The Impact of Food Services Protocol on the Quality and Safety of Egg Served by Hospitals in Khartoum State, Sudan

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ABSTRACT

This work purpose was to assess the safety and quality of hospital meals and services. The egg was taken in several phases of the hospital food chain (raw food, storage, preparation, processing, and display) to highlight the cause of nutrient, safety, and quality changes in patient meals in Khartoum State. Chemical composition (moisture content, ash, protein and fat percents),total titrable acidity and pH value) and microbial loads (total viable count, yeast and mould, total *Coliform* bacteria, *Salmonella* and *Staphylococcus* spp.) were measured at all stages. The moisture content of eggs showed a significant ($P \leq 0.05$) slight decrease in private hospitals and a potential increase in government hospitals, while fat content showed a slight non-significant decrease in all samples, except for the sample taken from (D) governmental hospital, which showed a significant potential increase at the end-stage (processing and display stages), There were no significant differences ($P \leq 0.05$) in ash content, titratable acidity and pH served at all hospitals in all chain stages. Total bacterial count served at hospitals, all samples showed a significant ($P \leq 0.05$) decrease during food chain stages and total yeasts and moulds content served at privatized hospitals.

Keywords: Hospital , governmental, egg, food chain, microbial load.

INTRODUCTION

Historically, hospital food services have been an integral aspect of hospital operations. Nutritional and medicinal needs have been the primary focus of research and improvements to hospital food service systems, rather than productivity issues. Because these issues are interconnected, addressing productivity difficulties necessitates a detailed understanding of the food service system's operational, nutritional, and medical requirements. As a result, this work examines and explains the general components of the food service system, such as food quality, menus, meal preparation methods, meal transport and serving methods, and space and resource issues. Simulation is also looked at, as it was used to explore and measure the productivity of hospital food service systems. The debate over simulation's usage in the field of health care, in particular, argues that simulation can be a useful tool for enhancing operational aspects of health care systems (Lowry *et al*., 1994).

The goal of this study was to determine the quality of hospital food service, as well as the reasons for quality issues and potential solutions (Assessment of hospital food service quality). The study's specific goals were to investigate the effects of food handling and processing services on the nutrients in the food served, compare and evaluate the efficiency of nutrition departments in public and private hospitals, and evaluate the impact of food hygiene practices on microbial loads in patients' food.

MATERIALS AND METHODS

Study area: Four general hospitals were selected for the study, two were governmental hospitals (C and D) and two were private hospitals (A and B). in Khartoum state.

Methods

Sampling: The samples were taken at five stages, the first stage was raw food stage from the delivery procedure, The collection of samples was carried out according to a-septic techniques in sterile plastic bags and transferred to the laboratory in an icebox, directly with minimum delay. the second stage was storage stage where the food

materials were stored before making meals in one day at room temperature, the third stage was the preparation stage where food material are boiled, the fourth stage was processing stage where food materials had been prepared by peeling , the last stage was display stage where food served to the patients in trolley or in tray.

Chemical composition :

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

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

The pH of the pulp was measured with a glass electrode pH meter (Model: HANNA instruments 8521) at ambient temperature.

The total titrable acidity was determined according to Board (1988) method,

Microbial load (total viable count, yeast and mould, total *Coliform* bacteria, *Salmonella* detection and *staphylococcus* spp.) determination were carried out As described by Nickerson and Sinskey (1974), and by Harrigan (1998).

Statistical analysis: The Least Significant Difference test (LSD analysis) was used to separate the means for each replicate of each sample, and the analysis of variance was performed to analyze the significant influence in all parameters (Peterson, 1985).

