Advances in Research

13(5): 1-9, 2018; Article no.AIR.33121
ISSN: 2348-0394, NLM ID: 101666096

Effect of Milk Type and Salt Concentration on the Physicochemical Characteristics of *Mudaffara* (Braided) Cheese

Mohamed Osman Mohamed Abdalla[1*] and Habza Elamin Adam Gamer Eldin[1]

[1]Department of Dairy Production, Faculty of Animal Production, University of Khartoum, Shambat, P.O.Box 32, Postal Code 13314, Khartoum North, Sudan.

Authors' contributions

This work was carried out in collaboration between both authors. Author MOMA performed the statistical analysis and wrote the first draft of the manuscript. Author HEAGE designed the study, managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AIR/2018/33121
Editor(s):
(1) Maria Selvaggi, Department DETO - Section of Veterinary Science and Animal Production, University of Bari "Aldo Moro", Italy.
(2) Jinyong Peng, Professor, College of Pharmacy, Dalian Medical University, Dalian, China.
Reviewers:
(1) Noutfia Younes, National Institute of Agronomic Research, Morocco.
(2) José Alberto López Díaz, Universidad Autónoma de Ciudad Juárez, México.
(3) Magdy Mohamed Ismail, Animal Production Research Institute, Egypt.
Complete Peer review History: http://www.sciencedomain.org/review-history/23111

Original Research Article

Received 30th March 2017
Accepted 4th February 2018
Published 10th February 2018

ABSTRACT

Aims: This study was conducted to determine the physicochemical characteristics of *mudaffara* cheese during the storage period.
Methodology: Cheese was manufactured from raw cow milk and goat milk using starter culture and rennet. After forming, the curd was preserved in the salted whey (4%, 10% and 15%) for 24 hr, followed by preserving at 4°C for 30 days. Physicochemical characteristics were determined at 1, 7, 15 and 30-day intervals.
Results: The results showed that all physicochemical characteristics were significantly affected by the type of milk and salt concentration except ash and acidity which were not affected by the type of milk. The fat and moisture contents were high in cheese made from cow milk, while protein and total solids contents were high in cheese made from goat milk. Fat, protein, total solids and ash contents were high in cheese brined with 15% salt, while moisture content and acidity were high in

**Corresponding author: E-mail: abutahany1960@yahoo.com;*
E-mail: abutahany@yahoo.com;

cheese brined with 10% salt. During the storage period, fat, protein and ash contents fluctuated decreasing at day 7 followed by a slight increase at day 15 before decreasing towards the end. The total solids content increased from 49.45% at day 1 to 55.16% at the end of the storage period, while moisture content decreased as the storage period progressed, and the acidity increased till day 15 (0.81%), then decreased to 0.79% at day 30.

Conclusion: Cheese made from goat milk had high protein, TS, ash contents and acidity, while cheese made from cow milk had high fat and moisture contents. Cheese made with the addition of 15% salt had high fat, protein, TS, ash contents and acidity compared to other salt levels.

Keywords: Milk; mudaffara; physicochemical; salt.

1. INTRODUCTION

Mudaffara cheese is a braided, unmatured semi-hard cheese which originated in the Mediterranean area having a close texture, yellowish colour, slightly acid and salty taste consumed more often by rural communities in Sudan [1]. There are some cheeses in the world that resemble *mudaffara* cheese such as Roumi and Rass cheese (Egypt), Romia cheese (the Middle East) and Mozzarella cheese [2]. Manufacture of *mudaffara* cheese needs highly experienced and skilled workers and its manufacture usually takes quite long time compared to white soft cheese [3]. *Mudaffara* cheese is made from unpasteurized milk, partially skimmed or a mixture of skim milk and whole cow, sheep or goat milk [4].

