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Microbiological Quality Assessments of Biradon, Kesham and Kindrimo: Milk Products Sold in Maiduguri, Nigeria

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ABSTRACT

The presence of selected pathogenic bacteria in biradon, kesham and kindrimo sold in Maiduguri, Nigeria was investigated. Results showed that the mean *E. coli* count was 2.43, 3.31 and 2.82 $\log_{10}$ cfu mL^{-1}, with range from 0.0 to 6.22, 0.0 to 6.30 and 0.0 to 5.48, respectively. Percentage *E. coli* in the samples was 21.6, 23.2 and 26.4%, respectively. The overall mean *S. aureus* count was 2.65, 1.16 and 2.41 $\log_{10}$ cfu mL^{-1} and ranged from 0.0 to 6.79, 0.0 to 3.87 and 0.0 to 6.39, respectively with percentage distribution of 32.8, 19.6 and 18.6%, respectively. The overall mean *Shigella* count was 0.15, 0.40 and 0.24 $\log_{10}$ cfu mL^{-1}, respectively whereas, the range fell between 0.0 and 0.48, 0.0 and 2.48 and 0.0 and 0.90, respectively and percentage distribution was between 0.0 and 4, 2 and 10 and 2 and 8%, respectively. The overall mean *Salmonella* count was 1.44, 1.83 and 1.23 $\log_{10}$ cfu mL^{-1}, the range was between 0.0 and 4.02, 0.0 and 4.76 and 0.0 and 3.30, respectively and percentage distribution was 7.6, 9.8, 7.6%, respectively. Coliform overall mean of 2.94, 4.12 and 3.72 $\log_{10}$ cfu mL^{-1}, respectively was recorded and the range between 0.0 and 6.48, 0.0 and 7.51 and 0.0 and 6.70 and overall mean percentage coliform was 30.8, 38.6 and 35.2%, respectively. The total viable overall mean of 5.34, 7.27 and 6.58 $\log_{10}$ cfu mL^{-1} and range value of between 0.0 and 8.48, 0.0 and 9.85 and 0.0 and 9.90, respectively was recorded. The products are contaminated with organisms with potential health risks to consumers. Proper hygiene in the process-line of nono was recommended.

Key words: Raw milk (biradon), fermented milk (kesham, kindrimo), coliform, total viable count, bacteria

INTRODUCTION

Milk is plentiful in Northern Nigeria owing to the abundance of cows, camels, goats and other milk producing animals and is consumed in both processed and unprocessed forms. It is therefore a major source of protein and a good source of calcium, phosphorous and vitamins A, the B complex, C and E (Nebedum and Obiakor, 2007), lactose sugar and fatty acids to the people. Traditionally, in Northern Nigeria, consumption of locally processed or unprocessed milk is remarkable.

Raw unpasteurised milk from cow called 'biradon' (Fulani) has high fats and oil content. Fulani is one of the ethnic groups in Nigeria. The people are known for flock keeping especially cows. The biradon is boiled for about 20 min and allowed to chance-ferment in open calabash or other containers for 12-24 h to make two types of nono products: 'kesham' and 'kindrimo' (both Fulani language for fermented milk). While Kesham is a watery nono, kindrimo is nono semi-solid in

rheology. In most situations, starter culture is not required and where required, it is a little quantity of the leftover of nono which is introduced into boiled and cooled biradon. After fermentation, the precipitated milk butter is filtered out for cheese processing in Kesham whereas, the fats and oil is left as part of kindrimo sold in markets. Biradon, kesham and kindrimo could be consumed anywhere including markets, schools, homes and offices and in fact in places of social gathering.

