.
4 Department of Food Science and Technology, Faculty of Agriculture, the International University of Africa
5 Department of Biology.Faculty of Science and Art .Al Baha University Al makhwah Saudi Arabia
Corresponding author: Fatin Hassan Osman Farahat E.mail: fatin.farahat@ hotmail .com
P.Box 382 sudan. Omdurman

Received: March 2022 **Accepted: October 2022**

Abstract

This study aimed to assess the quality of food services provided to patients in hospitals and identify causes of quality problems in fruits. Samples of oranges fruits were collected for the study. Four hospitals in Khartoum and Omdurman were selected, two of which were private (Royal Care and Alamal) and two were governments (Omdurman and Alnaow). To identify the cause of the change in nutritional value and food quality, samples were collected throughout the food chain in hospitals raw food phase, storage phase, preparation phase, treatment phase, and presentation phase. The physiochemical properties moisture, protein, oil, ash, acidity, and pH were measured, with the highest value (37.31%) at Omdurman Hospital and the lowest value (84.01%) at Alamal Hospital for humidity in the preparation stage. In the storage phase, the Royal Care Hospital had the highest protein record of 0.32%, and in the preparation phase, Alnaow Hospital had record the lowest at 0.15%, The highest oil measurement rate in the treatment phase was 0.66% at Alnaow Hospital, at least in the preparation phase, and 0.11% at the Royal Care Hospital, and the highest ash measurement rate in the presentation phase was 0.32% at Royal Care Hospitals, at least in the presentation phase at Alnaow Hospital. The highest pH rate in the presentation stage was 0.61% at Royal Care Hospital, at least at the stage. Treatment at Alamal Hospital is 0.26%. In comparison, Alamal Hospital treated at 0.26%. The highest pH measurement rate at Alamal Hospital was 4.60 % during the treatment phase, and the lowest was 4.25 percent during the presentation stage. Bacterial count showed a significant decrease ($P \leq 0.05$) during each stage. At all stages of the food chain, the level of yeast, mold, colon bacteria, and salmonella did not differ statistically. In light of the above, it was clear that the health safety associated with these hospitals was satisfactory.

Keywords: orange, hospital, food service, food chain, bacteria, yeast and mold

Introduction

A hospital foodservice system consists of preparing food for hospital patients as well as hospital cafeteria patrons (doctors, nurses, staff, and visitors). Conceptually, the cafeteria and patient meals components of the foodservice system can be considered separately since the food prepared for patients is, in general, different from food served in the cafeteria. Patient food is prepared to meet medical and nutritional requirements and would not sell well in the cafeteria. (Olney, 2003).The focus of this thesis is the patient meals components of the foodservice system. The patient meals component can be broken down into preparation and serving methods. Meal preparation involves making a variety of food in large quantities. In many hospitals, the staff that prepares the cafeteria food and the staff that prepares the patient meals are one and the same(Abdul-Rashid, *et al*. 2022). The equipment is commonly shared; therefore, a large amount of planning must be done to organize the utilization of the equipment and labor for each meal. The serving methods for patient meals include the process of taking patient meal orders, assembling them on trays, and then delivering the meals to the patients. Since the food preparation requirements are primarily determined by the menu items for a particular meal, food preparation methods are beyond the scope of this work. The focus of this paper is on the operational issues involved in serving meals to hospital patients(Omar, *et al*. 2020).

Objective of this study: The objectives of this study were to assess hospital food service quality, identify the causes of the quality problems and improvement strategies, study the effect of food handling and processing services on nutrients of orange served, evaluate the efficiency of the nutrition departments between public and private hospitals and to evaluate the food hygienic practices on microbial loads of patients' food.

Materials and Methods

Study area:

Four general hospitals were selected for the study, two of them were governmental hospitals located in Omdurman city Omdurman teaching hospital and Alnaowteaching hospital and two private hospitals, one of them locate at Khartoum city Royal care international hospital, and the other locate at Khartoum Bahri city AlamalNational Hospital.

Methods

Sampling:

one kg of orange samples had been chosen to demonstrate the effect of food service protocol on chemical properties and microbial loads. The samples were taken at five stages; the first stage was raw stage from the delivery procedure, the second stage was storage stage where the food materials were stored before making meals, the third stage was the preparation stage, the fourth stage was processing stage, the last stage was display stage where food served to the patients in trolley or in tray. The collection of samples was carried out according to aseptic techniques in sterile plastic bags and transferred to the laboratory in an icebox, directly with minimum delay.

