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A STUDY ON THE EFFECT OF HEAT TREATMENTS ON COMPOSITION AND SOME PROPERTIES OF CAMEL MILK

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ABSTRACT

The present study was carried out to investigate the effect of different heat treatments on composition and some physico-chemical properties and rennet clotting time of camel's milk. Camel milk samples were heated at 63, 80, 90^{0}C for 30 min and 72 ^{0}C for 15 sec., whereas unheated sample was served as control. Fat content was not affected by the applied treatments (3.2 %), but the protein contents were found as 3.2, 3.4, 3.4, 3.3 and 3.1 % respectively. Ash values were 0.70, 0.71, 0.73, 0.71 and 0.68 % in order and total solids were 10.0, 10.10, 10.16, 10.05 and 9.9 % respectively. The non protein nitrogen (NPN), non casein nitrogen (NCN) and whey protein nitrogen (WPN) gradually decreased as heat treatments were increased but casein number and percent of denaturation were increased. Rennet clotting time in the presence of different $CaCl_2$ concentrations (0 - 20 mg /100 ml) increased gradually by raising heating temperature. On the other hand, increased amount of calcium chloride added decreased the rennet clotting time at any heat treatment applied. Incubation of milk with yoghurt culture at 40^{0}C revealed significant differences in acidity development and pH changes as affected by the applied heat treatments. After 12 h incubation, the acidity values were only 0.30, 0.22, 0.30, 0.32 and 0.26% in the control and heat treated milk for 63, 80, 90^{0}C for 30 min. and 72^{0}C for 15sec. in order The corresponding pH values were 5.1, 5.7, 5.4, 4.9 and 5.4 in order.

Key words: Camel milk, Heat treatments, Chemical composition, some properties

INTRODUCTION

Camel milk is one of the main components of the human diet in many parts of the world especially in the arid and semi-arid zones since camel can survive under extreme hostile conditions of temperature, drought and lake of pastures, and can produce milk of a good quality even when water is severly restricted.

Different studies on production and composition of camel milk were reviewed by Khan and Iqbal (2001), whereas those concerned with the detailed chemical composition, properties, processing and products were given - in details - by Mal and Pathak (2010).

In Egypt, despite the share of camel milk in the total milk production is very low, there are some recent studies regarding composition, physico-chemical properties and ability of camel milk for processing (Bayoumi, 1990; Farag and Kebary, 1992; El-gammal and Moussa, 2007; Hassan et al. 2009). However, a great awareness was recorded in many parts from Egypt to consume camel milk inspite of its saltish taste and acidic nature. This may be due to the intensive interest given in the media regarding the health benefits of camel milk.

In fact, it was reported that nutrients from camel milk represent considerable value comparing to those of cow's milk, besides the medicinal and health effects due to camel milk contains measurable quantities from lactoferrin, lactoperoxidase, lysozyme and a number of other antibacterial and anti – viral protective proteins (El- Agamy et al. 1992, Abd El-Gawad et al. 1996, El-Agamy 2000; Mal and Pathak, 2010).

On the other hand, milk is usually heat treated to improve its keeping quality and to achieve desirable quality in the final product. However, it is well known that milk is a heat labile material and knowledge of the impact of heat treatments is of importance in understanding the changes in the technological, biological and functional properties of milk which occur during the applied treatments. Such changes were extensively studied for cow's and buffalo's milk and even with less extent for sheep and goat's milk. According to our knowledge only limited studies were carried out on camel milk in this respect (Farah, 1986; Farah and Atkins, 1992;

Hassan et al.2009).

Our objective in the current research was to study impact of different heat treatments on the gross chemical composition and nitrogen distribution of camel milk. Activity of rennet and yoghurt culture in raw and heat treated milk was also taken into consideration.

MATERIALS AND METHODS

Milk samples:

Collected from the herd of Marsa Matrouh Animal Production Research Station, Animal production Research Institute and kept under cooling (4 ± 1^0C) until analysis.

Experimental procedure:-

Milk sample was divided into 5 equal portions. The first one was kept without heating and served as control sample, while the other 4 parts were heat treated at 63, 80, 90^0C for 30 min and 72^0C / 15 sec. This was done by taking 100 ml of sample in a 250 ml round bottomed flask having a long neck and fitted stopper in thermostatically controlled water bath. The samples were gentely stirred during heating and cooled immediately after the required time using running tap water. .