RESULT AND DISCUSSION

Moisture content: Table (1) indicates the impact of food service procedures on egg moisture content % in Sudanese hospitals. All hard-boiled eggs given in all hospitals and at all stages had moisture content that was comparable to the moisture content reported by Spada *et al*. (2012) who found the moisture content of eggs to be between 74.86 and 71.14 percent . At all food chain stages, there were significant differences ($P \leq 0.05$) in egg moisture content percent served at private and governmental hospitals, with a modest increase in private hospitals and a potential drop in government hospitals. The moisture content of eggs was steady during the basic food chain stages (raw food and storage), but it increased significantly ($P \leq 0.05$) following the preparation stage in all samples. The action of boiling in salted water, which results in hard-boiled eggs, could be to blame for the shift in egg moisture content during the processing step. These findings support those of Sukker (1983), who discovered that cooking treatments affected the moisture content of whites and yolks significantly($P \leq 0.05$). The moisture content of steaming and raw egg whites and yolks was identical. When compared to the uncooked form, eggs cooked by boiling had the greatest moisture reduction.

Crude protein content: Table (2) indicates the impact of food service procedures on egg crude protein percent in Sudanese hospitals. Egg is an excellent source of high-quality protein. Egg protein ranks first on the most widely used protein evaluation scale, with a score of 100, and is recognized as the benchmark against which all other foods are rated. This is related to the essential amino acid makeup of egg protein as well as its efficient digestion Layman & Rodriguez (2009).All hard-boiled

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

Food chain stages	Private hospitals		Governmental hospitals		Overall of food chain stages
	A	B	C	D	
Raw	$76.05^{ab} \pm 0.16$	$75.56^{abc} \pm 0.11$	$74.73^{abc} \pm 0.16$	$76.59^{bc} \pm 0.14$	75.73^{A}
Storage	$75.38^{ab} \pm 0.20$	$75.23^{abc} \pm 0.18$	$75.10^{abc} \pm 0.10$	$73.93^{bc} \pm 0.16$	74.91^{A}
Preparation	$74.73^{abc} \pm 0.14$	$73.55^{bc} \pm 0.22$	$76.08^{ab} \pm 0.09$	$75.99^{ab} \pm 0.14$	75.09^{A}
Processing	$74.96^{abc} \pm 0.16$	$73.28^{c} \pm 0.14$	$76.70^{d} \pm 0.11$	$63.96^{d} \pm 0.10$	69.47^{B}
Display	$76.06^{ab} \pm 0.16$	$76.76^{a} \pm 0.17$	$63.85^{d} \pm 0.15$	$63.75^{d} \pm 0.11$	70.11^{B}
Overall mean hospitals	75.44^{A}	74.88^{A}	71.09^{B}	70.84^{B}	
P-value	0.00**				
LSD0.05	2.171				
SE±	0.7594				

Mean±SD values in a columns bearing different superscripts are significantly different ($P \leq 0.05$).

Table 2: Effect of food services protocol on eggs crude protein content (%) in Sudanese hospitals(on wet weight basis)

Food chain stages	Private hospitals		Governmental hospitals		Overall of food chain stages
	A	B	C	D	
Raw	$3.47^{def} \pm 0.05$	$3.68^{def} \pm 0.08$	$3.31^{def} \pm 0.01$	$4.39^{c} \pm 0.02$	3.71^{C}
Storage	$3.42^{def} \pm 0.02$	$3.62^{def} \pm 0.06$	$3.38^{def} \pm 0.07$	$4.54^{c} \pm 0.05$	3.74^{C}
Preparation	$3.70^{def} \pm 0.04$	$3.48^{def} \pm 0.03$	$3.45^{def} \pm 0.02$	$4.39^{c} \pm 0.04$	3.75^{C}
Processing	$3.57^{def} \pm 0.02$	$3.35^{f} \pm 0.01$	$3.47^{def} \pm 0.03$	$5.85^{a} \pm 0.06$	4.06^{A}
Display	$3.40^{def} \pm 0.07$	$3.57^{def} \pm 0.05$	$3.32^{f} \pm 0.02$	$5.37^{b} \pm 0.03$	3.92^{B}
Overall mean hospitals	3.51^{B}	3.54^{B}	3.38^{C}	4.91^{A}	
P-value	0.00**				
LSD0.05	0.2609				
SE±	0.0913				

Mean±SD values in columns bearing different superscripts are significantly different ($P \leq 0.05$).

eggs provided in all hospitals and stages had lower protein content than those determined by (Layman & Rodriguez 2009), who found that an egg's protein content was 12.6-12.5 percent (albumin 10.6 and yolk 16.0 percent).