Physio-chemical properties:

Moisture and crude protein contents were determined according to the method of AOAC, (2000).

Fat content: The fat content was determined by Gerber method according to AOAC (1990).

Ash content: The ash content was carried out as described by AOAC, (2000).

Total titratable acidity: The total titratable acidity was calculated according to Board (1988) method,

pH Value: The pH was measured with glass electrode pH meter (Model: HANNA instruments 8521) at ambient temperature.

Microbiological analysis:
Total viable count, Yeast, mouldand Salmonellawere determinedas described by Nickerson and Sinskey (1974), and Harrigan (1998).

Statistical analysis:
Replicate of each sample was analyzed using statistical system, the analysis of variance was performed to examine the significant effect in all parameters, Least Significant Difference test (LSD test), was used to separate the means (Peterson, 1985).

Results and Discussion

Physio-chemical properties:

Moisture content (%):

Table1 shows the effect of food services protocol on quality and safety on orange moisture content% in Sudanese hospitals. All food chain stages had no significant differences (P≤ 0.05) on orange moisture content% served at all hospitals until preparation stage which show potential significant (P≤ 0.05) decrease. Moisture content value of all orange served in all hospitals and all stages were higher than moisture content that reported be Bain (1957) who stated that orange moisture content average from 21 to 71%. It can be observed that the orange moisture content didn't affect by primary stages of food chain (raw food stage, storage stage), orange serviced as slices hence its preparation stage Include just cut it into pieces without any thermal process, the process of cutting the pulp into small pieces exposes it to the normal atmosphere and thus to lose a significant part of its moisture content.

Table (1): Effect of food services protocol on orange moisture content (%) in Sudanese hospitals

Food chain stages	Private hospitals		Governmental hospitals		Overall,of food chain stages
	Royal care	Alamal	Omdurman	Alnaow	
A	86.40^{abcd} ±0.22	86.72^{abcd} ±0.18	86.75^{abc} ±0.11	86.46^{abc} ±0.23	86.58^{A}
B	85.82^{abcd} ±0.09	85.04^{bcd} ±0.12	86.70^{abc} ±0.15	86.40^{abc} ±0.11	85.99^{AB}
C	86.83^{abc} ±0.14	84.01^{d} ±0.24	87.31^{a} ±0.19	86.90^{ab} ±0.22	86.26^{AB}
D	86.06^{abc} ±0.21	85.30^{abcd} ±0.14	87.09^{ab} ±0.16	87.09^{ab} ±0.10	86.38^{AB}
E	84.76^{cd} ±0.11	85.08^{bcd} ±0.12	86.60^{abc} ±0.15	85.61^{abcd} ±0.17	85.51^{B}
Overall mean hospitals	85.97^{BC}	85.23^{C}	86.89^{A}	86.49^{AB}	
P-value	$.0362^{*}$				
$Lsd_{0.05}$	1.75				
SE±	0.6124				

Mean ±SD values bearing different superscripts are significantly different (P0≤05).

Key:
A ≡ Raw food stage - B ≡ Storage stage - C ≡ Preparation stage -D ≡ Processing stage- E ≡ Display stage

Crude protein content (%):

Table 2 shows the effect of food services protocol on quality and safety on orange crude protein content in Sudanese hospitals. All food chain stages had significant differences (P≤ 0.05) on orange crude protein content served at all hospitals, there were potential significant (P≤ 0.05) increase. Protein content value of all orange Slices served in all hospitals and all stages were comparable by protein content that reported by Smith (1924) who stated that orange protein content average from 0.9 to 0.2 %. It can be observed that the orange protein content affected by different stages of food chain, however the increase of protein content was not due to the effect of food chain stages, but from the effect of decrease in moisture content through food chain stages and therefore increased total soluble solids.

