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Microbial Safety of Dried Fish Meat (*Kejeik*) Produced in Sudan

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Abstract

The present study aimed to estimate the microbiological characteristics as well as the safety of traditionally fermented fish product, *Kejeik*. *Kejeik* samples were collected from Singah city (Blue Nile) and Kusti city (White Nile), Sudan. These samples were previously prepared from Ijl, Nawk and Garmut fish types. The microbiological analyses indicated that *Kejeik* products were devoid of any harmful bacteria like *Salmonella*, *Listeria monocytogenes* and *Escherichia coli* O157:H7. The highest count of aerobic bacteria was found in Singa ijl *Kejeik* (SIK) which was 7.6×10^4 cfu/gm. The *Enterbacteriaceae* isolated from *Kejeik* samples were identified as *Enterobacter cloacae*, and their counts in *Kejeik* prepared from Ijil, Nawk and Garmut fish were 1.09×10^4, 0.93×10^5 and 3.5×10^4 cfu/gm, respectively. On the other hand, the counts of aerobic bacteria in *Kejeik* prepared from Ijl, Nawk and Garmut were 7.2×10^5, 4.1×10^5 and 3.4×10^5 cfu/gm, respectively. The higher aerobic bacterial load of the various *Kejeik* samples could be due to improper handling and sanitary condition during the preparation and their moisture contents. The *Bacillus* isolated from *Kejeik* samples were identified as *Bacillus cereus*, and the counts of it in *Kejeik* prepared from Ijl, Nawk and Garmut were 5×10^5, 2.3×10^4 and 1.0×10^4 cfu/gm, respectively. The fungi isolated from *Kejeik* samples were identified as *Aspergillus niger*, *Alternaria*, and *Penicillium*. However, fungi counts in Ijl Kejeik, Nawk *Kejeik* and Garmut *Kejeik* were 1.6×10^4, 1.6×10^4 and 1.2×10^4 cfu/gm, respectively. The yeast isolated was identified as *Rhodotorula* and *Cryptococcus laureate*, and their counts in Ijl *Kejeik* and Nawk *Kejeik* were 0.9×10^4 and 0.9×10^4 cfu/gm, respectively. The halophlic bacteria found in *Kejeik* samples could be identified as *Kocuria rosea* and *Streptococcus dysgalactiae*.

Keywords

***Kejeik*; Microbiological Analysis; Coliform; *Escherichia coli*; Gram Staining**

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1. Introduction

Fish is one of the most important sources of animal protein available in the tropics and has been widely accepted as a good source of protein and other elements for the maintenance of healthy body. Salting and drying is an ancient and simplest method to preserve fish. Salting and sun drying of fish is a traditional method of seafood preservation employed in many countries.

Sudan has the presence of a number of large water reservoirs, which contains a huge wealth of fish of several types, and the estimated wealth was about 110 thousand tons of fish [1].

The main sources of fish in Sudan are the Blue Nile, White Nile, River Nile, lake reservoirs behind dams and irrigation canals as well as the red sea for marine fish production.

The fishing industry in Sudan practiced in primitive ways, and thus relatively few quantities are manufactured and consumed locally, which does not allow for the export level which promotes the expansion of large scale manufacturing. It is imperative to increase investment in the exploitation of fish stocks and commercial quantities by the appropriate preservation of fish [1]. Currently, seven fish products mostly produced in Sudan include: Alvesikh, dried fish *Kejeik*, indigenous Turkein "salinity" chilled fish, frozen fish, canned fish, smoked fish and fish waste. Dried fish from low-cost traditional industries and citizens exercised on the Blue Nile and White Niles [2]. One of these home Products is a dried black or brown *Kejeik* made from Garmut (*mud-fish, Clarias angullaris*, *Clazera*); Nawk (thick-skinned fish, *Heterotis niloticus*,) Humar-el-hout (black spotted cat fish, *Heterotis niloticus bidarsalis*).