Fat content : Table (3) indicates the impact of food service procedures on egg fat content in Sudanese hospitals. The fat percentage of all hard-boiled eggs served at all hospitals and stages was lower than that reported by Paul and Potter,(1978), who calculated a fat content of 6.0 percent in one egg. Almost all of an egg's fat is found in the yolk, while less than 0.05 percent is found in the albumen. The majority of an egg's fatty acid content is made up of monounsaturated fatty acids (approximately 47 percent). The remaining 18 percent is polyunsaturated, with only 34% saturated (Ruxton, 2010). At any level of the food chain, there were no significant differences ($P \leq 0.05$) in egg fat content delivered at private and governmental hospitals, nevertheless, samples taken from (D) governmental hospitals reveal a large potential rise at the ultimate stages of the food chain (processing and display stages). According to Imai *et al*. (1984) increased boiling and storage durations reduced cholesterol levels in egg yolks. While boiling increased total fat content, long-term storage reduced it. Total unsaturated fatty acids decreased as boiling and storage duration, but total saturated fatty acids increased.

Ash content: Table (4) indicates the impact of food service procedures on egg ash levels in Suda-

Table 3: Effect of food services protocol on eggs fat content (%) in Sudanese hospitals(on wet weight basis)

Food chain stages	Private hospitals		Governmental hospitals		Overall of food chain stages
	A	B	C	D	
Raw	$4.67^{bc} \pm 0.23$	$4.75^{bc} \pm 0.19$	$4.73^{bc} \pm 0.11$	$4.27^{bc} \pm 0.10$	4.61^{A}
Storage	$4.37^{bc} \pm 0.15$	$4.38^{bc} \pm 0.20$	$4.45^{bc} \pm 0.08$	$4.14^{bc} \pm 0.09$	4.34^{B}
Preparation	$4.25^{bc} \pm 0.11$	$4.29^{bc} \pm 0.12$	$4.45^{bc} \pm 0.10$	$4.29^{bc} \pm 0.16$	4.32^{B}
Processing	$4.07^{bc} \pm 0.07$	$4.71^{bc} \pm 0.10$	$4.31^{bc} \pm 0.11$	$4.84^{a} \pm 0.13$	4.73^{A}
Display	$4.14^{bc} \pm 0.12$	$4.55^{bc} \pm 0.09$	$4.35^{bc} \pm 0.05$	$5.45^{a} \pm 0.10$	4.62^{A}
Overall mean hospitals	4.30^{B}	4.54^{B}	4.46^{B}	4.80^{A}	
P-value	0.00**				
LSD0.05	0.5473				
SE±	0.1915				

Mean±SD values in column sbearing different superscripts are significantly different ($P \leq 0.05$).

Table 4: Effect of food services protocol on eggs ash content (%) in Sudanese hospitals(on wet weight basis)

Food chain stages	Private hospitals		Governmental hospitals		Overall of food chain stages
	A	B	C	D	
Raw	1.403ab±0.05	1.283b±0.04	1.477ab±0.02	1.527ab±0.03	1.423A
Storage	1.557ab±0.02	1.463ab±0.05	1.410ab±0.03	1.340ab±0.02	1.442A
Preparation	1.460ab±0.01	1.297b±0.02	1.573a±0.01	1.350ab±0.04	1.420A
Processing	1.483ab±0.02	1.403ab±0.04	1.450ab±0.01	1.483a±0.01	1.455A
Display	1.580a±0.02	1.357ab±0.03	1.423ab±0.02	1.480ab±0.01	1.460A
Overall mean hospitals	1.497A	1.361B	1.468AB	1.463AB	
P-value	0.0387*				
LSD0.05	0.2275				
SE±	0.0796				