Table (2): Effect of food services protocol on orange crude protein content (%) in Sudanese hospitals

Food chain stages	Private hospitals		Governmental hospitals		Overall, of food chain stages
	Royal care	Alamal	Omdurman	Alnaow	
A	**0.1833^{cd} ±0.02**	**0.2467^{abcd} ±0.01**	**0.1833^{cd} ±0.00**	**0.2057^{abcd} ±0.02**	**0.21.75^{B}**
B	**0.3233^{a} ±0.02**	**0.1833^{cd} ±0.03**	**0.2667^{abc} ±0.01**	**0.2067^{bcd} ±0.01**	**0.2450^{AB}**
C	**0.2600^{abcd} ±0.05**	**0.1933^{cd} ±0.01**	**0.2100^{bcd} ±0.02**	**0.1567^{d} ±0.01**	**0.2050^{B}**
D	**0.2333^{abcd} ±0.02**	**0.1900^{cd} ±0.03**	**0.1867^{cd} ±0.01**	**0.1967^{bcd} ±0.00**	**0.2017^{B}**
E	**0.3033^{ab} ±0.04**	**0.2633^{abcd} ±0.02**	**0.2667^{abc} ±0.01**	**0.2333^{abcd} ±0.02**	**0.2267^{A}**
Overall mean hospitals	**0.2607^{A}**	**0.2153^{B}**	**0.2227^{AB}**	**0.2100^{B}**	
P-value	**0.0497***				
Lsd$_{0.05}$	**0.0904**				
SE±	**0.0316**				

Mean±SD values bearing different superscripts are significantly different (P0≤05).

Key:

A ≡ Raw food stage - B ≡ Storage stage - C ≡ Preparation stage - D ≡ Processing stage - E ≡ Display stage

Fat content (%):

Table 3 shows the effect of food services protocol on quality and safety on (orange oil content %) in Sudanese hospitals. Orange oil is an essential oil produced by cells within the rind of an orange fruit (*Citrus sinensis* fruit). In contrast to most essential oils, it is extracted as a by-product of orange juice production by centrifugation, producing cold-pressed oil. It is composed of mostly (greater than 90%) d-limonene, and is often used in place of pure d-limonene. D-

limonene can be extracted from the oil by distillation, (Bauer *et al.,* 2001).All food chain stages had no significant differences (P≤ 0.05) on (orange oil content %) served at all hospitals.Orange essential oil of all orange slices served in all hospitals and all stages were lower than that reported by (Bauer *et al.,* 2001) who stated that the essential oil percentage ranged from 0.46 to 1.70 %, depending on the species, type of extraction and form of the orange.There were slight decreases in orange essential oil during food chain stages, that may be due to evaporation of essential oil at room temperature after processing stage, due to peeling and cutting of orange to slices prior to be served, these finding in agreement with (Mazzuz, 2001) who stated that essential oil tends to vaporize at room temperature until the oil in gaseous form is in equilibrium with the liquid phase. But, this evaporation will be minute and may not be measurable in a closed system.

Table (3): Effect of food services protocol on orange oil content (%) in Sudanese hospitals

Food chain stages	Private hospitals		Governmental hospitals		Overall, of food chain stages
	Royal care	Alamal	Omdurman	Alnaow	
A	0.1933^{c} ±0.00	0.4367^{b} ±0.02	0.4033^{b} ±0.01	0.5167^{b} ±0.04	0.3625^{AB}
B	0.1700^{c} ±0.01	0.5333^{ab} ±0.02	0.4233^{b} ±0.03	0.4133^{b} ±0.02	0.3850^{AB}
C	0.1100^{c} ±0.00	0.4000^{b} ±0.01	0.3467^{b} ±0.02	0.3767^{b} ±0.04	0.3083^{B}
D	0.1567^{c} ±0.04	0.4600^{b} ±0.05	0.4167^{b} ±0.02	0.6600^{b} ±0.05	0.4233^{A}
E	0.1267^{c} ±0.00	0.3867^{b} ±0.02	0.3833^{b} ±0.04	0.4400^{b} ±0.01	0.3342^{B}
Overall mean hospitals	0.1313^{C}	0.4433^{AB}	0.3947^{B}	0.4817^{A}	
P-value	0.0382*				
$Lsd_{0.05}$	0.1566				
SE±	0.0548				

Mean ±SD values bearing different superscripts are significantly different (P0≤05**)**

Key:
A ≡ Raw food stage
B ≡ Storage stage
C ≡ Preparation stage
D ≡ Processing stage
E ≡ Display stage

Ash content (%):

Table 4 shows the effect of food services protocol on quality and safety on (orange ash content) in Sudanese hospitals. All food chain stages had no significant differences (P≤ 0.05) on orange ash content served at all hospitals. Orange ash content of all orange slices served in all hospitals and all stages were higher than that reported by Eltahir (2015) who stated that the ash percentage of orange grown in Sudan range from 0.065-0.322%, depending on the orange species. There was slight decrease in orange ash during food chain stages that may be due to the effect of decrease in moisture content through food chain stages and therefore increased total soluble solids.