Giving the composition of milk, it is naturally ideal for the cultivation of many microbial species. As such, it could be contaminated with both pathogenic and non pathogenic microorganisms and could produce both desirable and non desirable products. Poor milk quality brought about by the presence of pathogenic organisms may result from either contamination via milkers or soiled equipment or infection of the diary animal (Chabo *et al.*, 2000) or could arise from the process water (Abdalla and El-Zubeir, 2006). In addition, cows are known to harbour enteric pathogenic microorganisms including *Salmonella, E. coli, Campylobacter* spp. and *Listeria* spp. (Adesiyun *et al.*, 1997) either in the udder's interior or exterior (Feresu and Muzondo, 1990) which could gain access to the milk during milking. Contaminated raw milk can be a source of harmful bacteria such as those that cause undulant fever, dysentery, salmonellosis and tuberculosis. Unpasteurized raw milk obtained from healthy cow can still contain significant level of disease causing microorganisms (Feresu and Nyati, 1990).

Recently, surveys of some organisms implicated in milk borne human infections or intoxications are being made. Hence, *E. coli*, *Staphylococcus aureus*, *Streptococcus* spp. and *Salmonella* have been isolated from fermented milk in Sudan (Abdalla and El-Zubeir, 2006). Similarly *E. coli*, *Staphylococcus aureus* and *Salmonella* had been isolated by other authors (Mohamed and El-Zubeir, 2007; Obi and Ikenebomeh, 2007). Other foodborne disease microorganism *Bacillus cereus* is frequently implicated in milk contamination.

The present study was aimed at assessing the microbiological quality and safety of three milk products: biradon, kesham and kindrimo consumed in Maiduguri, Nigeria.

MATERIALS AND METHODS

Sample collection: Biradon, kesham and kindrimo samples were purchased from Fulani Farm and four markets: Bulunkutu, Gwange, Monday and Bama in Maiduguri and transported to the Microbiology Laboratory in sterile corked plastic tubes packed in iced container. Twenty samples were purchased from each place for each of the milk product. Purchases were done between 8.00 and 11.00 a.m. each day lasting from March 2010 to July 2010.

Microbiological analyses: Biradon, kesham and kindrimo samples about 40 mL each contained in sterile screw-capped plastic bottles were used for the isolation and enumeration of the microorganisms. Ten milliliters of each sample was aseptically introduced into 90 mL of sterile normal saline and was homogenized by hand-shaking for 5 min followed by further decimal dilutions to up to 10^{-6} concentrations. A 0.1 mL quantity of appropriately diluted sample was used to inoculate freshly prepared media as described previously (Okonkwo, 2011). Media employed for the isolation and enumeration of the organisms included: Nutrient Agar (NA) (Biotech Lab. Ipswich, UK) for Total viable counts; MacConkey agar (Fluka Biochemika Steinhein, Germany) for Coliform; Baird Parker Medium (BPM) (Lab M. Ltd, Bury Lancashire BL9 6As, United Kingdom) for *S. aureus*; Eosine Methylene Blue Agar (EMBA) (Himedia Laboratories Pot Ltd, India) for *E. coli* and Desoxycholate Citrate Agar (DCA) (Park Scientific Limited, Moultan Park,

Northampton) for *Salmonella* and *Shigella* sp. All media except DCA were sterilized by autoclaving at 121°C for 15 min. DCA was sterilized by boiling over gauze as recommended by the manufacturer. Emergent colonies following incubation were counted using digital colony counter (Labtech, New Delhi, India).

Isolation and enumeration of *E. coli*: Isolation and enumeration of *E. coli* was done on EMBA plates inoculated as described above and incubated at 37°C for 48 h after which typical colonies with greenish metallic sheen were subjected to further biochemical testing for *E. coli*.

Isolation and enumeration of *S. aureus*: BPM were inoculated as above, incubated at 37°C for 48 h and subsequently examined for characteristics typical of *S. aureus*. Greyish-black or black colonies with or without a halo were presumptively identified as Staphylococci as recommended by Macfaddin (1977) and coagulase test was carried out to further characterize *S. aureus*.

Isolation and enumeration of *Salmonella* and *Shigella* sp.: Macfaddin (1977) procedure was used for the isolation and enumeration of *Salmonella* and *Shigella* sp. Typical colonies with black centres were identified as *Salmonella* sp. whereas, pinkish colonies were identified presumptively as Shigella and each subjected to further biochemical testing.