Method of analysis:-

All milk samples were tested for fat, ash, total solids (TS), acidity and pH as given in the AOAC (2007). .

Total nitrogen (TN), non - casein nitrogen (NCN) and non - protein nitrogen (NPN) were determined using the kjeldahl's method according to Ling (1963) and used for the following calculations:

Total protein = TN × 6.38

Whey protein nitrogen (WPN) = NCN - NPN

Casein No = [(TN - NCN) / TN] × 100.

Denaturation % = WPN_{raw} - WPN_{heated} / WPN_{raw} × 100 (Manji and Kakuda, 1987).

Rennet clotting time (RCT) was measured according to Berridge (1952) using calf rennet powder (Hansen's Lab., Copenhagen, Denmark), whereas the changes in acidity and pH were followed during 12 h incubation at 40^0C in the presence of yoghurt culture (YC-X11) obtained from Hansen's Lab. (Denmark). The starter consisted of

Streptococcus thermophilus and Lactobacillus delbruckii subsp. Bulgaricus and was added in adequate amount recommended for making good quality yoghurt from cow's milk.

Statistical Analysis for the attained data was done using SPSS computer program (SPSS, 1999).Analysis of variance and Duncan's test were carried out in this respect.

RESULTS AND DISCUSSION

Table (1) shows the chemical composition of camel milk samples subjected to different heat treatments. The fat content was not affected by the applied treatments since the value of fat remained constant being 3.2%. The highest value of protein (3.4%) was found in milk heated at 80^{o}C for 30 min and 90^{o}C for 30 min compared with unheated milk (3.1%). The differences in this respect were significant. Ash content was the highest (0.73%) when milk was subjected to the severe heat treatment (90^{o}C / 30 min.) followed by the value of 0.71% in milk treated by heating at 80^{o}C / 30 min or 72^{o}C / 15 sec. The control (unheated) milk had the lowest value (0.68%) in this respect. The values of TS contents were 9.9, 10.0, 10.10, 10.16 and 10.05% in the control milk and milk treated with different heat treatments of 63 ^{o}C, 80 ^{o}C, 90 ^{o}C /30 min. and 72 ^{o}C /15 sec. respectively suggesting that the control milk had the lowest value in this respect, whereas impact of heat treatment was significant. The results given by Farah (1996) indicated that the heat treatment of at 63^{0}C for 30min did not affect the chemical composition of camel milk. On the other hand, gross chemical composition of camel's milk agrees with the composition range reviewed by Khan and Iqbal (2001).In the local studies carried out by El-gammal and Moussa (2007) and by Hassan et al. (2009) camel's milk samples contained 3.9 and 3.1% fat, 2.9 and 2.81% protein, 0.74 and 0.90% Ash, whereas TS contents were 11.93 and 11.94% respectively.

Table (1):- Effect of different heat treatments on gross chemical composition of camel milk*

Constituent (%)	Unheated milk	Heat treatments			
		63^0C /30 min	80^0C /30 min	90^0C /30 min	72^0C /15 sec
Fat	3.2[a]	3.2[a]	3.2[a]	3.2[a]	3.2[a]
Protein	3.1[b]	3.2[b]	3.4[a]	3.4[a]	3.3[a]
Ash	0.68[c]	0.70[b]	0.71[b]	0.73[a]	0.71[b]
Total solids	9.9[c]	10.0[b]	10.10[a]	10.16[a]	10.05[b]

* Averages of three replicates.
* Values (a, b ……etc.) within the same row with different superscripts differed significantly (P<0.05).

Distributions of nitrogen fractions in unheated milk as well as in heated milk samples are presented in Table (2). Total nitrogen (TN) was not affected by the different heat treatments, since the same value of 0.612% was recorded. Non protein nitrogen (NPN) and NPN/TN% were affected significantly by the different heat treatments. The highest corresponding values were recorded for the control samples, whereas the lowest values of 0.037% and 6.046% were found for NPN and NPN/TN of milk samples treated with the severe heat treatments of 80^0C /30min. and 90^0C /30min. respectively. Hassan et al. (2009) gave the same value of 0.029% for NPN of raw and heated (85^0C / 5min) camel's milk. On the other hand, the values of non casein nitrogen (NCN) and NCN/TN% were affected by the different heat treatments following the same trend of NPN results being the highest corresponding values were recorded for the control samples whereas the minimum values were observed in milk subjected to the aforementioned severe heat treatments. This agrees with the results given by Hassan et al. (2009) who gave values of 0.147 and 0.104% for NCN of raw and heated (85^0C/5 min.) camel's milk.