Mean±SD values in columns bearing different superscripts are significantly different ($P \leq 0.05$)

nese hospitals. The ash content of all hard-boiled eggs provided at all hospitals and stages was comparable to that found by Muir *et al*. (2008), who found that an egg's ash content was 1.0 percent. Eggs include many of the elements that the human body needed for optimum health. Iodine, which is required for the production of thyroid hormone, and phosphorus, which is vital for bone health, are both abundant in eggs. The egg is high in selenium, a vital antioxidant, as well as zinc, which is required for wound healing, growth, and resistance to infection. Iron, a crucial component of red blood cells, is also found in eggs, though the body's ability to absorb it is now being researched. (Ruxton *et. al*., 2010). There were significant variations ($P \leq 0.05$) in egg ash content delivered in private and governmental hospitals at all food chain stages, samples from private hospitals showed a minor increase, while those from governmental hospitals showed a big increase. In general, heat treatment does not influence the ash level of eggs. Boiling reduced the ash concentration in whole eggs from 0.9 percent in raw eggs to 0.8 percent in boiled eggs, according to Roe *et al*. (2013).

Titratable acidity: Table (5) shows how the food service procedures in Sudanese hospitals impact the quality and safety of egg titratable acidity. The titratable acidity values of all hard-boiled eggs given at all hospitals and stages were lower than those claimed by the manufacturer (Paul & Potter, 1978). The titratable acidity value of eggs was 0.19- 0.17. for egg titratable acidity served in private and government hospitals, there were no significant changes ($P \leq 0.05$) in any of the food

Table 5: Effect of food services protocol on eggs titratable acidity (%) in Sudanese hospitals(on wet weight basis)

Food chain stages	Private hospitals		Governmental hospitals		Overall of food chain stages
	A	B	C	D	
Raw	0.003^{a}±0.01	0.007^{a}±0.01	0.020^{a}±0.01	0.00^{a}±0.00	0.010^{A}
Storage	0.023^{a}±0.01	0.00^{a}±0.00	0.043^{a}±0.01	0.010^{a}±0.01	0.025^{A}
Preparation	0.027^{a}±0.03	0.027^{a}±0.03	0.077^{a}±0.02	0.00^{a}±0.00	0.044^{A}
Processing	0.017^{a}±0.03	0.017^{a}±0.02	0.027^{a}±0.03	0.017^{a}±0.03	0.020^{A}
Display	0.012^{a}±0.03	0.014^{a}±0.01	0.027^{a}±0.02	0.017^{a}±0.02	0.018^{A}
Overall mean hospitals	0.016^{A}	0.013^{A}	0.037^{A}	0.015^{A}	
P-value	3.291^{NS}				
LSD0.05	0.0456				
SE±	0.0831				

Mean±SDvalues in a columns bearing different superscripts are significantly different ($P \leq 0.05$).

chain phases, but there was a minor significant ($P \leq 0.05$) increase in all samples during the preparation stage. According to Lehninger(1970), the increase in egg acidity during and after cooking could be due to several variables, the first of which is that egg white proteins undergo thermal denaturation and polypeptide chain unwinding during cooking. These structural changes expose previously hidden ionizable amino acid residues to an alkaline environment, causing protons to be released.

pH value: Table (6) indicates the impact of food service procedures on egg pH value in Sudanese hospitals. All hard-boiled eggs given at all hospitals and stages were compared to the pH values reported by Hong and Kirk (1995)who observed that the pH of an egg was 7.6.While whole eggs have a neutral pH, egg white is one of the few naturally alkaline foods, with a pH as low as 7.6 when laid but increasing alkalinity as the egg ages, eventually reaching a pH of 9. One of two elements that can alter the pH of the egg is the hen's age at the time of laying. The pH of a fresh egg yolk is around 6.0, but it rises from 6.4 to 6.9 following storage. By storing the thick egg white in the refrigerator, the pH shift is significantly reduced, as is the rate of thinning (Hong and Kirk 1995) . The pH of eggs administered in private and government hospitals did not vary significantly ($P \leq 0.05$) at any point in the food chain, nevertheless, there was a minor non-significant reduction in all samples during the processing stage, when the egg was heated to boil. This matches the findings of Sukker (1983), who reported a pH drop during and after cooking, likely due to ion migration from the yolk to the white via the vitelline membrane, the pH of the egg white drops during cooking while the pH of the yolk rises. According to Goodno *et al*., (1976), the rise in the pH of the eggs could be due to the release of carbon dioxide from the egg through the pores in the shell. Eggs kept at ambient temperature have a higher pH than boiled and refrigerated eggs.