Coliform count (CC): Sterile MacConkey agar plates (MAP) were inoculated as above, incubated at 37°C for 48 h and subsequently examined for typical pinkish colonies.

Total viable count (TVC): TVC was performed by inoculating sterile Nutrient Agar plates as above, incubating at 37°C for 48 h and subsequently examining for emergence of colonies.

Biochemical identification of the isolates: The biochemical tests for the identification of the isolates were the IMVC; namely: indole, methyl-red, Voges-proskauer and citrate utilization and Triple Sugar Iron (TSI), urease, oxidase, coagulase and catalase tests described previously (Okonkwo, 2011). Confirmation of test results were based on Cowan and Steel (1965) and Cheesbrough (2004) s' procedures.

Statistical analysis: Data were analyzed by Multiple-Sample Comparison using STATGRAPHICS Centurion XVI Version 16.1.05 (32-bit). A one-way Analysis of Variance (ANOVA) was performed and when the F-test in the ANOVA was significantly ($p \leq 0.05$) different between the means, Multiple Range Tests were conducted to tell which means were significantly different from others.

RESULTS

***E. coli* count ($\log_{10}$ cfu mL^{-1}):** The mean *E. coli* counts ($\log_{10}$ cfu mL^{-1}) of biradon, kesham and kindrimo were between 1.24 and 3.30, 2.40 and 4.82 and 1.02 and 3.66, respectively from the different markets (Table 1) with an overall mean of 2.43, 3.31 and 2.82 $\log_{10}$ cfu mL^{-1}, respectively. The mean *E. coli* count of Gwange (kesham) was significantly higher ($p \leq 0.05$) than that of the other markets. *E. coli* counts ($\log_{10}$ cfu mL^{-1}) of biradon, kesham and kindrimo from different markets ranged from 0.0 to 6.22, 0.0 to 6.30 and 0.0 to 5.48, respectively (Table 2) with distribution

Table 1: Mean counts of different microorganisms isolated from biradon, kesham and kindrimo from different markets in Maiduguri (counts were expressed as log $_{10}$ cfu mL^{-1})

	E. coli			*S. aureus*			*Shigella*			*Salmonella*			*Coliform*			TVC		
Markets	BI	KE	KI	BI	KE	KI	BI	KE	KI	BI	KE	KI	BI	KE	KI	BI	KE	KI
Bulunkutu	2.14	3.42	3.60	3.48	1.12	2.90	0.00*	0.20*	0.16*	2.00	2.36	1.85	3.00	4.45*	3.90*	5.66*	6.39*	7.44*
Gwange	2.88	4.82*	3.66	4.12*	0.30*	4.31	0.11*	0.23*	0.20*	1.25	2.00	1.23	3.12	5.80*	4.33*	5.21*	8.60*	6.74*
Monday	2.60	3.41	2.86	3.40	1.68	2.00	0.30*	0.10*	0.30*	1.80	1.60	1.40	2.45	3.79*	3.66	4.75*	7.70*	8.20*
Bama	3.30	2.40	3.02	1.00	1.24	1.53	0.18*	1.00	0.40*	1.00	1.45	1.22	4.30*	3.44	4.45*	6.22*	7.57*	5.85*
Fulani farm	1.24	2.43	1.02	1.23	1.44	1.33	0.14	0.45	0.12	1.15	1.75	0.45	1.88	3.12*	2.24	4.84*	6.10*	4.65*
Overall mean	2.43	3.31	2.82	2.65	1.16	2.41	0.15	0.40	0.24	1.44	1.83	1.23	2.94	4.12	3.72	5.34	7.27	6.58

NB: BI: Biradon, KE: Kesham, KI: Kindrimo, TVC: Total viable counts. There is statistically significant difference *($p<0.05$) between organisms in the column with asterisks and other organisms in the same row

Table 2: Minimum and maximum values of count of microorganism isolated from different markets from biradon, kesham and kindrimo in Maiduguri (counts were expressed as log $_{10}$cfu mL^{-1})

