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Effect of storage time on physiochemical and sensory properties of Karadi sheep milk yoghurt

Kocher Jamal Ibrahim[1] & Jasim Mohammed Salah Al-Saadi[2]
[1]*Food Science and Human Nutrition Department, College of Agriculture Science, Sulaimani University, Sulimmania, Iraq*
[2]*Dairy Science and Technology Department, College of Food Sciences, AL-Qasim Green University, Iraq*
** Corresponding author: e.mail: jasim_salih@yahoo.com*

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Abstract

The composition of local sheep milk showed that it contained high total solids, which was 16.8%. Beside, this milk also marked by its higher ratio of total protein and fat, that were 5.3 and 6.4%, respectively.

Viscosity of sheep milk yoghurt after one day and 28 days of storage at 5° C was higher than the viscosity of cow milk yoghurt.

Spontaneous whey separation from cow's milk yoghurt and sheep's milk yoghurt were 3.6 and 0.3 ml after one day of production, respectively. These values were increased with the progress of storage to 4.5 and 1.5 ml after 28 days of storage at 5 °C for cow's milk yoghurt and sheep milk yoghurt, respectively.

Water holding capacity in sheep's milk yoghurt was higher than cow milk yoghurt during 28 days of storage at 5 °C. Hardness at the first day of storage, were 52 and 70 g for local sheep milk yoghurt and cow milk yoghurt, respectively. These values increased gradually to 58.5 and 85 g after 28 days of storage at 5 ° C for local sheep milk yoghurt and cow milk yoghurt, respectively.

The total degrees of sensory evaluation of yoghurt produced from local sheep's milk were higher than the degrees of cow milk yoghurt during the storage for 28 days at 5°

Introduction

Yoghurt is one of the fermented dairy products widely consumed all over the world. It's obtained by lactic acid fermentation of milk by the action of a starter culture containing *Streptococcus salivarius* sub sp. *thermophilus* and *Lactobacillus delbrueckii* Sub sp. *bulgaricus*. The role of these two bacteria in yoghurt manufacture can be summarized by milk acidification and synthesis of aromatic compounds *[1;2]*. Yoghurt can be stored for up to four weeks on cooling conditions. Yoghurt is more nutritive than milk due to its higher milk solids, protein contents, calcium, phosphorus and a range of vitamins in addition to nutrients developed during fermentation *[3;4]*. Total solids effect yoghurt texture. Higher TS milk improves the texture and made it less susceptible to syneresis and had shorter casein particle chains *[5]*. Yoghurt mix is normally heated at a higher temperature and longer time than normal pasteurization, ranging from 90 to 95°C for 5 to 10 min. beside, this heat treatment helps to improve product consistency through whey protein denaturation *[6]*. The degree of denaturation consist on the strength of heat applied, low TS yoghurt may require more whey protein denaturation than high TS yoghurt *[7]*. Whey proteins that participate in casein aggregation in yoghurt are α-lactalbumin and β-lactoglobulin, the former has a denaturation temperature of 62°C and the latter 78°C *[8]*.

Sheep milk is especially suitable for yoghurt production because of its high protein and total solids content *[9]*. Jumah *et al.* (2001) *[10]* found that yoghurt produced from sheep milk had the highest viscosity in comparison with goat>cow>camel milk yoghurt. Sheep population in Iraq is about 7 million *[11]*. The native breeds include Karadi (20%), Awassi (58.2%) and Arabic sheep (21.8%) *[12]*.

The objectives of this work were to study the effect of storage on physiochemical and sensory properties of yoghurt produced from Iraqi Karadi sheep milk.

Materials and Methods

A. Milk sources

Karadi sheep milk was collected from thirteen animals in Priss village at Halabja governorate -Iraq. Cow milk was supplied by the dairy farm of Faculty of Agricultural Sciences- University of Sulaimani –Iraq.

Fat determination

Milk fat in the samples was determined by Gerber method according to British Standard Institution *[13]*.

Moisture content

The moisture content in milk and yoghurt samples were determined using drying methods [14].

Ash determination

Ash concentration in milk was estimated using the method given in AOAC *[14]*.

Protein

The nitrogen content in milk sample was estimated by Kjeldahl's method *[14]*. The protein content in milk was estimated by multiplying the percent nitrogen with 6.38.

Carbohydrate determination

Phenol-sulfuric acid method mentioned by Dubois *et al*., (1956) *[15]* was used to estimate carbohydrates concentration in yoghurt.

B. Yoghurt preparation and physiochemical analysis

Yoghurt manufacturing

Fresh milk was heated to 90±2 ^{o}C for 10min then cooled to 42^{o}C and 3% of pre-activated starter in skim milk was added. The inoculated milk sample was distributed in 100 ml plastic cups and incubated at 42 ±2 ^{o}C for 3 – 4 hours until pH decreased to 4.6 then storage a 4 -5 ^{o}C*[16]*.

pH determination

The pH of milk and yoghurt was measured using electronic digital pH meter (Inolab WTW Series 720, Germany). Buffer solution of pH 4 and 7 were used to calibrate the pH meter. Milk sample was taken in a beaker; pH meter electrode was immersed in the sample to determine pH.

Titratable acidity determination

Titratable acidity of milk and yoghurt samples, expressed as percentage of lactic acid, was determined by titration of 10 g sample mixed with 20 ml of distilled water and titration with 0.1 N NaOH using phenolphthalein as indicator to the end-point of faint pink colour following IDF standard method*[17]*.

Viscosity determination

The viscosity determination was based on Rawson and Marshall, (2007) *[18]*. Method, with some modification. The gel was broken by stirring with a glass rod (10 times clockwise; 10 times anticlockwise). Rotational viscosity measurements were done using a Brookfield viscometer (model DV- E; Brookfield Engineering laboratories) using spindle No 7. Each measurement was made at room temperature at 100 rpm for 1 min.