Cheese is considered as being the most important dairy product involving the use of salt (sodium chloride) in the manufacture [5,6]. Salting is the most common and reliable traditional method used in combination with lactic acid fermentation, and the salting is done by sprinkling dry salt on the surface of the cheese after moulding and/or dipping the cheese in brine. The concentration and distribution of salt in cheese mass are important parameters affecting its quality and acceptability [7]. Salting process in cheese not only contributes to the flavour of cheese; but also has an impact on the growth of microorganisms with the viability of probiotic bacteria being inversely proportional to salt concentration, therefore, salting process may also lead to poor survival of bacteria in cheese [8]. Salt acts as a preservative material due to its ability to reduce the water activity that prevents the growth of most undesirable microorganisms [5,6]. Salting process in cheese not only contributes to the flavour of cheese but can also have an impact on the growth of microorganisms with the viability of probiotic bacteria being inversely proportional to salt concentration, therefore the salting process may also lead to poor survival of bacteria in cheese [9].

In addition, salt concentration and storage temperature affect the quality of *mudaffara* cheese and storage of cheese in 10% salted whey gives a product of superior quality than 15% or 20% NaCl [10]. Ripening *mudaffara* cheese in whey with low salt concentration was found to be better than ripening in high salted whey for a prolonged period to minimize the reduction in protein content [11]. *Mudaffara* cheese made from pasteurized milk stored in 10% salted whey has a short shelf life compared to that stored in 5% salted whey [12]. *Mudaffara* cheese is made from unpasteurized milk, partially skimmed or a mixture of skim milk and whole cow, sheep or goat milk, and its manufacture needs highly experienced and skilled workers and its manufacture usually takes quite long time compared to white soft cheese [13]. The aim of this study is to evaluate the effect of milk type and salt concentration on physicochemical characteristics of *mudaffara* cheese during the storage period.

2. MATERIALS AND METHODS

2.1 Materials

Fresh cow milk and goat milk (20 L each) were obtained from the University of Khartoum dairy farm, transported to the laboratory at 4ºC and analyzed for fat, protein, total solids, ash and titratable acidity. Rennet and starter culture (1:1 combination of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*) were obtained from Chr. Hansen's (Denmark). Sodium chloride and black cumin (*Nigella sativa*) were obtained from the local market. All Chemicals and reagents used were of the technically recommended analytical grade.

2.2 Manufacture of Braided Cheese

The braided cheese was manufactured according to the method described by Abdel Razig and Abdalla [14]. Fresh raw milk was warmed to 40ºC, then starter culture (3%, w/w) and rennet (20 ml /10 L milk) were added to both treatments. Coagulation occurred after 45 min, and the curd was then cut by a sterile knife into small pieces for whey drainage and incubated at 40ºC for 3 hr in the whey to develop acidity until the curd was ready for cooking in hot water (75ºC) for 5 min to encourage enough elasticity. The curd in both treatments was formed into balls and stretched on a clean table and black cumin (*Nigella sativa*, 0.5% w/w) was added and the curd was braided into the final form. Salt was added to the whey (4%, 10% and 15% w/w) and cheese was preserved in the whey for 24 hr at 4ºC, after which cheese (5 kg) was preserved in sterile plastic bags aseptically sealed without whey at 4ºC for 30 days. Physicochemical characteristics were determined at 1, 7, 15 and 30-day intervals. The experiment was carried out in triplicate.

2.3 Physicochemical Characteristics of Milk and Cheese

The fat content was determined by Gerber method [15], while the protein content was determined by Kjeldahal method [15], the total solids content was determined by oven drying method [15] and the ash content was determined by incineration of the solid matter at 550ºC [15]. The titrable acidity was determined by titration of cheese against 0.1 N NaOH using phenolphthalein indicator [15]. The moisture content was determined by subtracting the total solids content from 100.

2.4 Statistical Analyses

Data were analyzed by Statistical Analyses Systems (SAS, ver. 9). Factorial design (2x3x4) was used to determine the effect of type of milk, sodium level and storage period on the physicochemical characteristics of cheese. Means were separated by Duncan multiple ranges test ($P \leq 0.05$).