Table (4): Effect of food services protocol on orange ash content (%) in Sudanese hospitals

Food chain stages	Private hospitals		Governmental hospitals		Overall, of food chain stages
	Royal care	Alamal	Omdurman	Alnaow	
A	0.1833^{bc} ±0.01	0.1900^{bc} ±0.02	0.2033^{bc} ±0.02	0.1667^{c} ±0.03	0.1858^{A}
B	0.2133^{bc} ±0.01	0.1800^{bc} ±0.02	0.2367^{bc} ±0.01	0.1700^{c} ±0.02	0.2000^{A}
C	0.1800^{bc} ±0.03	0.1767^{bc} ±0.04	0.2067^{bc} ±0.01	0.2633^{c} ±0.01	0.2067^{A}
D	0.2367^{bc} ±0.02	0.2033^{bc} ±0.01	0.2100^{bc} ±0.02	0.1867^{c} ±0.03	0.2992^{A}
E	0.3200^{bc} ±0.04	0.1967^{bc} ±0.01	0.2133^{bc} ±0.02	0.1633^{c} ±0.02	0.2233^{A}
Overall mean hospitals	0.2267^{A}	0.1893^{B}	0.2140^{AB}	0.1900^{B}	
P-value	0.0082^{**}				
$Lsd_{0.05}$	0.0342				
SE±	0.012				

Mean±SD values bearing different superscripts are significantly different (P0≤05).

Key:

A ≡ Raw food stage - B ≡ Storage stage -C ≡ Preparation stage - D ≡ Processing stage
E ≡ Display stage

Titratable acidity (%):

Table 5 shows the effect of food services protocol on quality and safety on orange titratable acidity percentage in Sudanese hospitals.All food chain stages had no significant differences (P≤ 0.05) on orange titratable acidity percentage served at all hospitals, until preparation stage there were slightly significant (P≤ 0.05) increase. Titratable acidity value of orange slices

served in all hospitals and all stages were higher than that reported be Eltahir (2015) who stated that titratable acidity of orange grown in Sudan range between 0.95 to 1.31%. The orange titratable acidity is affected by different stages of food chain. however the decrease of titratable acidity content was not due to the effect of food chain stages, but maybe due to the effect of storage period between receiving orange batch until serving it, these finding are compatible with finding of (Ibrahim *et al.*, 2014) who declare that there was a significant increase in titratable acidity content during storage, this might be due to conversion of acids into salts and sugars by enzymes particularly invertase, Safdar *et al.* (1999) observed gradual increase in acidity during storage of orange concentrate at three different temperatures. The rise in acidity may be explained by the fact that the concentration of weakly ionized acid and their salts increased during storage. Another explanation for the acidity increase due to formation of acid by degradation of polysaccharides and oxidation of reducing sugars or by breakdown of pectic substances.

Table (5): Effect of food services protocol on orange titratable acidity (%) in Sudanese hospitals

Food chain stages	Private hospitals		Governmental hospitals		Overall, of food chain stages
	Royal care	Alamal	Omdurman	Alnaow	
A	1.543^{abc} ±0.06	1.360^{abc} ±0.02	1.367^{abc} ±0.04	1.300^{abc} ±0.01	1.418^{A}
B	1.407^{abc} ±0.05	1.530^{abc} ±0.03	1.357^{abc} ±0.02	1.267^{abc} ±0.03	1.390^{A}
C	1.500^{abc} ±0.02	1.320^{bc} ±0.03	1.410^{abc} ±0.01	1.450^{abc} ±0.04	1.420^{A}
D	1.673^{a} ±0.03	1.267^{c} ±0.02	1.363^{bc} ±0.04	1.400^{abc} ±0.05	1.426^{A}
E	1.613^{ab} ±0.02	1.583^{ab} ±0.01	1.350^{bc} ±0.02	1.323^{bc} ±0.01	1.467^{A}
Overall mean hospitals	1.547^{A}	1.412^{B}	1.389^{B}	1.348^{A}	
P-value	0.0265^{*}				
$Lsd_{0.05}$	0.2609				
SE±	0.0913				

Mean±SD values bearing different superscripts are significantly different (P0≤05)

Key:

A ≡ Raw food stage - B ≡ Storage stage - C ≡ Preparation stage

D ≡ Processing stage

E ≡ Display stage

pH-value:

Table 6 shows the effect of food services protocol on quality and safety on (orange pH-value) in Sudanese hospitals. All food chain stages had no significant differences (P≤ 0.05) on (orange pH-value) served at all hospitals. Orange pH-value of all orange slices served in all hospitals and all stages were comparable by results that reported by Eltahir (2015) who stated that pH percentage of orange grown in Sudan range from 3.40 - 4.19 depending on the orange species. There were slight decreases in orange pH-value during food chain stages that may be due to the effect of increase in titrable acidity through food chain stages, and therefore decline of pH-value.