The whey protein nitrogen (WPN) and WPN/TN% contents significantly decreased as affected by the different heat treatments compared to the unheated milk. Contrary to that, the casein number (Casein No. = [(TN - NCN) / TN] × 100) showed an increased trend. This agrees with the finding of Hefnawy and Mehanna (1988) who

reported that the higher was the severity of heat treatments, the higher were the values of CN and the lower were the values of WPN of goat's milk. They attributed such impact to denaturation of whey proteins that co-precipitated with the caseins. The same was concluded by Qi et al. (1995). On the other hand, the current figures are in accordance with those given by Hassan et al. (2009) for raw and heat - treated (85^0C /5 min.) camel's milk. They gave the corresponding values of 0.102 and 0.059 % for WPN and 0.348 and 0.391 % for CN respectively.

Table (2):- Effect of different heat treatments on the nitrogen distribution in camel milk*

Property	unheated milk	Heat treatments			
		63^0C /30 min	80^0C /30 min	90^0C /30 min	72^0C /15 sec
TN%	0.612[a]	0.612[a]	0.612[a]	0.612[a]	0.612[a]
NPN%	0.040[a]	0.038[a]	0.037[b]	0.037[b]	0.038[a]
NPN/TN%	6.536[a]	6.206[b]	6.046[c]	6.046[c]	6.209[b]
NCN%	0.168[a]	0.154[a]	0.129[b]	0.112[c]	0.136[b]
NCN/TN%	27.385[a]	25.196[a]	21.029[b]	18.317[c]	22.222[b]
WPN%	0.124[a]	0.118[a]	0.093[b]	0.079[c]	0.099[b]
WPN/TN%	20.261[a]	19.066[a]	15.226[b]	12.923[c]	16.305[b]
Casein No	72.62[c]	74.81[c]	78.97[b]	88.79[a]	77.78[b]
Denaturation, %	-	5.89[d]	24.48[b]	36.21[a]	19.52[c]

* See legend to Table (1) for details.

Denaturation of whey proteins expressed as percentage was given in Table (2). It was apparent that at the highest heat treatment (90^0C /30 min.) the denaturation was 36.21 %, but at the low heat treatment (63^0C /30 min) there was very low whey protein denaturation (5.89 %). The denaturation rate was increased to be 24.84 and 19.52 % by applying heat treatments of 80^0C / 30 min. and 72^0C / 15 sec. respectively. However, it was reported in the literature that moderate heat treatment (60-70^0C) induced structural unfolding of

the milk proteins, whereas at higher temperature protein aggregaration occurred (Schmidt et al.1984).

In general, Stephen and Ganguli (1974) mentioned that there occur considerable changes in the nitrogen distribution in milk as a result of heat treatments especially at temperature higher than 65^0C, whereas it was reported that camel's milk was generally more heat-stable than buffalo's and cow's milk and this could be due to deficiency of k-casein and β-lactoglobulin in camel's milk (Farah and Atkins, 1992).

The current study was also concerned with behaviour and activity of rennet and yoghurt culture in raw and heated camel's milk since coagulation and fermentation are important principles in making cheese and yoghurt in order. Table (3) shows rennet clotting time (RCT) of raw and heat treated milk in the presence of different calcium chloride concentrations. The control milk had the lowest RCT whereas the value gradually increased in milk treated at 63, 80, 90^0C for 30 min and 72^0C / 15 sec.This was true at any concentration of calcium chloride suggesting that the differences in RCT due to the applied heat treatments were significant. Impact of increasing the amount of calcium chloride added on decreasing RCT was significant in all cases. The higher was the amount used, the lower was RCT.

Table (3):- Rennet clotting time (RCT,min.) of camel milk in the presence of different concentrations of calcium chloride as affected by different heat treatments *

Amount of $CaCl_2$ (mg/100ml)	unheated milk	Heat treatments			
		63^0C /30 min	80^0C /30 min	90^0C /30 min	72^0C /15 sec
0	17 ^{dA}	20 ^{cA}	26 ^{aA}	28 ^{aA}	23 ^{bA}
5	14 ^{dB}	17 ^{cB}	24 ^{aA}	25 ^{aB}	20 ^{bB}
10	12 ^{dB}	14 ^{cC}	21 ^{aB}	23 ^{aC}	18 ^{bC}
20	9 ^{dC}	12 ^{cC}	18 ^{aC}	20 ^{aC}	15 ^{bC}

* Averages of three replicates.