	E. coli			*S. aureus*			*Shigella*			*Salmonella*			*Coliform*			TVC		
Markets	BI	KE	KI	BI	KE	KI	BI	KE	KI	BI	KE	KI	BI	KE	KI	BI	KE	KI
Bulunkutu	0-4.11	0-4.48	0-5.00	0-5.48	0-3.87	0-4.77	0-0.00	0-0.32	0-0.48	0-4.02	0-4.76	0-3.30	0-5.30	0-6.48	0-5.60	0-7.70	0-9.00	0-8.30
Gwange	0-5.23	0-6.30	0-5.48	0-6.79	0-2.14	0-6.39	0-0.30	0-0.40	0-0.60	0-2.90	0-3.79	0-2.95	0-5.60	0-7.51	0-6.60	0-7.50	0-9.85	0-9.90
Monday	0-4.68	0-4.85	0-4.40	0-5.60	0-3.75	0-4.90	0-0.48	0-0.30	0-0.69	0-3.00	0-2.70	0-3.60	0-4.30	0-5.90	0-5.95	0-6.85	0-9.60	0-9.00
Bama	0-6.22	0-4.30	0-5.00	0-2.10	0-2.90	0-2.50	0-0.30	0-2.48	0-0.90	0-1.00	0-3.48	0-2.48	0-6.48	0-5.79	0-6.70	0-8.48	0-9.30	0-7.60
Fulani farm	0-4.45	0-3.20	0-2.60	0-2.76	0-3.64	0-3.45	0-0.48	0-1.30	0-0.30	0-2.30	0-2.90	0-1.70	0-4.00	0-5.70	0-4.60	0-7.30	0-8.79	0-6.90

NB: BI: Biradon, KE: Kesham and KI: kindrimo, TVC: Total viable counts

and percentage frequency of occurrence between 10 and 40, 10 and 30 and 10 and 36%, respectively. The overall mean percentage *E. coli* were 21.6, 23.2 and 26.4%, respectively (Table 3).

***S. aureus* count ($\log_{10}$ cfu mL^{-1}):** The mean *S. aureus* counts of biradon, kesham and kindrimo were between 1.00 and 4.12, 0.30 and 1.68 and 1.33 and 4.31, respectively from the different markets (Table 1) with an overall mean of 2.65, 1.16 and 2.41 $\log_{10}$ cfu mL^{-1}, respectively. The mean *S. aureus* count of Gwage market was significantly lower ($p \leq 0.05$) than that got from other markets. The *S. aureus* counts ($\log_{10}$ cfu mL^{-1}) of biradon, kesham and kindrimo ranged from 0.0 to 6.79, 0.0 to 3.87 and 0.0 to 6.39, respectively (Table 2) whereas, the distribution and percentage frequency of occurrence was between 15 and 48, 10 and 40 and 10 and 30, respectively (Table 3).

***Shigella* sp. count ($\log_{10}$ cfu mL^{-1}):** The mean *Shigella* count of biradon, kesham and kindrimo were between 0.0 and 0. 30, 0.10 and 1.00 and 0.12 and 0.40, respectively from the different markets (Table 1) with an overall mean of 0.15, 0.40 and 0.24 $\log_{10}$ cfu mL^{-1}, respectively. There was no significant ($p \leq 0.05$) difference between the means of *Shigella* from the markets. However, *Shigella* was significantly ($p \leq 0.05$) lower than other organisms in the same row except in Fulani farms. The range values of count of *Shigella* ($\log_{10}$ cfu mL^{-1}) for biradon, kesham and kindrimo fell between 0.0 and 0.48, 0.0 and 2.48 and 0.0 and 0.90, respectively (Table 2) and percentage distribution between 0.0 and 4, 2 and 10 and 2 and 8%, respectively (Table 3).