Table (6): Effect of food services protocol on orange pH-value in Sudanese hospitals

Food chain stages	Private hospitals		Governmental hospitals		Overall, of food chain stages
	Royal care	Alamal	Omdurman	Alnaow	
A	4.38^{abc} ±0.07	4.49^{abc} ±0.05	4.41^{abc} ±0.03	4.31^{abc} ±0.02	4.40^{A}
B	4.46^{abc} ±0.04	4.31^{abc} ±0.03	4.33^{abc} ±0.01	4.37^{abc} ±0.02	4.37^{A}
C	4.41^{abc} ±0.05	4.47^{abc} ±0.02	4.38^{abc} ±0.03	4.38^{abc} ±0.02	4.41^{A}
D	4.18^{abc} ±0.05	4.60^{abc} ±0.06	4.38^{abc} ±0.01	4.57^{ab} ±0.02	4.43^{A}
E	4.34^{abc} ±0.04	4.25^{abc} ±0.02	4.39^{abc} ±0.01	4.30^{abc} ±0.01	4.32^{A}
Overall mean hospitals	4.35^{A}	4.42^{A}	4.38^{A}	4.39^{A}	
P-value	0.0274^{*}				
$Lsd_{0.05}$	0.2712				
SE±	0.0949				

Mean±SD values bearing different superscripts are significantly different (P0≤05).

Key:

A ≡ Raw food stage - B ≡ Storage stage - C ≡ Preparation stage
D ≡ Processing stage
E ≡ Display stage

Microbiological analysis:

Total viable count of bacteria log^{10} (CFU/g):

Table 7 shows the effect of food services protocol on quality and safety on total viable count of bacteria log^{10} (CFU/g) in Sudanese hospitals. All food chain stages had significant differences (P≤ 0.05) on total viable count of bacteria log^{10} (CFU/g) served at all hospitals. Orange total viable count of bacteria of all orange slices served in all hospitals and all stages were higher those

reported be (Plaza *et al*., 2011) who stated that the viable count of bacteria of orange was 1.45 $\log^{10}$ CFU/g. There were fluctuated decreases in orange total viable count of bacteria during food chain stages however the sample taken from Royal care private hospitals show potential increase in total viable count of bacteria, that may be due to cross contamination resulting from the use of contaminated tools (knives, cutting boards, dishes, etc.) in addition to the lack of personal hygiene.

Table (7): Effect of food services protocol on Orange total viable count of bacteria log10 (CFU/g) in Sudanese hospitals

Food chain stages	Private hospitals		Governmental hospitals		Overall, of food chain stages
	Royal care	Alamal	Omdurman	Alnaow	
A	3.25^{ab} ±0.04	2.25^{abc} ±0.03	3.25^{ab} ±0.04	4.50^{a} ±0.06	3.31^{A}
B	2.00^{bc} ±0.02	4.50^{a} ±0.06	0.00^{c} ±0.00	4.50^{a} ±0.06	2.75^{A}
C	2.00^{bc} ±0.02	0.00^{c} ±0.00	3.25^{ab} ±0.04	0.00^{c} ±0.00	1.31^{B}
D	2.00^{bc} ±0.02	0.00^{c} ±0.00	0.00^{c} ±0.00	0.00^{c} ±0.00	0.50^{B}
E	4.50^{a} ±0.06	0.00^{c} ±0.00	0.00^{c} ±0.00	0.00^{c} ±0.00	1.13^{B}
Overall mean hospitals	2.75^{A}	1.35^{B}	1.30^{B}	1.80^{B}	
P-value	0.002^{**}				
$Lsd_{0.05}$	2.06				
SE±	0.6982				

Mean±SD values bearing different superscripts are significantly different (P0≤05)

Key:

A ≡ Raw food stage - B ≡ Storage stage - C ≡ Preparation stage
D ≡ Processing stage
E ≡ Display stage