* Values (a, b ……etc. and A, B…….etc) within the same row and column in order with different superscripts differed significantly ($P<0.05$).

Different trends of results were recorded in the literature in this respect, Bayoumi (1990) reported that the raw camel's milk characterized with poor rennet ability even with the addition of

calcium chloride. The RCT values given by Farag and Kebary (1992) ranged in 13.5 - 76 min. with an average of 36.3 min. after analysis of 40 camels milk samples. Recently, Hassan et al. (2009) demonstrated that no time could be recorded for RCT of both raw and heat treated (85^0C /5 min.) camel's milk.

Table (4) shows the changes in acidity and pH during 12 h of incubation at 40^0C as an index for activity of yoghurt culture in camel's milk Acidity of raw and heated milk increased gradually on advancing incubation period with very slow rate since the figures were 0.16, 0.15, 0.17, 0.18 and 0.16 % after one hour incubation of raw and milk treated with 63, 80, 90^0C for 30 min. and 72^0C / 15 sec. respectively and increased to be 0.30, 0.22, 0.30, 0.32 and 0.26 % in order at the end of incubation period. The differences in acidity values due to the applied heat treatments were almost significant and could be due to transference of calcium phosphate from the soluble phase to the colloidal one which would result from the liberation of hydrogen ion. This agrees with the finding of Hassan et al. (2009) for camel's milk.

The opposite trend was recorded concerning pH values which gradually decreased upon incubation reaching the corresponding minimum values of 5.1, 5.7, 5.4, 4.9 and 5.4 respectively at the end of incubat period.

Such slow development of acidity in spite of adding adequate amount of active yoghurt starter may be due to presence of antibacterial substances in camel's milk which inhibited activity of yoghurt culture in such milk. This besides effect of heat treatment on camel milk proteins with respect to antimicrobial factors which were given in details by El-Agamy et al.(1992) and El-Agamy (2000). However, El-gammal and Moussa (2007) gave acidity value of 0.58 % and pH of 5.5 for the fresh yoghurt made from camel's milk which needed also longer incubation time for complete coagulation.

Table (4):-Changes in acidity (%) and pH values (in parenthesis) of milk inoculated with yoghurt culture during incubation at 40^0C for 12 h*

Incubation time(h)	unheated milk	Heat treatments			
		63^0C /30 min	80^0C /30 min	90^0C /30 min	72^0C /15 sec
Zero	0.16^{b} (6.6^{a})	0.15^{c} (6.5^{a})	0.17^{a} (6.4^{b})	0.18^{a} (6.3^{b})	0.16^{b} (6.6^{a})
1	0.16^{b} (6.6^{a})	0.15^{c} (6.5^{a})	0.17^{a} (6.4^{b})	0.18^{a} (6.3^{b})	0.16^{b} (6.6^{a})
2	0.18^{b} (6.3^{b})	0.15^{c} (6.5^{a})	0.19^{a} (6.1^{c})	0.20^{a} (5.9^{c})	0.18^{b} (6.3^{b})
4	0.18^{b} (6.3^{b})	0.15^{c} (6.5^{a})	0.22^{a} (5.8^{c})	0.22^{a} (5.7^{c})	0.20^{b} (5.9^{c})
6	0.20^{b} (5.9^{b})	0.17^{c} (6.4^{a})	0.24^{a} (5.6^{c})	0.25^{a} (5.5^{c})	0.22^{b} (5.7^{c})
8	0.22^{b} (5.7^{b})	0.17^{c} (6.4^{a})	0.26^{a} (5.4^{c})	0.27^{a} (5.3^{c})	0.22^{b} (5.7^{b})
10	0.26^{b} (5.4^{b})	0.19^{d} (6.2^{a})	0.28^{b} (5.4^{b})	0.30^{a} (5.1^{c})	0.24^{c} (5.6^{b})
12	0.30^{a} (5.1^{c})	0.22^{c} (5.7^{a})	0.30^{a} (5.4^{b})	0.32^{a} (4.9^{c})	0.26^{b} (5.4^{b})

*See legend to Table (1) for details.

REFERENCES

Abd El-Gawad, I. A.; El-Sayed, E. M.; Mahfouz, M. B. and Abd El-Salam, M. H. (1996).Changes of lactoferrin concentration incolostrums and milk from different species. Egyptian J. DairySci.24: 297.