Table 3: Distribution and % frequency of occurrence of different microorganisms isolated from biradon, kesham and kindrimo samples in Maiduguri

	E. coli			*S. aureus*			*Shigella*			*Salmonella*			*Coliform*		
Markets	BI	KE	KI	BI	KE	KI	BI	KE	KI	BI	KE	KI	BI	KE	KI
Bulunkutu	20	30	36	40	10	20	0	10	2	10	20	20	30	43	36
Gwange	18	18	16	48	40	30	2	8	6	15	10	5	40	48	40
Monday	10	30	20	36	18	20	4	5	8	7	5	7	28	42	30
Bama	40	10	30	15	10	10	2	2	5	4	6	4	36	30	44
Fulani Farm	20	28	10	25	20	10	2	5	7	2	8	2	20	30	26
Mean %	21.6	23.2	26.4	32.8	19.6	18.6	2.0	6.0	5.6	7.6	9.8	7.6	30.8	38.6	35.2

NB: BI: Biradon, KE: Kesham and KI: Kindrimo, TVC: Total viable

***Salmonella* count ($\log_{10}$ cfu mL^{-1}):** The mean *Salmonella* count of biradon, kesham and kindrimo were between 1.00 and 2.00, 1.45 and 2.36 and 0.45 and 1.85, respectively from the different markets (Table 1) with an overall mean of 1.44, 1.83 and 1.23 $\log_{10}$ cfu mL^{-1}, respectively. Results obtained for *Salmonella* had no significant difference ($p \leq 0.05$) from results of *Shigella* from the different milk products. The different market means were statistically ($p \leq 0.05$) homogeneous. The range value of counts of *Salmonella* ($\log_{10}$ cfu mL^{-1}) for biradon, kesham and kindrimo were between 0.0 and 4.02, 0.0 and 4.76 and 0.0 and 3.30, respectively (Table 2) and the distribution and percentage frequency of occurrence between 2 and 15, 5 and 20 and 2 and 20%, respectively (Table 3).

Coliform count ($\log_{10}$ cfu mL^{-1}): The mean coliform count of biradon, kesham and kindrimo were between 1.88 and 4.30, 3.12 and 5.80 and 2.24 and 4.55, respectively from the different markets (Table 1) with an overall mean of 2.94, 4.12 and 3.72 $\log_{10}$ cfu mL^{-1}, respectively. Biradon from Bama market was significantly higher than other biradon from other markets. Similarly, mean coliform of kesham and kindrimo were significantly higher than other organisms in the same row except the TVC. The range value of counts of coliform ($\log_{10}$ cfu mL^{-1}) for biradon, kesham and kindrimo were between 0.0 and 6.48, 0.0 and 7.51 and 0.0 and 6.70, respectively (Table 2). The distribution and percentage frequency of occurrence of coliform ranged between 20 and 40, 30 and 48 and 26 and 44%, respectively. The overall mean percentage coliform was 30.8, 38.6 and 35.2%, respectively (Table 3).

Total viable count (TVC) ($\log_{10}$ cfu mL^{-1}): The mean TVC of biradon, kesham and kindrimo were between 4.75 and 6.22, 6.10 and 8.60 and 4.65 and 8.20, respectively from the different markets (Table 1) with an overall mean of 5.34, 7.27 and 6.58 $\log_{10}$ cfu mL^{-1}, respectively. TVC was significantly higher than mean values obtained for other groups of organisms in almost all of the samples except some coliform results that were statistically homogeneous with TVC. The range value of counts of TVC ($\log_{10}$ cfu mL^{-1}) for biradon, kesham and kindrimo were between 0.0 and 8.48, 0.0 and 9.85 and 0.0 and 9.90, respectively (Table 2).

DISCUSSION

Biradon, kesham and kindrimo samples were analysed microbiologically for the presence of *E. coli*, *S. aureus*, *Salmonella* and *Shigella* sp. frequently implicated in food safety problems. Coliform was used as a measure of sanitary quality and TVC was used to indicate the overall

microbial quality and shelf-life of the product. While *E. coli* was used as an index of faecal contamination, *S. aureus*, *Salmonella* and *Shigella* sp. were used as measure of organisms frequently associated with foodborne diseases.