Yeasts and moulds count $\log^{10}$ (CFU/g):

Table 8 shows the effect of food services protocol on quality and safety on yeasts and moulds $\log^{10}$ (CFU/g) in Sudanese hospitals. All food chain stages had no significant differences (P≤ 0.05) on yeasts and moulds $\log^{10}$ (CFU/g) served at all hospitals. Orange yeasts and moulds of all orange slices served in Omdurman hospitals were higher than that reported be Seow *et al*, (2012) who stated that the ash percentage of orange range from 0.1 to 1.9 $\log^{10}$ CFU/g, and Badosa *et al*., (2008) reported yeasts and moulds counts for orange fruits and juices as ranging from 1 to 3 $\log^{10}$ CFU/g. There were no growth of mold and yeasts in orange slices during food chain stages, however the sample taken from Omdurman hospital show growth in raw food stage. Contamination with fungi and yeasts in fresh fruit oranges, which are consume without storage is very rare due to the slow growth of fungi as aresultof high acidity These results are agreement to these obtains by Heard, (1999) who found that the spoilage

caused by growth of moulds is not a major issue in fresh-cut fruits, as far as limited research has shown. Nonetheless, there are possible health risks associated with moulds found in fruits and vegetables as some moulds may produce mycotoxins or induce allergies (Tournas, 2005)

Table (8): Effect of food services protocol on orange yeasts and moulds count log[10] (CFU/g) in Sudanese hospitals

Food chain stages	Private hospitals		Governmental hospitals		Overall of food chain stages
	Royal care	Alamal	Omdurman	Alnaow	
A	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	1.13^{A}
B	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{B}
C	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{B}
D	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{B}
E	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{B}
Overall mean hospitals	0.00^{B}	0.00^{B}	0.90^{B}	0.00^{B}	
P-value	0.00^{**}				
$Lsd_{0.05}$	0.0006396				
SE±	0.0002236				

Mean±SD values bearing different superscripts are significantly different (P0≤05).

Key:

A ≡ Raw food stage - B ≡ Storage stage - C ≡ Preparation stage - D ≡ Processing stage
E ≡ Display stage

***Salmonella* and *E. coli* (MPN/g):**

Tables9 and 10 show the effect of food services management on quality and safety on orange pathogen (*Salmonella* and *E. coli*) cfu/ml and MPN/g, in Sudanese hospitals. The likelihood of *Salmonella* survival on sliced citrus may vary significantly depending strain. Oranges, a citrus variety that has a higher pH (3.8 - 33) are able to support *Salmonella* survival and have previously been identified as vehicles for salmonellosis outbreaks caused by consumption of contaminated oranges slices and juice (Jain *et al.*, 2005).There were no contaminations in all orange samples taken from all hospitals by *salmonella* spp. These finding was comparable by finding of Feng *et al.*, (2002) who stated that orange products (juices and jams) are usually contaminated through the equipment used in production because orange acidity is not enough to inhibit and/or kill *salmonella* cell.Acidic fruit juices have been implicated in outbreaks of highly acid-resistant *Escherichia coli* O157:H7; hence, effective sanitation of fruit

surfaces is crucial for reducing the risks posed by this pathogen, especially as. *E. coli* O157:H7 has been shown to survive in OJ (Eblen*et al.*, 2004).There was no contamination in all orange samples taken from all hospitals by *E. coli.*

Table (9): Effect of food services protocol on orange *Salmonella* log 10 CFU\g in Sudanese hospitals

Food chain stages	Private hospitals			Governmental hospitals
	Royal care	Alamal	Omdurman	Alnaow
A	Nil	Nil	Nil	Nil
B	Nil	Nil	Nil	Nil
C	Nil	Nil	Nil	Nil
D	Nil	Nil	Nil	Nil
E	Nil	Nil	Nil	Nil

Table (10): Effect of food services protocol on orange *E. coli* (MPN/g) in Sudanese hospitals

Food chain stages	Private hospitals		Governmental hospitals	
	Royal care	Alamal	Omdurman	Alnaow
A	Nil	Nil	Nil	Nil
B	Nil	Nil	Nil	Nil
C	Nil	Nil	Nil	Nil
D	Nil	Nil	Nil	Nil
E	Nil	Nil	Nil	Nil

Key:
A ≡ Raw food stage
B ≡ Storage stage
C ≡ Preparation stage
D ≡ Processing stage
E ≡ Display stage

Conclusions

The function of a foodservice system in a hospital is a fundamental part of the health care industry. Consequently, the efficiency of the operational aspects of foodservice can significantly impact a hospital's budget and perceived level of satisfaction by the patient. This study has provided information about microbial loads affected of food chain stage on nutritional status of the food serve. All food chain stages had significant differences ($P \leq 0.05$) on total viable count of bacteria $\log^{10}$ (CFU/g) served at all hospitals. Mold, yeasts, Salmonella and *E. coli* were not detected in orange slices during food chain stages in all hospitals. Private hospitals show more organization at last stage of food services rather than governmental hospitals.