Total viable count of bacteria (CFU/g): Table (7) indicates the impact of food service procedures on total viable count of bacteria log10 CFU/g values in Sudanese hospitals. The total viable count of bacteria in all hard-boiled eggs delivered at all hospitals and stages was compared to the total viable count of bacteria in eggs as found by Eke *et al.* (2013), being 3.6 log10 CFU/g. The economic viability of the global egg business is dependent on egg shell quality. Poor egg shell quality might lead to food illness. The majority of foodborne outbreaks are caused by microorganisms that have the potential to multiply in food. Foodborne illness is a worldwide public health threat that can cause chronic illness, increased medical expenditures, investigations, missed productivity, and even death. The majority of Salmonella and Campylobacter are adaptive animal illnesses that do not cause illness in animals but can harm humans if spread through eggs and poultry (Momani *et al.,* 2018). The total live bacteria content of eggs given at private and governmental hospitals varied significantly ($P \leq 0.05$) at all stages of the food chain, with a probable decrease in all samples during the processing step, where the egg was heated to boil. This is in line with the findings of (Kim *et al.,* 2014),

Table 6: Effect of food services protocol on eggs pH value in Sudanese hospitals

Food chain stages	Private hospitals		Governmental hospitals		Overall of food chain stages
	A	B	C	D	
Raw	$7.74^{a}\pm0.20$	$7.66^{a}\pm0.27$	$7.66^{a}\pm0.20$	$7.55^{a}\pm0.12$	7.65^{A}
Storage	$7.41^{a}\pm0.13$	$7.42^{a}\pm0.26$	$7.50^{a}\pm0.16$	$7.66^{a}\pm0.15$	7.50^{A}
Preparation	$7.19^{a}\pm0.08$	$7.32^{a}\pm0.30$	$7.12^{a}\pm0.07$	$7.13^{a}\pm0.04$	7.19^{A}
Processing	$7.12^{a}\pm0.05$	$7.18^{a}\pm0.11$	$7.05^{a}\pm0.06$	$7.10^{a}\pm0.03$	7.11^{A}
Display	$7.07^{a}\pm0.09$	$7.06^{a}\pm0.11$	$7.04^{a}\pm0.14$	$7.08^{a}\pm0.10$	7.06^{A}
Overall mean hospitals	7.31^{A}	7.33^{A}	7.27^{A}	7.30^{A}	
P-value	4.713^{NS}				
LSD0.05	0.2918				
SE±	0.1026				

Mean±SD values in a columns bearing different superscripts are significantly different($P \leq 0.05$).

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

Food chain stages	Private hospitals		Governmental hospitals		Overall of food chain stages
	A	B	C	D	
Raw	$3.00^{a}\pm0.03$	$2.00^{ab}\pm0.02$	$2.00^{ab}\pm0.02$	$2.00^{ab}\pm0.02$	2.25^{A}
Storage	$3.25^{a}\pm0.04$	$1.00^{bc}\pm0.01$	$2.00^{ab}\pm0.02$	$0.00^{c}\pm0.00$	1.56^{AB}
Preparation	$3.25^{a}\pm0.04$	$2.00^{ab}\pm0.02$	$2.00^{ab}\pm0.02$	$2.00^{ab}\pm0.02$	2.31^{A}
Processing	$0.00^{c}\pm0.00$	$3.25^{a}\pm0.04$	$0.00^{c}\pm0.00$	$0.00^{c}\pm0.00$	0.81^{B}
Display	$0.00^{c}\pm0.00$	$0.00^{c}\pm0.00$	$0.00^{c}\pm0.00$	$0.00^{c}\pm0.00$	0.00^{C}
Overall mean hospitals	1.90^{A}	1.65^{A}	1.20^{AB}	0.00^{B}	
P-value	0.0143*				
LSD0.05	1.706				
SE±	0.5784				

Mean±SD values in a columns bearing different superscripts are significantly different ($P\leq0.05$).

who found that the total bacterial count was reduced from 3.7 to 0.9 log10 CFU/g during and after cooking.