The mean *E. coli* content of kesham is greater than kindrimo greater than biradon in almost all of the samples except in Bulunkutu and Bama where kindrimo had slightly higher level of *E. coli* than kesham. Mean *E. coli* content of biradon of between 1.24 and 3.30 $\log_{10}$ cfu mL^{-1} of the present study (Table 1) perhaps supports 1.85 and 2.31 obtained by Abdalla and El-Zubeir (2006). For kesham and kindrimo, *E. coli* mean values of between 2.40 and 4.80 $\log_{10}$ cfu mL^{-1}, respectively (Table 1) supports 2.92 and 4.76 obtained by Gran *et al.* (2002) but contradicts lower mean values of other fermented milk products (yoghurt, roub and mish) obtained by Abdalla and El-Zubeir (2006). The range of *E. coli* of between 0 and 6.20 for the raw milk biradon also supports that obtained by Adesiyun *et al.* (1997) and Abdalla and El-Zubeir (2006). The range of *E. coli* in Kesham and kindrimo also supports previously published data on fermented milk by Abdalla and El-Zubeir (2006). Similarly, results obtained for percentage *E. coli* content of the samples supports previously recorded data by Soomro *et al.* (2002); Fadel and Ismail (2009) and Okonkwo (2011) but disagrees with lower values of not detectable to 20% reported by Ekici *et al.* (2004); Tambekar and Bhutda (2006) and El-Zubeir *et al.* (2008). Using *E. coli* as an index of faecal contamination, the samples with *E. coli* content up to 1 ($\log_{10}$ cfu mL^{-1}) are feared to have recent faecal contamination and capable of triggering some negative health consequences.

The mean *S. aureus* contents of the biradon (2.65 $\log_{10}$ cfu mL^{-1}) (Table 1) relates to that of raw milk obtained by Abdalla and El-Zubeir (2006). The result is however, significantly lower than that obtained by El-Zubeir and Mahboba (2007); Mohamed and El-Zubeir (2007) and Gran *et al.* (2002). Mean *S. aureus* contents of kesham of 1.16 supports the mean obtained previously for fermented milk by Abdalla and El-Zubeir (2006) mish and (Okonkwo, 2011) (nono). Mean *S. aureus* contents of kindrimo (2.41) is higher than values obtained by Abdalla and El-Zubeir (2006) (mish) and (Okonkwo, 2011) (nono) which are also fermented milk products. The range value of count of *S. aureus* between 0.0 to 6.7 (Table 2) of biradon supports 0.0-4.90 obtained by Abdalla and El-Zubeir (2006) for whole and skim milk but disagrees with high values obtained by El-Zubeir and Mahboba (2007) in Sudan. The range value of count of *S. aureus* between 0.0 to 3.8 and 0.0 to 6.3, respectively for kesham and kindrimo (Table 2) support 0.0 and 6.60 of (Okonkwo, 2011) but contradicts Abdalla and El-Zubeir (2006) results of 0.00-2.90 log cfu mL^{-1}. If *S. aureus* is found in foods or drinks handled by man, it is no surprise since Jablonski and Bohach (1997) noted that *S. aureus* could be spread from humans to food by direct contact, indirectly by skin fragments or through respiratory tract droplet nuclei and also since it could be normal on healthy human skin. Similarly, Tormo *et al.* (2011) also noted that *Staphylococcus* was the dominant bacterial sp of milk and inferior health condition of the animal increased the contamination of milk with *Staphylococci*. The percentage distribution Staphylococci in samples of between 15 and 48, 10 and 40 and 10 and 30, respectively for biradon, kesham and kindrimo, was lower than 75% obtained by Ekici *et al.* (2004) from cow milk and 60% from goat milk Tormo *et al.* (2011). The values however supported that obtained by Tambekar and Bhutda (2006) and El-Zubeir *et al.* (2008).