A.O.A.C. (2007).Official Methods of Analysis. Association of Official Analytical Chemists. 18th Ed, Benjamin Franklin Station. Washington, D.C., USA.

Bayoumi, S. (1990). Studies on composition and rennet coagulation of camel milk. Kieler-Milchwirtschafliche Forschungsberichte 42:3. CF. Hassan et al. (2009).

Berridge, N. J. (1952). Some observations on the determination of the activity of rennet. Analyst, 77, 57.

El-Agamy, E.I. (2000).Effect of heat treatment on camel milk proteins with respect to antimicrobial factors; a comparison with cows' and buffalo milk proteins. Food Chemistry 68,227.

El-Agamy, E. I.;Ruppanner, R. ;Ismail, A. ;Champagne, C. P. and Assaf, R. J. (1992).Antibacterial and antiviral activity of camel milk protective proteins. J. Dairy Res., 59,169.

El-gammal, O. and Moussa, M. A. M. (2007). Improving the quality of yoghurt manufactured from camel milk. J. Agric. Sci.Mansoura Univ., 32:6431.

Farag, S.I. and Kebary, K. M. K. (1992). Chemical composition and physical properties of camel's milk and milk fat. In Proc. 5th Egyptian Conf. DairySci. Techno. P 57, Nov. 1992.

Farah, Z. (1986). Effect of heat treatment on whey proteins of camel milk. Milchwissenschaft, 41,763.

Farah, Z. (1996). Camel milk properties and products. SKAT, Swiss Center for Development Cooperation in Technology and Management.PP.14-19. St.Gallen, Switzerland.

Farah, Z. and Atkins, D. (1992). Heat coagulation of camel milk. J.Dairy Res.59:229.

Hassan, Z. M. R.; Farahat, A. M. and Abd El-Gawad, M. A. (2009). Effect of cold storage and heating of camel's milk on functional properties and microstructure in comparison with cow's and buffalo's milk .Annals Agric. Sci. Ain Shams Univ., 54:137.

Hefnawy, Sh. A. and Mehanna, N. M. (1988). Nitrogen distribution and some properties of raw and heated goat's milk .Egyptian J.Dairy Sci.16:39.

Khan, B. B. and Iqbal, A. (2001). Production and composition of camel milk. A review. Pak. J. Agri. Sci., 38:64.

Ling, R. E. (1963). A Text Book of Dairy Chemistry. Vol. 2, 3rd ed., Chapman and Hall Ltd, London.

Mal, G. and Pathak, K. M. L. (2010). Camel milk and milk products. SMSV' Dairy Year Book. 97-103.

Manji, B. and Kakuda, Y. (1987). Determination of whey protein denaturation in heat – processed milk: Comparison of three methods.J Dairy Sci. 70: 1355.

Qi, X. L.; Brounlow, S.; Holt, C. and Sellers, P. (1995).Thermal denaturation of β- Lactoglobulin: effect of protein concentration at pH 6.75 and 8.05. Biochem. Biophys. Acta, 1248:43.

Schmidt, R. H.; Packard, V. S. and Morris, H. A. (1984). Effect of processing on whey protein functionality. J. Dairy Sci., 67, 2723.
Stephen, J. and Ganguli, N. C. (1974). Distribution of nitrogen in buffalo milk and ultracentrifugal whey as affected by heat treatments.Milchwissenschaft, 29:594.
SPSS (1999). SPSS for Windows. Release 10 (27Oct. 1999). Standard Version. Copyright SPSS Inc., 1989-1999.

تاثير المعاملات الحرارية على تركيب و بعض خواص لبن النوق

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نظرا للاهتمام الكبيربلبن النوق فى السنوات الاخيرة فقد حظى بالعديد من الدراسات التفصيلية لتركيب اللبن و دراسة مكوناته بالاضافة الى دراسة بعض الخواص التصنيعية لة و ربما يرجع ذلك الى خواصة المناعية و العلاجية و التى اهتمت بها الكثير من المراجع الحديثة فى العديد من بلدان العالم.