Kejeik, which is also called *Korki* and hout, is a traditional food product obtained by sun drying of large fish. It is prepared along the White Nile, Blue Nile and the Atbara River. *Kejeik* is consumed in many parts of Sudan as a whole food or as a sauce. *Kejeik* is produced in the southern Sudan by the Nilotic tribes: the Dinka, Nure and Shulluk. Many subgroups of these large tribes live in the vast swampy area of the alongside the Nile. Here the river spreads out inundating thousands of hectares, thus supporting a large growth of aquatic weeds. Here the water is shallow so that members of these tribes catch fish by spears. Although the greater majority of the products come from the Southern Sudan, *Kejeik* is also prepared in some part of northern Sudan along the White Nile, the Blue Nile and Atbara River [2]. Generally, fish contains a large number of microorganisms, and the major factors contributing to the poor quality of fish in retail trade are unhygienic handling and storage leading to off-smell, physical damage and contamination by dirt and objectionable microorganisms. Data about microbiological safety of fish products in Sudan are scarce, which initiates the researchers to investigate the microbiological quality and safety of *Kejeik* product collected from two different areas in Sudan.

2. Materials and Methods

2.1. *Kejeik* Preparation

Eighteen processed *Kejeik* (**Figure 1**) previously prepared from fish types: Garmut (Eelcat fish), Ijl (Nile perch) and Nawk (Armoured fish) samples were collected from local markets in Singah and Kusti (Central Sudan) during the period January-April 2010. The fish samples had been produced by natural fermentation. In this process the fisher men are used to prepare *Kejeik* from fresh water Nile fish, the fish were split longitudinally, gutted and beheaded, the split fish were then hung on ropes or spread on rock or tree branches, out in the open air, under the direct sun. When the drying process was over, the large pieces of fish are stacked together on mats, covered with another set of mats and trodden check on by fishermen, to flatten and pack the dry fish more compactly, further shade drying them follows after which the fish products were ready to be transported to the local markets [2].

The *Kejeik* samples were collected in clean, dry containers, and were ground, homogenized and packed in sterilized plastic vacuum bags, stored in carton and kept at room temperature (25˚C). Some of samples were transported to the Central Food Laboratory in Qatar for microbiological and chemical analyses.

2.2. Microbiological Analysis

Different microbiological analyses were carried out to determine the safety of *Kejeik* products. However, all microbiological parameters were conducted in triplicate, the means and standard deviations were calculated.

2.2.1. Preparation of Dilutions

Serial dilutions from each sample were prepared before subsequent culturing according to the microbiological

Figure 1. *Kejeik* product.

techniques of, Food and Drug Administration (FDA) published and distributed by AOAC [3].

Twenty five gram of *Kejeik* were weighed to Stomacher® lab system then mixed with 225 ml of peptone water, the mixer was blended for 60 seconds. Then 10 ml from each *Kejeik* were transferred to 90 ml sterile peptone water (0.1%) and thoroughly mixed to give 10 ml of each sample was transferred to 90 ml of sterile diluent, as a first dilution 10^{-1}, serial dilutions were made up to 10^{-6} and 1 ml of each dilution was transferred aseptically in triplicate into Petri-dishes

2.2.2. Enumeration of Standard Plate Count/Total Viable Count (SPC)

The Standard plate count (SPC) was used to enumeration the total visible count in *Kejeik* sample using plate count agar according to the Standard methods of AOAC [4]. 0.1 ml amount of each dilution (10^1, 10^2, 10^3, 10^4, 10^5) were transferred into 3 Petri dishes, of prepared standard plate agar plate, (Dried at 50˚C for 30 minutes), spread thoroughly to give a uniform dispersion of the microbial cell. The plates were incubated in an inverted position at 37˚C for 48 hours, plates with 30 < X > 300 colonies were counted, and the average was multiplied by the relevant dilution factor to give the number of colony-forming units (cfu/ml) of original sample.

2.2.3. Enumeration of Coliform and *Escherichia coli*

Coliform and *Escherichia coli* count were determined by pour technique according to AOAC [4].

One ml of diluents was mixed with 10 - 12 ml of VRBA (Violet Red Bile Salts Agar)/Mac-Conkey agar, then after solidification over layed with VRBA with MUG (5 - 10 ml) and incubated at 37˚C for 24 hours, all the colonies having >0.5 mm in diameter were presumed as coliforms. Then tubes were incubated at 37˚C except for *E.coli* broth which was incubated at 44.5˚C for 24 - 48 hours (For fecal coliforms), turbid tubes with gas produced were taken as coliforms. And all fluorescent LST-MUG tubes and turbid EC tubes at 44.5˚C without or with gas were presumed as fecal coliforms or *E. coli*.