3. RESULTS AND DISCUSSION

The physicochemical characteristics of raw milk used in the preparation of cheese were as follows: cow's milk fat 4.3%, protein 3.6%, total solids 12.5%, ash 0.60%, titratable acidity 0.18%; goat's milk fat 3.6%, protein 3.3%, total solids 11.7%, ash 0.70%, titratable acidity 0.17%. The yield values of *mudaffara* cheese are as follows: cow's milk cheese 12%; goat's milk cheese 11.8%.

3.1 Physicochemical Characteristics of *Mudaffara* Cheese

Tables 1 and 2 present the effect of type of milk and salt on physicochemical characteristics of cheese. All physicochemical characteristics of cheese except ash content and acidity were significantly affected by the type of milk. The high-fat content was found in cow milk cheese (19.60%) and cheese brined with 15% salt (19.38%). These results are in agreement with those of Altahir et al. [11] and Ahmed [4] who reported a fat content of 18.00 - 20.33% and 16.2% - 20.3%, respectively. However, the results are lower than those reported in previous studies [16- 19]. Frau et al. [20] reported that the fat content of goat milk cheese was 22.42% - 23.5%. These results do not comply with SSMO [21]. The variation in the fat content of raw milk used in *mudaffara* cheese processing is influenced by several factors such as animal breed, animal individuality, stage of lactation, seasonal variation, feeding level, type of feed, hygiene, animal age and milking intervals [22]. In addition to the storage condition (e.g. storage without whey), temperature and storage period play a role in increasing the weight of cheese and thus the fat content [23]. The protein content was significantly ($P<0.001$) higher in cheese made from goat milk (26.39%) and cheese brined with 15% salt (27.04%). Similar results were reported by Abd El-Wahab [23], Bakheit [24] and Altahir et al [11]. These results, on the other hand, are higher than those reported by El-Hag et al. [19] who reported a protein content of 17.4% and lower than those reported by Elsheikh and Abdalla [16] who reported a protein content of 28.47% and 30.28% for cow and goat milk cheese, respectively. The total solids content was significantly ($P<0.01$) higher in cheese made from goat milk (54.48%) and significantly ($P<0.001$) higher in cheese brined with 15% salt (56.76%). These results are in agreement with those reported by Altahir et al. [11] who reported total solids content of 54.18 - 55.99% in *mudaffara* cheese made from raw and pasteurized milk, and Abdelrahman [18] who reported that the total solids content of braided cheese (*mudaffara*) marketed in Khartoum State was 55.4%. However, these results are in

disagreement with those reported by Ahmed [4], Elsheikh and Abdalla [16] and El-Hag et al. [19]. The total solids content of *mudaffara* cheese reported in our study comply with SSMO [21]. Abdalla et al. [17] and Frau et al. [20] reported higher values (57.93%) than the ones reported in this study. The difference in the total solids content of *mudaffara* cheese may be affected by many factors, the important of which are the close correlation between moisture content and total solids, preservation methods applied and temperature during storage period [25]. The moisture content was significantly ($P<0.01$) higher in cheese from cow milk (49.56%) and in cheese brined with 10% salt (50.83%). The results of the moisture content of cheese from cow milk are higher than those reported by Altahir et al. [11] who reported a moisture content of 44.98 - 45.32%, while the moisture content of goat milk cheese is lower than that of Altahir et al. [11]. Abdelrahman [18] reported a moisture content of 44.6%. The variation in moisture content of cheese may be due to the composition of cheese milk and method of manufacture. The ash content was higher in cheese made from goat milk (4.98%) although the difference was not significant. The ash content of cheese brined with different concentrations of salt was significantly ($P<0.001$) higher in cheese brined with 15% salt (6.46%). These results are in line with those of Kardak [22] for Cokelek cheese. However, these results are in disagreement with those reported by Ahmed [4], Abdalla et al. [17], and El-Hag et al. [19]. The results of this study are higher than those reported by Abdelrahman [18] and Elskeihk and Abdalla [16] who reported that the ash content of cow, goat and mixed milk cheeses was 0.63%, 4.22% and 3.79% respectively, and Frau et al. [20] who reported a value of 1.9% in goat milk cheese. The variation of ash content is affected by organic and inorganic salts, which are dissolved in milk [15]. The structure and percentage of ash in milk, an element responsible for that varies to a greater extent in the raw milk and in milk ash [26]. The acidity of cheese made from goat milk was slightly higher (0.78%) than that of cow milk cheese. The acidity significantly increased when cheese was brined with 4% salt (1.11%) compared to that brined with 15% salt (0.53%). These results are in agreement with those reported by Elsheikh and Abdalla [16] who reported acidity of 0.88%, 0.79% and 0.83% for cheese made from cow, goat and mixed milk, respectively. However, Abdelrahman [18] reported higher acidity (1.94%) compared to results in this study, while Abdalla and Mohammed [9] and ElOwni and Osman [27] reported lower values in white and mozzarella cheeses, respectively. The added salt during processing of cheese markedly affected the cooking performance and overall quality [28]. Low acidity in cheese brined with 15% salt may be attributed to the adverse effect of salt on lactic acid bacteria in such a way that they could not grow and produce lactic acid.