اهتم هذا البحث بدراسة تاثير بعض المعاملات الحرارية (63، 80 ، 90 ْم/30دقيقة ، 72 ْم/15ثانية) على التركيب الكيماوى للبن النوق و كذلك تاثير هذه المعاملات مقارنة باللبن غير المعامل على توزيع النتروجين مع دراسة مدى مناسبةهذا اللبن للتصنيع حيث تم دراسة سلوك المنفحة فى وجود تركيزات مختلفة من كلوريد الكالسيوم و ايضا نشاط بادئ اليوغورت للوصول الى الرقم الهيدروجينى المناسب لتمام الصناعة.

و قد اظهرت النتائج الاتى:-

1- لم يتاثر دهن اللبن بالمعاملات الحرارية المختلفة حيث كانت نسبة الدهن واحدة(3.2%) فى اللبن غير المعامل و اللبن المعامل حراريا.

2- تاثرت نسبة بروتين اللبن تاثرا بسيطا بالمعاملات الحرارية المختلفة حيث كانت القيم 3.2 ، 3.4 ، 3.4 ، 3.3 % على التوالى مقارنة باللبن غير المعامل حيث احتوى على 3.1 % بروتين.

3- كان تاثير المعاملات الحرارية معنويا على المحتوى من الجوامد الكلية و الرماد مقارنة باللبن غير المعامل حراريا حيث كانت قيم الجوامد الكلية 10.0 ، 10.10 ، 10.16 ، 10.05 ، 9.9 % على التوالى و 0.70 ، 0.71 ، 0.73 ، 0.71 ، 0.68 % للرماد على التوالى.

4- لم يتاثر المحتوى من النتروجين الكلى بالمعاملات الحرارية المختلفة للبن (0.612 %)

5- أدت المعاملات الحرارية المختلفة الى تناقص نسبة النتروجين غير البروتينى (0.038 ، 0.037 ، 0.037 ، 0.038 و الغير معامل 0.040 %) على التوالى و النتروجين غير الكازينى (0.154 ، 0.129 0.112 ، 0.136 0.168 %) على التوالى و نتروجين بروتين السيرم (0.118 ، 0.093 ، 0.079 ، 0.099 ، 0.124%) على التوالى و دل التحليل الاحصائى ان التناقص كان معنويا.

6- زاد الرقم الكازينى زيادة معنوية حيث كانت القيم 74.81 ، 78.97 ، 88.79 ، 77.78 ، 72.62 % على التوالى للبن المعامل و غير المعامل.

7- أدت المعاملات الحرارية المختلفة للبن الى زيادة نسبة البروتين المدنتر زيادة معنوية مقارنة بغير المعامل حيث كانت القيم 5.89 ، 24.48 ، 36.21 ، 19.52 % على التوالى مقارنة باللبن غير المعامل و الذى بالطبع كانت فية نسبة البروتين المدنتر مساوية للصفر.

8- أدت المعاملات الحرارية المختلفة الى زيادة وقت التجبن بالمنفحة زيادة معنوية مقارنة باللبن غير المعامل و دون اضافة كلوريد الكالسيوم حيث كانت 20 ، 26 ، 28 ، 23 دقيقة على التوالى مقارنة باللبن غير المعامل (17 دقيقة) بينما أدت اضافة كلوريد الكالسيوم بنسب 5 ، 10 ، 20 ملجم / 100 مل لبن الى تقليل و قت التجبن بالمنفحة و كانت الفروق معنوية بزيادة نسبة كلوريد الكالسيوم فى كل العينات التى عرضت للمعاملات الحرارية المختلفة.

9- أدت المعاملات الحرارية للبن الى عدم تقدم الحموضة فى الساعة الاولى من التحضين مع بادى اليوغورت على درجة حرارة 40° م و كانت التاثير معنويا فى نهاية فترة التحضين حيث كانت الحموضة بعد الساعة الاولى 0.15 ، 0.17 ، 0.18 ، 0.16 % على التوالى مقارنة باللبن غير المعامل (0.16 %) و لكن بعد مرور 12 ساعة من التحضين زادة القيم الى 0.22 ، 0.30 ، 0.32 ، 0.26 ،0.30 % على التوالى فى حين ان القيم المقابلة للرقم الهيدروجينى كانت لها اتجاها عكسيا حيث كانت القيم بعد الساعة الاولى 6.5 ،6.4 ، 6.3 ، 6.6 ، 6.6 على التوالى و انخفضت الى 5.7 ، 5.4 ، 4.9 ، 5.4 ، 5.1 بعد 12 ساعة من التحضين على الرغم من اضافة كمية كافية من بادى اليوجورت النشط.