2.2.4. *Escherichia coli* O157:H7

For enumeration *E. coli* in *Kejeik* samples, ten grams of *Kejeik* were weighed, added to sterile stomacher bag and 90 ml of modified EC broth supplemented with Vancomycin, Cefsulodin, Cefixime-VCC), then blended for 30 - 60 seconds, and incubated at 37˚C for 24 hours. The enrichments streaked on 5-Bromo.4-Chloro-3indoxyl-*β* D glucuronic acid (BCIG) Chromogenic media, and then incubated at 37˚C for 24 hours. Then straw yellow colored colonies on BCIG Chromogenic media were presumed as *E. coli* O157:H7.

2.2.5. Determination of Acidophilic Bacteria

The acidophilic bacteria count was enumerated according to APHA [5] method. Twenty five gram of each sample were weighed to sterile stomacher bag and 225 ml peptone water (Official method 59 g/450 ml) were added then blended for 60 seconds, 0.1 - 0.2 ml were spread for each dilution (10^1 - 10^2) were transferred into each of 3

Petri dishes streaked on selective agar plates Rogosa Agar, and incubated at 37˚C for 48 hours, then plates with 50 colonies were counted, and the average was multiplied by the relevant dilution factor to give the number of colony-forming units (cfu/gm) of original sample.

2.2.6. Determination of Halophilic Bacteria

Twenty five gram of each sample were weighed to sterile stomacher bag and 225 ml peptone water were added, then blended for 30 - 60 seconds. Each dilution (10^1 - 10^5) was transferred into Petri dishes containing Tryptone soya agar with 3% NaCl (TSA 3% NaCl), and incubated at 37˚C for 48 hours, plates with 30 - 300 colonies were counted, and the average was multiplied by the relevant dilution factor to give the number of colony-forming units (cfu/gm) of original sample [6].

2.2.7. *Vibrio parahaemolyticus* and *Vibrio cholera* (MPN Procedure (9 Tube System))

Twenty five grams of each sample were weighed to sterile stomacher bag and 225 ml alkaline peptone water/3% NaCl (10^1) (Official method 59 g/450 ml) were added, then blended for 30 - 60 seconds, serial dilutions were prepared to get 10^2 and10^3 diluents, and one ml aliquot of samples were transferred in 3% NaCl dilution tubes, and incubated at 35˚C for 24 hours. Then tested for turbidity, the positive and negative tubes were then recorded for all dilutions. The turbid tubes were streaked on Thiosulfate Citrate Bile Salt Sucrose Agar (TCBS) plates and incubated at 35˚C for 24 hours. The plates were examined for typical *Vibrio parahaemolyticus* colonies which were large (3.5 mm diameter), round with blue green color, were presumed as *Vibrio parahaemolyticus* and yellow colonies were presumed as *Vibrio cholera*. Confirmation of *Vibrio* spp. was done biochemically by picked the colony from non-selective agar (blood agar/nutrient agar). Then identified by system of VITEK2 (Compact) (GP-KIT).

2.2.8. Detection of *Salmonella* spp.

The *Salmonella* was detected in *Kejeik*, by the MSRV method, in which, 25 grams of each sample were weighed to a sterile stomacher bag and 225 ml of Lactose Broth were added, the mixture was then homogenized in the stomacher bag for 30 - 60 seconds and, after sealing the bag with tape, the homogenate was incubated at 37˚C for 24 hours. Then 0.1 - 0.2 ml of enrichments were transferred to the center of modified Semisolid Rapp port Vassiliadies plates (MSRV), and incubated at 42˚C for 24 hours, the motile *Salmonella* spp present in food sample the migrate through the medium ahead of competing motile organisms thus producing opaque halos of growth forming a circle with uniform growth. Then was streaked on selective agar plates Xylose Lysine Desoxycholate agar (XLD), and incubated at 37˚C for 18 - 24 hours, red colonies with black center on XLD plates and typical reaction of acid yellow with gas formation and alkaline (red) slope with black (H_2S production) was presumed as *Salmonella* spp. [7].