3.2 Effect of Storage Period on Physicochemical Characteristics of *Mudaffara* Cheese

The fat content of cheese made from cow milk and goat milk gradually decreased during the storage period from 19.19% at day 1 to 18.04% at day 30 (Table 3). The fat content of cheese made from cow milk and goat milk separately gradually decreased from 21.5% at day 1 to 19.29% at day 30 in cow milk cheese, while in goat milk cheese the fat content increased to 18.33% before decreasing to 16.79% at day 30 (Table 4). The fat content of cheese brined with different salt concentrations gradually decreased during storage period in cheese brined with 4% and 15%, while in cheese brined with 10% salt, the fat content increased to a maximum at day 7 before gradually decreasing towards the end (Table 5). These results are in disagreement with those reported by ElOwni and Hamid [29] who reported an increase in fat content during the ripening of Sudanese white cheese. Hayaloglu et al. [30] and Tarakci and Kucukoner [31] reported a significant variation in the fat content of Turkish Kasher cheese during the ripening period. The fluctuation of fat may be influenced by degradation of fat during the storage period and the temperature of storage. Protein content fluctuated during the storage period reaching the maximum at day 15 (18.69%) then decreased towards the end of the storage period (Table 3). The protein content of cow milk cheese decreased at day 7 (21.04%) before increasing towards the end (24.51%), while that of goat milk cheese increased gradually to a maximum at day 15 (29.97%) before decreasing towards the end (Table 4). The protein content of cheese salted with different concentrations increased to a maximum at day 15 (27.54% and 23.60%, respectively) for cheese salted with 4% and 10%, and decreased to a minimum at day 7 (25.16%)for cheese brined with 15% salt (Table 5). These results are in disagreement with those reported by Elsheikh and Abdalla [16] who reported a decreasing trend of protein content as the storage period