Yeasts and moulds count (CFU/g): Table (8) shows the influence of food service protocol on the log10 CFU/g value of yeasts and moulds in Sudanese hospitals. All hard-boiled eggs were counted for yeast and moulds at all hospitals and stages, and the results were compared to those reported by Eke *et al.* (2013). They found that yeast and mould level of 3.6 log10 CFU/g in an egg. The presence of yeasts and moulds in both the shell and the internal content of eggs may be due to fungal spores entering the eggs almost as soon as they are laid.According to Etches (1992), the resistance of eggs to yeast and moulds deteriorates as they age, allowing yeast and moulds to penetrate the egg inside. There were significant differences ($P\leq0.05$) in total yeasts and moulds content offered at private and governmental hospitals at all food chain levels, there was cross-contamination in samples taken from C and A hospitals. Food handlers failing to pay attention to the kitchen's hygienic design, as well as cleaning and sanitation practices, could result in cross-contamination in the hospitals indicated. The heat treatment has reduced the number of yeasts and moulds, most yeasts and moulds are not resistant to high temperatures.

Salmonella* and *E. coli: *Salmonella* infections have a long history of producing a variety of bacterial foodborne diseases (Mead *et al.,* 1999). One of the most prevalent serotypes of Salmonella is Salmonella enteritidis, which is closely associated with eggs and egg products (McKellar & Knight,

Table 8: Effect of food services protocol on eggs yeasts and moulds count log10 (CFU/g) in Sudanese hospitals

Food chain stages	Private hospitals		Governmental hospitals		Overall of food chain stages
	A	B	C	D	
Raw	$2.00^{ab}\pm0.03$	$2.00^{ab}\pm0.03$	$2.00^{ab}\pm0.03$	$2.25^{ab}\pm0.04$	2.06^{AB}
Storage	$0.00^{b}\pm0.00$	$3.25^{a}\pm0.05$	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	0.81^{ABC}
Preparation	$2.00^{ab}\pm0.03$	$2.00^{ab}\pm0.03$	$2.00^{ab}\pm0.03$	$0.00^{b}\pm0.00$	1.50^{AB}
Processing	$2.25^{ab}\pm0.04$	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	0.56^{BC}
Display	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	0.00^{C}
Overall mean hospitals	1.25^{A}	1.45^{A}	0.80^{A}	0.45^{A}	
P-value	0.0492*				
LSD0.05	2.255				
SE±	0.7645				

Mean±SD values in a columnsbearing different superscripts are significantly different ($P\leq0.05$).

2000). *Salmonella spp*. was not discovered in any of the hospital egg samples. According to Sharma & Carison (2000) the percentage of eggs affected in the retail market is estimated to be less than 0.01 percent of eggs generated by non-infected flock Sharma & Carison (2000). *E. coli* is a frequent food-borne bacterial disease, with the most common sources of human sickness being eggs, chicken, and poultry products. It's usually associated with eating polluted animal-based items including poultry, dairy, and eggs (Gebreyes *et al*., 2000, Rajashekara *et al*., 2000, Daly *et al.,* 2002 & Sahilah *et al*., 2010). Infection with *E. coli* was not discovered in any of the eggs samples taken from any of the hospitals. These findings are similar to those of (De Reu *et al.,* 2006), who foundd *E. coli* in 0.8 percent of total egg samples, indicating exogenic contamination by bacteria deposited on the egg's surface after it was laid.