2.2.9. Determination of Yeast and Moulds

For determination of yeast and mold, from suitable dilution 0.1 - 0.2 ml was aseptically transferred onto solidified PDA medium, samples were spread all over the plates using bacteriological sterile plastic loops (10 µl). Plates were then incubated at 22˚C for (120) hours. Colony forming units (cfu) were counted using a colony counter and the results were presented as cfu/ml.

2.2.10. Identification of Pathogenic Bacteria Gram Staining

Smear for isolates of yeast and moulds under microscope, were prepared according to Bartholomew [8]. The heat was fixed on glass slide the smear was stained with crystal violet for 1 min, then washed off excess stain with water, the iodine solution was added and was allowed to react for a minute, after that the slide was rinsed with ethanol (95%) for 30 sec so as to remove excess crystal violet, finally, the smear was counter stained with safranin solution, then was allowed to react for 30 sec, washed with water, dried and examined. Gram positive cells were appeared as blue, while gram negative cell as pink colored.

2.2.11. Identification of Pathogenic Bacteria Using Biochemical Tests

The culture were purified and streaked on non selective agar (Nutrient agar) and identified by system of VITEK2 (Compact) by KIT.

2.2.12. Identification of *Listeria monocytogenes*

Ten grams sample were weighed to sterile stomacher bag and 90 ml of Listeria enrichment broth (LEB) were added, the mixture was blended and incubated at 32˚C for 24 hours [9]. From the incubated broth (per enrichments) one ml was transferred to 9 - 10 ml of fraser broth, and incubated at 35˚C for 24 hours, then tube that darker or turned black, was taken as presumptive positive for *Listeria* spp.

2.2.13. Identification of *Staphylococcus aureus*

Twenty five grams of each sample were weighed to sterile stomacher bag, and 225 ml peptone water (Official method 59 g/450 ml) were added, then blended for 30 - 60 seconds, and serial dilutions were prepared, 0.1 - 0.2 ml diluents were spread on Baird-Parker agar plate (dried at 32˚C for 30 min), and incubated at 35˚C for 48 hours. Then clear zone with typical gray-black colonies was taken as presumptive evidence of *Staphylococcus aureus*.

2.2.14. Identification of *Bacillus cereus*

Twenty five grams of each sample were weighed to sterile stomacher bag and 225 ml peptone water (Official Method 59 g/450 ml) were added, then blended for 30 - 60 seconds, serial dilutions were prepared, 0.1 - 0.2 ml diluents were spread on *Bacillus cereus* selective agar (BC) (dried at 50˚C for 30 mints), incubated at 30˚C - 32˚C for 48 hours, turquoise to peacock blue color colonies surrounded by zone of same color on (BC) plates was presumed as *Bacillus cereus*.

3. Results and Discussion

Fish, because of their soft tissues and aquatic environment are extremely susceptible to microbial contamination. Millions of bacteria, many of them potential spoilers, are present in the surface slime, on the gills and in the intestines of live fish. Although the flesh itself is normally sterile, bacterial growth and invasion on the fish are prevented by the body's natural defense system while they are alive, but after death the defense system breaks down and the bacteria multiply and invade the flesh.

Fish is a reservoir of large number of microorganisms; one of the major factors contributing to poor quality of the fish in retail trade is unhygienic handling and storage leading to off smell, physical damage and contamination with dirt and objectionable microorganisms [10].

Microbial action has been known to play a large part in the spoilage of fish [11]. Bacterial spoilage is characterized by softening of the muscle tissue and the production of slime and offensive odours.

Data presented in **Table 1** show the microbiological characteristics of *Kejeik* samples collected from Singah city (Blue Nile). The count of aerobic bacteria in Kejeik samples prepared from Ijl, Nawk and Garmut were 7.6 × 10^4, 6.1 × 10^3 and 1.08 × 10^4 cfu/gm, respectively. The count of ijl *Kejeik* (7.6 × 10^4 cfu/gm**)** was higher than Nawk *Kejeik* and Garmut *Kejeik*. In fresh fish, the acceptable limit is 5 × 10^5 cfu/gm at 37˚C but for cooked or dried fish, the permissible limit is 1 × 10^5 cfu/gm at 37˚C. The high total viable count of aerobic bacterial load of *Kejeik* samples could be due to improper handling and sanitary conditions during the preparation.