progressed. The variation in protein content could be attributed to protein degradation leading to the formation of soluble compounds [32] and the effect of proteolytic enzymes as the result of the addition of starter culture [33]. Total solids content showed two peaks during the storage period at day 7 (53.06%) and day 30 (55.16%). The total solids content of cheese manufactured by two kinds of milk showed a gradual increase with the advancement of the storage period (Table 4). The total solids content of cheese brined with different salt concentrations showed two peaks during storage period, at day 7 (55.56%) and day 30 (52.98%) for cheese brined with 4% salt, while for cheese brined with 10% and 15% salt, the total solids content regularly increased towards the end of storage period (Table 5). The results are in agreement with those reported by Altahir et al. [11] who reported a decreasing trend of total solids content during the storage period. As the total solids content increased, the moisture content decreased, and that there is a close correlation between total solids content and moisture content. Abd El-Wahab [23] reported that the total solids content of braided cheese stored at cold temperature decreased from 60.06% in the first day to 52.2% after 2 months of storage. The total solids content is affected by preservation methods applied and temperature during the storage period [23]. Moisture content gradually decreased during the storage period from 50.46% at day 1 to 44.92% at day 30 (Table 3). The moisture content of cow milk and goat milk separately decreased with time from 50.17% at day 1 to 48.95% at day 30 in cow milk cheese, and from 50.76% at day 1 to 40.89% at day 30 in goat milk cheese (Table 4). The moisture content of cheese brined with different salt concentrations steadily decreased during the storage period. The decrease in moisture content during the storage is not in line with that reported by Bakheit [24] and Altahir et al. 11] who reported an increasing trend of the moisture content of cheese during the storage period. The ash content reached its maximum at day 15 (5.4%) before decreasing to 4.17% at the end (Table 3). The ash content of cheese made with cow milk showed a peak at day 15 (5.41%) then decreased, while that of goat milk cheese steadily decreased towards the end of the storage period (Table 4). The ash content of cheese brined with 4% and 10% salt gradually decreased with the advance of the storage period, while that brined with 15% salt reached its maximum at day 15 (7.93%), then decreased thereafter (Table 5). The results are in disagreement with those reported by Altahir et al. [11] and Alizadeh and Lavasani [34] who reported that ash content increased as the storage period progressed. The acidity of cheese gradually increased to 0.81% at day 15, and then decreased to 0.79% at day 30 (Table 3). The acidity of cheese made from cow milk showed a peak at day 15 (0.81%), while that of cheese made with goat milk showed an increasing trend throughout the storage period (Table 4). The acidity of cheese brined with 4% and 10% salt showed a gradual increase throughout the storage period with the increase being sharp in cheese brined with 4% salt, while the acidity of cheese brined with 15% decreased with the storage period reaching the minimum acidity at the end of storage period (Table 5). The results are in line with those of Altahir et al. [11] who reported that the acidity increased during the storage period and decreased with increasing salt concentration. This phenomenon is probably due the antagonistic effect of salt on lactic acid bacteria.

Table 1. Effect of milk type on physicochemical characteristics of *mudaffara* cheese made from cow and goat milk

Physicochemical characteristics (%)	Milk type		SE	*p*
	Cow	Goat		
Fat	19.60[a]	17.56[b]	0.996	<0.0001
Protein	22.71[b]	26.39[a]	2.096	<0.0001
Total solids	50.48[b]	54.48[a]	7.074	0.0065
Moisture	49.56[a]	45.48[b]	7.086	0.0055
Ash	4.85[a]	4.98[a]	0.189	0.5835
Acidity	0.74[a]	0.78[a]	0.020	0.6070

Means in the same row bearing similar superscripts are not significantly different (P>0.05)
SE = Standard error of means

Table 2. Effect of salt concentration on physicochemical characteristics of *mudaffara* cheese made from cow and goat milk

Physicochemical characteristics (%)	Salt concentration (%)			SE	*p*
	4	10	15		
Fat	18.53^{ab}	17.84^{b}	19.38^{a}	1.219	0.0714
Protein	24.50a^{b}	22.11^{c}	27.04^{a}	2.567	<0.0001
Total solids	51.58^{b}	49.11^{b}	56.76^{a}	8.664	0.0001
Moisture	48.42^{a}	50.83^{a}	43.31^{b}	8.679	0.0002
Ash	2.99^{c}	5.30^{b}	6.46^{a}	0.231	<0.0001
Titratable acidity	1.11^{a}	0.63^{b}	0.53^{b}	0.024	<0.0001

Means in the same row bearing similar superscripts are not significantly different (P>0.05)
SE = Standard error of means

Table 3. Effect of storage period on physicochemical characteristics of *mudaffara* cheese made from cow and goat milk

Physicochemical characteristics (%)	Storage period (days)				SE	*p*
	1	7	15	30		
Fat	19.19^{a}	18.42^{a}	18.69^{a}	18.04^{a}	2.965	0.4929
Protein	23.86^{b}	23.55^{b}	26.47^{a}	24.33^{ab}	1.408	0.0409
Total solids	49.45^{b}	53.06^{ab}	52.25^{ab}	55.16^{a}	0.267	0.0489
Moisture	50.46^{a}	46.94^{ab}	47.75^{ab}	44.92^{b}	10.00	0.0595
Ash	4.96^{a}	5.13^{a}	5.41^{a}	4.17^{b}	10.02	0.0026
Acidity	0.71^{a}	0.72^{a}	0.81^{a}	0.79^{a}	0.028	0.7336