Low *Shigella* count throughout the sampling supports the previous finding of Okonkwo (2011) where no *Shigella* sp. was detectable in some areas studied. Similarly, mean *Shigella* counts of biradon, kesham and kindrimo of 0.15, 0.40 and 0.24 $\log_{10}$ cfu mL^{-1}, respectively (Table 1) are statistically homogeneous with 0.30 recently obtained (Okonkwo, 2011). The range value obtained for *Shigella* also corroborates the earlier result of Okonkwo (2011). The mean *Salmonella* sp. count

of biradon, kesham and kindrimo of the order 1.0 to 2.0, 1.45 to 2.36 and 0.45 to 1.85 $\log_{10}$ cfu mL^{-1}, respectively (Table 1) support the value obtained by Abdalla and El-Zubeir (2006) for both fermented and raw milk and 1.17 previously obtained by Okonkwo (2011). The results however, contradict not detectable obtained by Gran *et al.* (2003). In public health view point, 10^6 cells of *Salmonella* sp. are needed to initiate infection in healthy individuals. The percentage distribution of Salmonella in samples of between 2 and 15, 5 and 20 and 2 and 20%, respectively for biradon, kesham and kindrimo, supports 16.30% obtained by Tambekar and Bhutda (2006) and 24% previously obtained by Okonkwo (2011) but contrasts not detectable reported by Ekici *et al.* (2004). The percentage distribution of *Shigella* was low and also supported low values previously recorded by Tambekar and Bhutda (2006), Akabanda *et al.* (2010) and Okonkwo (2011).

The mean coliform count of 2.94, 4.12 and 3.72 $\log_{10}$ cfu mL^{-1} obtained, respectively for biradon, kesham and kindrimo (Table 1) were significant in the sense it indicates an overall poor hygiene quality of the products. Mean coliform content of biradon of between 1.88 and 4.30 supports 3.96 previously obtained by Samolada *et al.* (1998) but disagree with higher value of 3.32×10^6 cfu mL obtained by Mohamed and El-Zubeir (2007). Similarly, mean coliform contents of kesham and kindrimo of between 3.12 and 5.80 and 2.24 and 4.45 $\log_{10}$ cfu mL^{-1} agrees partly or wholly with values obtained by Gran *et al.* (2002) and El-Bakri and El-Zubeir (2009) but disagrees with lower values obtained by Lore *et al.* (2005) and Nahar *et al.* (2007). Inadequate cleaning of milk utensils is noted to be the most common source of coliform in raw milk (Murphy and Boor, 2000).

The mean TVC of between 4.75 and 6.22 $\log_{10}$ cfu mL^{-1} obtained for biradon (Table 1) agrees with 5.70 obtained by Samolada *et al.* (1998) but disagree with higher value of 7.9×10^{10}, 1.4×10^8 and 3.8×10^8 cfumL^{-1} obtained by El-Zubeir and Mahboba (2007) and lower means of 2.1×10^2 cfu mL^{-1} obtained by Obi and Ikenebomeh (2007) and 3.6 $\log_{10}$ cfu mL^{-1} average bacterial counts of Tormo *et al.* (2011). Similarly, mean TVC of kesham and kindrimo between 6.10 and 8.20, respectively agrees with values obtained Rihab *et al.* (2010) and Nahar *et al.* (2007) and partly with El-Bakri and El-Zubeir (2009) since these authors recorded higher values in plain yoghurt. The mean TVC contradicts lower mean value of 3.76 $\log_{10}$ cfu mL^{-1} obtained by Okonkwo (2011) for aerobic mesophilic count. The range value of TVC 0.0 to 8.48; 0.0 to 9.85 and 0.0 to 9.90 $\log_{10}$ cfu mL^{-1}, for biradon, kesham and kindrimo, respectively (Table 2) supports values obtained by Savadogo *et al.* (2004), El-Zubeir *et al.* (2008), El-Bakri and El-Zubeir (2009) and Okonkwo (2011).

CONCLUSION

All the milk products both raw and fermented studied harbour some degree of microorganisms which are capable of endangering human health when consumed in sufficient dosage. There is no significant difference between results obtained for the different milk products. The sources through which these organisms gain access into the milk products are: via the milking animals themselves, the process line, process environment and distribution channel. Proper pasteurization and safety distribution of the products in a hygienic environment is recommended.

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