The *Enterbacteriaceae* isolated from Kejeik samples were identified at species level as *Enterobacter cloacae*, and their counts in Ijl *Kejeik*, Nawk *Kejeik* and Garmut *Kejeik* were 1.09 × 10^4, 0.93 × 10^5 and 3.5 × 10^4 cfu/gm, respectively. The count of Nawk Kejeik (0.93 × 10^5 cfu/gm) was higher than those of Ijl *Kejeik* and Garmut *Kejeik*.

The coliform bacteria were not detected in most of the *Kejeik* samples with exception to Garmut *Kejeik* which contained 3.6 × 10^4 cfu/gm. The absence of coliform in the different *Kejeik* samples could be attributed to the processing. Total coliform group can be sub grouped as fecal and non fecal coliforms. The fecal coliform subgroup is derived from feces of human and other warm-blooded animals such as cows, sheep, poultry etc. The presence of fecal coliform organisms indicates recent and possibly hazardous fecal pollution [12].

The *Bacillus i*solated from *Kejeik* samples were identified at species level as *Bacillus cereus*, the counts of it in Ijl *Kejeik*, Nawk *Kejeik* and Garmut *Kejeik* were 5 × 10^5, 2.3 × 10^4 and 1.0 × 10^4 cfu/gm, respectively. The count of *Bacillus cereus* of ijl *Kejeik* (5 × 10^5 cfu/gm) was higher than those of other *Kejeik* samples.

The fungi isolate *Kejeik* samples could be identified as *Aspergillusniger*, *Alternaria*, *and Penicillium* sp. However, fungi counts in Ijl, Nawk and Garmut were 0.91 × 10^4, 1.2 × 10^4 and 1.2 × 10^4 cfu/gm, respectively. Presence of different fungal species in dried seafood's in different seasons were reported by many investigators

Table 1. The microbiological characteristics* (mean ± SD) of *Kjeik* samples collected from Singa city (Blue Nile).

Microbial Characteristic	*Kejeik* samples		
(cfu/gm)	Ijl	Nawk	Garmut
Total bacterial count (spc)	$7.6 \times 10^6 \pm 0.77$	$6.1 \times 10^5 \pm 0.48$	$1.08 \times 10^6 \pm 0.06$
Enterbacteriacea	$1.09 \times 10^4 \pm 0.7$	$0.93 \times 10^5 \pm 0.14$	$3.5 \times 10^5 \pm 0.23$
Coliform	Nil	Nil	$3.6 \times 10^5 \pm 0.4$
Bacillus cereus	$5 \times 10^5 \pm 0.001$	$2.3 \times 10^4 \pm 0.23$	$1.0 \times 10^4 \pm 0.01$
Total Yeast	$0.21 \times 10^5 \pm 0.21$	$3.6 \times 10^4 \pm 0.33$	Nil
Total Molds	$0.91 \times 10^4 \pm 0.001$	$1.2 \times 10^4 \pm 0.52$	$1.2 \times 10^4 \pm 0.52$
Acidophlic bacteria	Nil	Nil	Nil
Halophlic bacteria	$5.5 \times 10^6 \pm 0.6$	$8.5 \times 10^5 \pm 1.1$	$6.2 \times 10^5 \pm 0.59$
Escheriaceae. coli (*E. coli*)	Nil	Nil	Nil
Escheriaceae. coli O157:H7	-ve	-ve	-ve
Staphyloccoccus aureus	Nil	Nil	Nil
Salmonella	-ve	-ve	-ve
Listeria monocytogenes	Nil	Nil	Nil
Vibrio parahaemolyticus	Nil	Nil	Nil
Vibrio cholorea	Nil	Nil	Nil

*All parameters were conducted in triplicate.

[13]-[16]. Fungi generally prefer substrate with low water activity and usually vary in dry samples. This probably explains the occurrence of fungi in sun-dried *Kejeik samples*. The water activity in dried products is low and in favour of spore-former fungi as a result of spreading of spores by air since fish is exposed to ambient atmosphere [17].