Means in the same row bearing similar superscripts are not significantly different (P>0.05)
SE = Standard error of means

Table 4. Effect of type of milk and storage period on physicochemical characteristics of *mudaffara* cheese made from cow and goat milk

Milk type	Storage period (days)	Physicochemical characteristics (%)					
		Fat	Protein	TS	Moisture	Ash	Acidity
Cow milk	1	21.5^{a}	22.31^{b}	49.83^{b}	50.17^{a}	4.18^{a}	0.73^{a}
	7	18.5^{c}	21.04^{b}	49.46^{b}	50.54^{a}	5.04^{a}	0.72^{a}
	15	19.13^{b}	22.97^{a}	51.42^{a}	48.58^{a}	5.71^{a}	0.81^{a}
	30	19.29^{b}	24.51^{a}	51.22^{a}	48.95^{a}	4.49^{a}	0.70^{a}
SE		1.0310	0.2031	0.9523	1.3302	0.5490	0.0091
p		<0.0001	0.0201	0.0056	1.9054	0.8675	0.6789
Goat milk	1	16.88^{b}	25.41^{b}	49.07^{d}	50.76^{a}	5.74^{a}	0.69^{a}
	7	18.33^{a}	26.05^{b}	56.66^{b}	43.34^{b}	5.23^{a}	0.73^{a}
	15	18.25^{a}	29.97^{a}	53.08^{c}	46.92^{b}	5.11^{a}	0.81^{a}
	30	16.79^{b}	24.15^{b}	59.11^{a}	40.89^{c}	3.85^{b}	0.88^{a}
SE		1.0310	0.2031	0.9523	1.3302	0.5490	0.0091
p		<0.0001	<0.0001	0.0002	0.0010	0.0405	0.9910

Means in the same row bearing similar superscripts are not significantly different (P>0.05)
SE = Standard error of means

Table 5. Effect of salt concentration and storage period on physicochemical characteristics of *mudaffara* cheese made from cow and goat milk

Salt concentration (%)	Storage period (days)	Physicochemical characteristics (%)					
		Fat	Protein	T S	Moisture	Ash	Acidity
4	1	19.25^{a}	23.44^{c}	47.46^{d}	52.53^{a}	3.41^{a}	1.02^{a}
	7	17.75^{a}	25.16^{b}	55.56^{a}	44.44^{d}	2.82^{b}	1.05^{a}
	15	18.63^{a}	27.54^{a}	50.31^{c}	49.69^{b}	3.07^{a}	1.17^{a}
	30	18.50^{a}	21.87^{c}	52.98^{b}	47.03^{c}	2.69^{b}	1.21^{a}
SE		2.0310	1.4401	0.9320	1.0452	0.0219	0.0023
p		0.1922	0.0390	<0.0001	<0.0001	<0.0001	0.1805
10	1	17.81^{a}	22.06^{b}	44.99^{c}	54.76^{a}	5.67^{a}	0.59^{a}
	7	18.06^{a}	20.32^{c}	48.69^{b}	51.31^{b}	5.65^{a}	0.57^{a}
	15	17.94^{a}	23.60^{a}	50.08^{b}	49.92^{b}	5.22^{ab}	0.67^{a}
	30	17.56^{a}	22.47^{b}	52.68^{a}	47.32^{c}	4.66^{b}	0.68^{a}
SE		2.0310	3.4401	0.9320	1.0452	0.0219	0.0023
p		0.2301	0.0002	0.0120	0.0366	0.0342	0.4638
15	1	20.50^{a}	26.07^{b}	55.90^{c}	44.10^{a}	5.79^{ab}	0.52^{a}
	7	19.44^{a}	25.16^{b}	54.93^{c}	45.07^{a}	6.94^{a}	0.56^{a}
	15	19.50^{a}	28.28^{a}	56.35^{b}	43.65^{b}	7.93^{b}	0.60^{a}
	30	18.06^{a}	28.65^{a}	59.84^{a}	40.41^{c}	5.16^{c}	0.48^{a}
SE		2.0310	3.4401	0.9320	1.0452	0.0219	0.0023
p		0.4611	<0.0001	0.0080	0.0023	0.0091	0.1177