CONCLUSIONS

The importance of a hospital's food service system to the success of the health care business can not be overstated. As a result, the operational efficiency of food service can have a significant impact on a hospital's budget and the patient's perceived level of satisfaction. The influence of the food chain stage on the nutritional status of food served as patient's foods, the effect of the food chain stage on the nutritional status of food, and the necessity to compensate for loss were all investigated in this study. Microbial loads were determined to be as low as feasible at one time, however,amicrobial activity must be kept as low as possible because many patients have compromised or defective immune systems that cannot tolerate microbial invasion in the GIT tract. Compared to governmental hospitals, private hospitals have better organization at the end of food service process.

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أثر بروتوكول الخدمات الغذائيه على جودة وسلامة البيض المقدم فى مستشفيات مختاره بولايه الخرطوم-السودان

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الهدف من هذا العمل هو تقييم جودة الخدمات الغذائية وتحديد أسباب مشكلات الجودة (تقييم جودة وسلامة البيض(في المستشفيات. شملت عملية التقييم؛ اختيار اثنتين من المستشفيات الخاصة (A&B) واثنتين من الحكومية (C&D) في ولاية الخرطوم، تم أخذ عينات البيض خلال مراحل السلسلة الغذائية في المستشفى (مرحلة الغذاء الخام، مرحلة التخزين، مرحلة الإعداد، مرحلة المعالجة ومرحلة العرض) للكشف عن سبب التغيير في القيمة الغذائية وسلامة وجودة طعام المرضي. تم دراسة التركيب الكيماوي (نسبة الرطوبة ٪، نسبة الرماد ٪، نسبة البروتين ٪ ونسبة الدهن ٪، قيمة الأس الهيدروجيني والحموضة الكلية ٪) والأعداد الجرثومية (العدد البكتيري الكلي، الخميرة والعفن، بكتيريا القولون الكلية، تواجد السالمونيلا والمكورات العنقودية) لجميع العينات في جميع المراحل. أظهرت نتائج محتوى الرطوبة (٪) تأثيرًا معنويًا (P≤٠,٠٥) حيث وجدت زيادة طفيفة في المستشفيات الخاصة وانخفاض محتمل في المستشفيات الحكومية. أوضحت قيمة محتوى البروتين (٪) الخام أن هنالك بشكل ملحوظ (P≤ ٠,٠٥) انخفاضًا طفيفًا في المستشفيات الخاصة وزيادة محتملة في المستشفيات الحكومية. أظهرت قيمة محتوى الدهن (٪) انخفاضًا طفيفًا في جميع العينات، أما العينة المأخوذة من المستشفي الحكومي (D) فقد أظهرت زيادة محتملة كبيرة في المرحلة الأخيرة (مراحل المعالجة والعرض). أظهر محتوى الرماد (٪) عدم وجود فروق معنوية ذات دلالة إحصائية (P≤٠,٠٥) في جميع العينات المقدمة في جميع المستشفيات. أما الحموضة (٪) فلم تكن في جميع مراحل السلسلة الغذائية ذات فروق معنوية لها دلالة إحصائية (P≤٠,٠٥). وكان هناك انخفاضًا غير معنوي (P≤٠,٠٥) في قيمة رقم الأس الهيدروجيني وأظهر انخفاضًا ليس له دلاله إحصائية (P≤٠,٠٥). اظهر تعداد البكتيريا في المستشفيات انخفاضا كبيرا (P≤٠,٠٥) خلال مراحل السلسلة الغذائية. أظهرت عينات البيض في إجمالي محتوى الخمائر والعفن في المستشفيات الخاصة (A&B) والحكومية (C&D) انخفاضًا ملحوظًا (P≤٠,٠٥).لم يتم اكتشاف السالمونيلا والبكتيريا القولونية في جميع العينات المأخوذة من جميع المستشفيات في جميع مراحل السلسلة الغذائية. مما سبق يتضح أن السلامة الصحية المرتبطة بهذه المستشفيات كانت خالية من الملوثات.