The need to keep the microbial activity as low as possible as many patients had impaired and defect immune system, can not handle microbial invasion in GIT track.

References

Abdul-Rashid, S., Fatimah U.andAzira. N (2022). "Relating Food Handlers' Knowledge, Attitude, and Self-Reported Practices on Food Safety and Hygiene to the Performance of Food Safety Assurance System: A Multiple Case Study in Government Hospital Kitchens." Pertanika J. Trop. Agric. Sci45(3): 731-745.

AOAC (1990).Official methods of analysis, 15 th ed .Association of Official Analytical Chemists, Wasshing ton, DC, USA.

AOAC.(2000). "Official Methods of Analysis". 26th edition. Published by AOAC Inc. Virginia 45743. USA.

Badosa, E., Trias, R., Pares, D., Pla, M., and Montesinos, E. (2008). Microbiological quality of fresh fruit and vegetable products in Catalonia (Spain) using nsormalized plate-counting methods and real time polymerase chain reaction (QPCR). Journal of the Science of Food and Agriculture, 88, 605-611.

Bain, J. M. (1957). Morphological, anatomical and physiological changes in the developing fruit of the 'Valencia' orange, Citrus sinensis (L.) Osbeck. Australian Journal of Botany, 6, 1-24.

Bauer, K., Garbe,D. and Surburg, H (2001). "Common Fragrance and Flavor Materials", 4th Ed, Wiley VCH, , ISBN 3-527-30364-2. 189.

Board , B . W. (1988). Quality control in fruit and vegetables processing .FAO , Food and Nutrition . Paper.39 .P.20.

Eblen, B.A., Walderhaug,O. M., Sharon, M., and Chirtel, S. (2004). Potential for Internalization, Growth, and Survival of Salmonella and Escherichia coli O157:H7 in Oranges. Journal of food protection 67(8):1578-84 ·

Eltahir, R. Y. I (2015). Comparative Characteristics of Fruits from Three Types of Sweet Oranges (Citrus sinensis). MS.c thesis. University of Khartoum.

Feng, P., S. D. Weagant, and M. A. Grant. (2002). Enumeration of Escherichia coli and the coliform bacteria. In Bacteriological analytical manual online. Available at: http://www.cfsan.fda.gov/ebam/ bam-4.html. Accessed 29 June 2005

Harrigan, W.I. (1998). Laboratory methods in food microbiology 3Eddition. Gulf Profession publishing. pp.295-296.

Heard, G. (1999). Microbial safety of ready-to-eat salads and minimally processed vegetables and fruits. Food Australia, 51, 414-420.

Jain, S., S. A. Bidol, J. L. Austin, E. Berl, F. Elson, M. Lemaile-Williams, M. Deasy, M. E. Moll, V. Rea, J. D. Vojdani, P. A. Yu, R. M. Hoekstra, C. R. Braden, and M. F. Lynch. (2009). Multistate outbreak of Salmonella Typhimurium and Saintpaul infections associated with unpasteurized orange juice—United States, 2005. Clin. Infect. Dis. 48:1065–1071.

Mazzuz, C., (2001). Optimización de pre-acondicionamientostérmicosenfrutoscítricos con tratamientoscuarentenariosporfrío. Doctoral thesis, Politec Univ Valencia, Spain.

Nickerson, J. T. and Sinskey, A.J. (1974). Microbiology of foods and Food-processing. New York, Amsterdam , London: American Elsevier publishing company.

Olney, E. M. (2003). design and analysis of meal assembly and delivery methods in hospital foodservice systems. M. Sc. in Industrial & Systems Engineering. Kate Gleason College of Engineering.

Omar, B. A., Shadia, S. M. Anas S. D.and Mohammed. A. E.(2020). "Food hygiene

knowledge, attitude and practices among hospital food handlers in Elmanagil City, Sudan." African Journal of Microbiology Research14(4): 106-111

Peterson, R. G. (1985). Design and analysis of experiments. March Dekker Inc., New York, PP: 429.