Means in the same row bearing similar superscripts are not significantly different (P>0.05)
SE = Standard error of means

4. CONCLUSION

The physicochemical characteristics of cheese made from cow milk and goat milk varied significantly except for ash and titratable acidity. Increasing the salt level improved the physicochemical characteristics of cheese except for titratable acidity. During the storage period, all physicochemical characteristics of cheese made from cow milk and goat milk were improved except for fat and ash content, and the same trend was noticed for cheese made with 4, 10 and 15% salt.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ahmed AM. The manufacture and packing of Sudanese white cheese. Paper presented at the UNESCO Regional Training Course of Fermented Foods of Arab world. 1 -15 Feb. 1987. Food Research Center Shambat, Sudan; 1987.
2. El-Sheikh NA. Production of Mudaffara cheese from cows and goats milk, M.Sc. thesis, University of Khartoum, Sudan; 1997.
3. FAO. The technology of traditional milk products in developing countries cheese and cheese product, Southern and Estern Africa. FAO Animal Production and Health.1990;85:333.
4. Ahmed TK. Evaluation of market (*Mudaffara)* braided cheese. Egyptian Journal of Dairy Science. 1995;23(1):53-58.
5. Aly SA, Galal EA. Effect of milk pretreatment on the keeping quality of Domiati cheese. Pakistan Journal of Nutrition. 2002;1:132-136.
6. Abdalla WM, ElZubeir IEM. Microbial hazards associated with fermented milk (Roub and Mish) Processing in Sudan. Internationa Journal of Dairy Science. 2006;1:21-26.
7. Turhan M, Kaletune G. Modeling of salt diffusion in white cheese during long term brining. Journal of Food Science. 1992;57(2):1082-1085.
8. Vinderola CG, Prosello W, Reinheimer JA. Viability of probiotic (*Bifidobacterium, Lactobacillus acidophilus and Lactobacillus casei*) and nonprobiptic microflora in Agrentinian Fresco cheese. Journal of Dairy Science. 2000;83:1905-1911.