The Yeast isolates from *Kejeik* samples were identified as Rhodotorula, and *Cryptococcus laurentii*, and their counts in Ijl *Kejeik* and Nawk Kejeik were 0.21×10^5 and 3.6×10^4 cfu/gm, respectively.

The Halophlic bacteria found in *Kejeik* samples could be identified as *Kocuria rosea*, *Streptococcus dysgalactiae* Subspecies *equisimilis* and *Enterococcus faecalis*. The count of halophic bacteria in Ijl, Nawk and Garmutwere 5.5×10^6, 8.5×10^5 and 6.2×10^2 cfu/gm, respectively. The count of Halophilic bacteria of ijl *Kejeik* (5.5×10^6 cfu/gm**)** was higher than those of other *Kejeik* samples. Contamination *of Kejeik* products with halophilic bacteria could be attributed to external contamination and handling at ambient temperature.

On the other hand data presented in **Table 2** show the microbiological characteristics of *Kejeik* samples collected from Kusti city (White Nile). The count of aerobic bacteria in *Kejeik* prepared from (Ijl), (Nawk) and (Garmut) were 7.2×10^5, 4.1×10^5 and 3.4×10^5 cfu/gm, respectively. The count of ijl *Kejeik* (7.2×10^5 cfu/gm**)** was higher than nawk *Kejeik* and garmut *Kejeik*. The high total viable count of aerobic bacterial load of Kejeik samples could be due to improper handling and sanitary condition during the preparation and moisture content.

The *Enterbacteriaceae* isolates from *Kejeik* samples were identified at species level as *Enterobacter cloacae*, and their count in Ijl *Kejeik*, Nawk *Kejeik* and Garmut *Kejeik* were 1.7×10^3, 2.1×10^4 and 1.3×10^5 cfu/gm, respectively. The count of Garmut *Kejeik* (1.3×10^5 cfu/gm) was higher than those of Ijl *Kejeik* and Nawk *Kejeik*.

The coliform bacteria were not detected in all *Kejeik* samples but the Ijl *Kejeik* contained (0.67×10^4 cfu/gm) and Nawk *Kejeik* contained (3.2×10^4 cfu/gm). The absence of coliform in the different *Kejeik* samples could be attributed to the source of food taken by the fish and water activity.

The *Bacillus i*solated from *Kejeik* samples were identified at species level as *Bacillus cereus*, the counts of it in Ijl *Kejeik*, Nawk and Garmut *Kejeik* were 1.3×10^4, 0.4×10^5 and 1.3×10^5 cfu/gm, respectively. The count of *Bacillus cereus* of Garmut *Kejeik* (1.3×10^5 cfu/gm) was higher than those of other *Kejeik* samples.

The fungi isolated from *Kejeik* samples were identified as *Aspergillus niger*, *Alternaria, and Penicillium*. sp. However, fungi counts Ijl *Kejeik*, Nawk *Kejeik* and Garmut *Kejeik* were 1.6×10^4, 1.6×10^4 and 1.2×10^4 cfu/gm, respectively.

The Yeast isolates were identified as *Rhodotorula* and *Cryptococcus laureate*, and their counts in Ijl *Kejeik*

Table 2. The microbiological characteristics (mean ± SD) of *Kjeik* samples collected from Kusti city (White Nile).