Plaza, L. Inés C., Sonia de P., Begoña d., Concepción S., Marina M., and Pilar C. (2011). Impact of minimal processing on orange bioactive compounds during refrigerated storage. Food Chemistry 124 (2011) 646–651.

Safdar, N., Asrar, M., Abdullah, N., Ziaur, R. and Shah, W. (1999). Studies on the effect of storage condition on ascorbic acid acidity and pH of tomato concentrate. Pak. J. Food Sci.

Seowa, J., Ágoston, R., Phua, B., and Yuk A (2012). Microbiological quality of fresh vegetables and fruits sold in Singapore, Food Control 25. 39-44.

Smith, A. H. (1924).a protein in the Edible portion of orange. LLC. New York, USA. Pp. 471-346.

Tournas, V. H. (2005).Moulds and yeasts in fresh and minimally processed vegetables, and sprouts. International Journal of Food Microbiology, 99, 71-77.

تقييم جودة الخدمات الغذائية لثمار البرتقال المقدمة في مستشفيات بولايتي الخرطوم وأم درمان

حذيفه مصطفي[1], خضر عبد الحكم[2] , فاتن فرحات[3], شفق سليمان[4]وندى محمد الخير[5]

1. قسم التغذية وتقانة الاغذيه /كلية العلوم والتقانة /جامعة امدرمان الاسلاميه
3و2 قسم علوم وتقانة الاغذيه /كليه الزراعة / جامعة امدرمان الاسلاميه
4. قسم علوم وتقانة الاغذيه / كلية الزراعة/ جامعة إفريقياالعالمية
5. قسم الأحياء – كلية العلوم –جامعة الباحة–المملكة العربية السعوديه

المستخلص

الهدف من الدراسة هو تقييم جودة الخدمات الغذائية المقدمة للمرضي في المستشفيات وتحديد أسباب مشكلات الجودة في الفواكه. تم اختيار فاكهة البرتقال كعينة للدراسة و تم اختيار أربعة مستشفيات في منطقتي الخرطوم وامدرمان اثنين منها خاصة(رويال كير و الأمل) و اثنين حكومية (امدرمان و النو) علي التوالي. تم اخذ العينات خلال مراحل السلسلة الغذائية في المستشفيات (مرحلة الغذاء الخام ، مرحلة التخزين ، مرحلة الإعداد ، مرحلة المعالجة ومرحلة العرض) للكشف عن سبب التغيير في القيمة الغذائية و سلامة وجودة الطعام. تم قياس الخواص الفيزيوكيميائية (الرطوبة ،البروتين، الزيت، الرماد ،الحموضة و الاس الهديروجيني) حيث سجلت نسبة الرطوبة في مرحلة الإعداد اعلي قيمة 37.31% في مستشفي امدرمان واقلها في مرحلة الإعداد 84.01% في مستشفي الامل. و سجل البروتين اعلي قيمة في مرحلة التخزين 0.32% في مستشفي رويال كير و اقلها في مرحلة الإعداد 0.15% في مستشفي النو و سجلت نسبة قياس الزيت اعلي قيمة في مرحلة المعالجة 0.66% في مستشفي النو واقلها فيمرحلة الإعداد 0.11% في مستشفى رويال كير و سجلت نسبة قياس الرماد اعلي قيمة في مرحلة العرض 0.32% في مستشفي رويال كير واقلها في مرحلة العرض في مستشفي النو 0.16%. و سجلت نسبة الحموضة اعلي قيمة في مرحلة العرض 0.61% في مستشفي رويال كير و اقلها في مرحلة المعالجة في مستشفي الأمل 0.26%. اما نسبة قياس الاس الهيدروجيني أعطت اعلي قيمة في مرحلة المعالجة 4.60% في مستشفي الأمل واقلها في مرحلة العرض 4.25 % في مستشفي الأمل. كما تم حساب العد الكلي البكتيري حيث اظهر انخفاض كبير ($P\leq 0.05$) خلال جميع المراحل. تم حساب الخمائر ،العفن، بكتيريا القولون و السالمونيلا وجميعها لم تظهر اي فروق كدلالة إحصائية في جميع مراحل السلسلة الغذائية. مما سبق يتضح ان السلامة الصحية المرتبطة بهذه المستشفيات كانت خالية من الملوثات.