9. Abdalla MOM, Mohammed IHS. Effect of storage period on the microbiological and sensory characteristics of Cooked low salt white soft cheese (*gibna beyda*). Pakistan Journal of Nutrition. 2010;9(3):205-208.
10. Abdel Razig AK. Quality attributes of braided cheese (*Mudaffara*) as affected by level of salt and storage temperature, Ph.D. Thesis, University of Khartoum, Sudan; 2000.
11. Altahir EOM, Elgasim AE, and Ahmed MAI. Ripening of Sudanese braided (mudaffara) cheese manufactured from raw or pasteurized milk: Effect of heat treatment and salt concentration on physicochemical properties. International Journal of Food Science. 2014;2014:Article ID 698263:7(1-70).
12. Elsamani OM, Elgasim AE, Ahmed MAI. Effect of heat treatment and salt concentration on free amino acids composition of Sudanese braided (*Mudaffara*) cheese during storage. Turkish Journal of Agriculture Food Science and Technology. 2014;3(1):9-16.
13. Abdel Razig AK, Ahmed AR, Mohamed BE. Ripening behavior of Sudanese braided cheese (*mudaffara*). First International Conference on Biotechnology and Application for Arid Regions, Kuwait Institute for Scientific Research. 2002;1:40-42.
14. Abdel Razig KA, Abdalla MO. Effect of storage period on the quality of White soft cheese. Sudan Journal of Veerinary Science and Animal Husbandry. 1997;36(1,2):28-35.
15. AOAC. Official Methods of Analysis, 15th edition. Washington, D.C.: The Association Official Analytical Chemists, USA; 2000.
16. Elsheikh AN, Abdalla OM. Effect of type of milk on the yield, physico-chemical and sensory characteristics of mudaffara cheese. Sudan Journal of Animal Production. 2001;14:1-9.
17. Abdalla MOM, Elsiddig HM, Elhag NM, Suliman TA. Chemical composition of sudanese braided cheese (mudaffara). University of Khartoum Journal of Agricultral Sciences. 2013;21(2):253-268.
18. Abdelrahman HAA. Chemical composition and properties of braided cheese (mudaffara) marketed in Khartoum satate. M.Sc. Thesis. Sudan University of Science and Technology, Sudan; 2013.
19. El-Hag FM, Ahmed MMM,; Bushara I, Hag Mohamed KE, Khair MAM, Elbushra OE, Ahmed TK. Assessment of rural dairy products in north Kordofan state, Sudan. Scientific Journal of Veterinary Advances. 2014;3(2):34-41.
20. Frau F, de Valdez GF, Pece N. Effect of pasteuriation Temperature, starter culture, and incubation temperature on the physicochemical properties, yield, rheology, and sensory characteristics of spreadable goat cheese. Journal of Food Processing. 2014;2014:Article ID 705746: 8(1-8).
21. SSMO. Standard for Mudaffara cheese. Sudanese Standard and Metrology Organization. Specification No. 1429/2007. Sudanese Standards and Metrology Organization, Khartoum, Sudan; 2007.
22. Speer E, Mixa A. Milk and dairy products technology. Basel: Marcel Deckker; 1995.
23. Abd El-Wahab AA. Effect of temperature and storage conditions on chemical properties of braided (mudaffara*)* cheese. M.Sc. Thesis, University of Khartoum, Sudan; 2008.
24. Bakheit MA. Studies of Mudaffara cheese as affected by some spices. Ph.D. Thesis, Cairo University, Egypt; 2010.
25. Kardak DA. Microbiological and chemical quality of cokelek cheese, Lor cheese and Torba (strained) yougurt. African Journal of Microbiology Reseach. 2012;6(45):7278-7284.
26. Smith G. Dairy proceeing improving quality. Cambridge: Wood Head Publishing Limited, UK; 2005.
27. ElOwni OAO, Osman SE. Evaluation of chemical composition an yield of mozzarella cheese using two different methods of processing. Pakistan Journal of Nutrition. 2009;8(5):684-687.
28. Guinee TP. Salting and the role of salt in cheese. International Journal of Dairy Technology. 2004;57:99-109.
29. ElOwni OAO, Hamid AIO. Effect of storage period on weight loss, chemical composition, microbiological and sensory characteristic of Sudanese white soft cheese (Gibna Bayda). Pakistan Journal of Nutrition. 2008;7(1):75-80.
30. Hayaloglu AA, Guven M, Fox PF, McSweeney PLHB. Influence of starter on chemical, biochemical and sensory changes in Turkish White-brined cheese during ripening. Journal of Food Science and Technology. 2005;2:31-32.
31. Tarakci Z, Kucukoner E. Change on physicochemical, lipolysis and proteolysis

of vacuum packed Turkish Kashar cheese during rippening. Journal of Central European Agriculture. 2006;7(3):459-464.

32. Abdalla OM, Christen GL, Davidson PM. Chemical composition of and *Listeria monocytogenes* survival in White pickled cheese. Journal of Food Protection. 1993;56(10):841-846.
33. Green LM, Foster PMD. Comparison of the rate of proteolysis during ripening of cheddar cheese made with calf rennet and swine pepsin a cogulant. Journal of Dairy Research. 1974;41:269-282.
34. Alizadeh M, Lavasani ARS. Effect of different types of milk on some physicochemical and sensory characteristics of Iranian white brined cheese. Annals of Biological Research. 2013;4(10):67-70.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/23111