Microbial Characteristic	*Kejeik* samples		
(cfu/gm)	Ijl	Nawk	Garmut
Total bacterial count (spc)	$7.2 \times 10^5 \pm 2.0$	$4.1 \times 10^5 \pm 0.44$	$3.4 \times 10^5 \pm 0.14$
Enterbacteriacea	$1.7 \times 10^3 \pm 0.2$	$2.1 \times 10^4 \pm 0.22$	$1.3 \times 10^5 \pm 0.57$
Coliform	$0.67 \times 10^4 \pm 0.29$	$3.2 \times 10^4 \pm 0.82$	Nil
Bacillus cereus	$1.3 \times 10^4 \pm 0.57$	$0.4 \times 10^5 \pm 0.17$	$1.3 \times 10^5 \pm 0.57$
Total Yeast	$0.9 \times 10^5 \pm 0.01$	$0.9 \times 10^5 \pm 0.01$	Nil
Total Molds	$1.6 \times 10^4 \pm 0.69$	$1.6 \times 10^4 \pm 0.69$	$1.2 \times 10^4 \pm 0.52$
Acidophlic	Nil	Nil	Nil
Halophlic bacteria	$2.3 \times 10^5 \pm 0.72$	$2.3 \times 10^5 \pm 0.72$	$7.3 \times 10^5 \pm 0.96$
Escheriaceae coli (*E. coli*)	Nil	Nil	Nil
Escheriaceae coli O157:H7	-ve	-ve	-ve
Staphyloccoccus aureus	Nil	Nil	Nil
Salmonella	-ve	-ve	-ve
Listeria monocytogenes	Nil	Nil	Nil
Vibrio parahaemolyticus	Nil	Nil	Nil
Vibrio cholorea	Nil	Nil	Nil

*All parameters were conducted in triplicate.

and Nawk *Kejeik* were 0.9×10^4 and 0.9×10^4 cfu/gm, respectively.

The halophlic bacteria found in *Kejeik* samples could be identified as *Kocuria rosea*, *Streptococcus dysgalactiae* Subspecies *equisimilis* and *Enterococcus faecalis*. The count of Halophic bacteria in Ijl *Kejeik*, Nawk *Kejeik* and Garmut *Kejeik* were 2.3×10^5, 2.3×10^5 and 7.3×10^5 cfu/gm, respectively. The count of halophilic bacteria of Garmut *Kejeik* (7.3×10^2 cfu/gm**)** was higher than those of other *Kejeik* samples.

The occurrence of *Aspergillus* sp, *Rhizopus* sp *and Penicillium* sp could be due to the fact that during storage, the fish sample reabsorbed moisture from the environment which then supported the growth of the microorganisms in addition to the contamination during processing, handling and display on the market stalls [18].

The results of the present study showed absence of acidophlic bacteria, *Escheriaceae coli* (*E. coli*), *Escheria coli* O157:H7, *Staphyloccoccus aureus*, *Salmonella*, *Listeria monocytogenes*, *Vibrio parahaemolyticus* and *Vibrio cholorea*. The absences of harmful and pathogenic bacteria indicate safety of the *Kejeik* products and encourage its recommendation for consumption. It is well known that those pathogens associated with food intoxications are indicators of very poor hygienic quality [19]. Sun-drying might reduced microbial load in fish flesh but did not eliminate completely contaminants in most samples.

The variations in microbial counts of *Kejeik* samples from different markets and seasons in which some have higher microbial counts may be likely due to a lack of proper procedures adopted by the Kejeik processor and/or improper hygienic conditions. In preparation of *Kejeik*, fish must be dried quickly and hygienically in presence of great amount of sunlight and moving air and this protects fish from insects and dirt. In a similar study on sun-dried fish, Prakash [20] concluded that the poor quality of the dried fishes may be due to unhygienic processing, inadequate salting with poor quality salt and lack of air tight packing of the dried fishes.

4. Conclusion

The presented study pointed out that *Kejeik* is free from harmful bacteria (pathogenic and spoilage bacteria) acidophlic bacteria such as *Escheriaceae coli* (*E. coli*), *Escheria coli* O157:H7, *Staphyloccoccus aureus*, *Salmonella*, *Listeria monocytogenes*, *Vibrio parahaemolyticus* and *Vibrio cholorea*. The absence of harmful and pathogenic bacteria indicated safety of the *Kejeik* products and encouraged its recommendation for consumption. The variations in microbial counts of *Kejeik* samples from different markets and seasons could be attributed to a lack of proper procedures adopted by the *Kejeik* processor and/or improper hygienic in some of these areas. It is highly recommended to employ good manufacturing practices (GMP) during preparation of *Kejeik* under controlled and hygienic conditions using the appropriate fish type such as Ijil, Nawk and Garmut. In addition, using the appropriate package and packing the products is a scientific way to be presented the local and international

markets. In addition, it is recommended to increase public awareness about the importance of quality products and to avail products by hygienic processing of the fishes and air tight packing of the final product up to marketing of the products.

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