C. Spontaneous whey separation determination

Spontaneous whey separation was determined according to the procedure described by Amatayakul *et al.,* (2006) *[19]*. A cup of the set yoghurt was removed from refrigerator at 5^{o}C. A needle connected to syringe was used to withdraw the liquid whey from the surface of the sample and the cup of

fermented skim was weight again. The process lasted for less than 10s to avoid further leakage of whey from the curd.

D. Water-holding capacity determination

Water-holding capacity (WHC) of yoghurt was determined as described by Harte *et al*. *[20]*. Briefly, 10 g of yoghurt was centrifuged at 5000xg for 10 min at 5°C. The resulting supernatant was carefully weighted to determine the amount of excluded water, WHC % = $[1-(w_2 / w_1)] \times 100$
[w_1: weight of yoghurt used, and w_2: weight of whey after centrifugation].

E. Texture determination

The evaluation of textural properties was conducted using a texture analyzer (CT3(4500), Brookfield engineering lab).The hardness of samples were measured and the operation conditions were an artificial plastic cylinder (20 mm in diameter) was inserted into each product to a depth of 20 mm with 5.0g trigger and speed of 1 mm/s *[21]*.

F. Sensory evaluation

Sensory evaluation was done for cow and sheep milk yoghurt to estimate the acceptability of yoghurt sample from 11 panelists among the staff of Food Technology department, Agriculture technical college of Halabja.

Statistical analysis

The data were statistical analysis according to the method of analysis of variance as a general test. Factorial experiment with three replication was used by XLSAT program ver. 7.5.2 and conducted using Complex Randomized Design (CRD).
All possible comparisons among the means were carried out by using Least Significant Difference (LSD) test at the significant level of 0.05 after they show their significant in the general test

Results and Discussion

Karadi sheep milk composition

The composition of karadi sheep milk is showed in table (1), moisture content in sheep milk was 83.2% while total solids was 16.8% and this value within the range of total solid in sheep milk as mentioned by park *et al*.(2007) *[22]*which was 15-20%.
Protein percentage in local (karadi) sheep milk was 5.3%, and this value is in the range of protein value mention by park *et al.* (2007) *[22]*. Fat content in local sheep milk was 6.4% and this value is higher than fat ratio in cow milk. Beside this value is close to the range of fat percentage in sheep milk mention by Pandya and Ghodke (2007) *[23]*.

Table-1: Chemical composition and some properties of local sheep milk (karadi)

Component	***%***
Moisture	83.2
Total solids	16.8
Solid non fat	10.4
Protein	5.3
Fat	6.4
Carbohydrate	4.2
Ash	0.91
Property	***value***
Acidity (%)	0.23
pH	6.61

Carbohydrate content in milk of different breeds of sheep was ranged between 4.1 – 4.9 % *[23]*. In this study carbohydrate ratio was 4.2%.

Ash ratio in local sheep milk was 0.91% and this value is higher than ash ratio in cow milk (0.7%) and this value is similar to the result found by park *et al*., (2007) *[22]*. Acidity and pH of karadi sheep milk in this study were 0.23 % and 6.61, respectively. These values were within the range of acidity (0.22 – 0.25%) and pH (6.51 – 6.85) mentioned by Haelein and Wendorff, (2006) *[24]* for sheep milk.

Effect of storage on some physiochemical properties of cow and sheep milk yoghurt Effect of storage on pH and acidity of cow and sheep milk yoghurt

Figure 1, shows the effect of storage time on the pH value of yoghurt sample stored for four weeks at 5 °C.

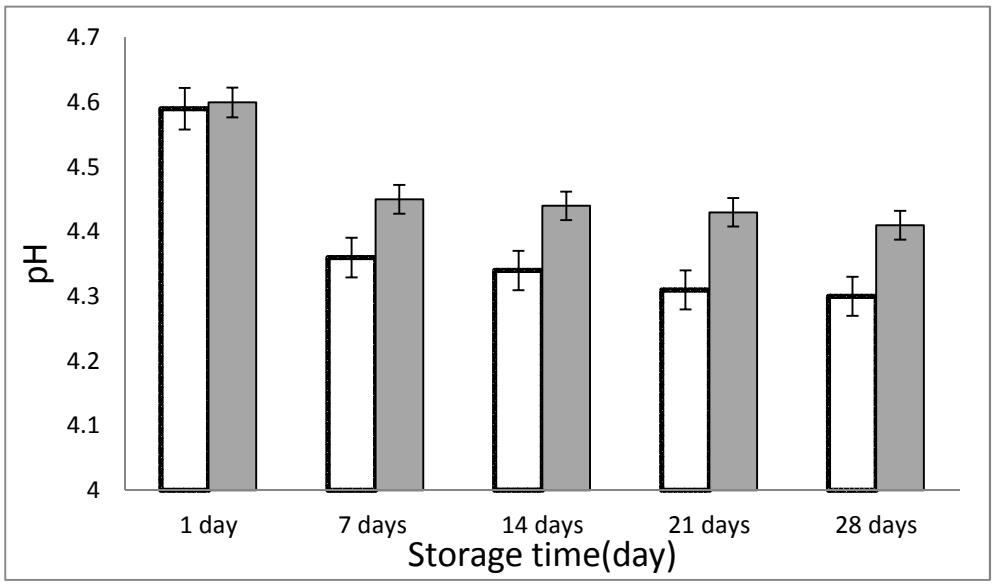

Figure-1 : Effect of storage time on the pH value of cow □ and sheep ■ yoghurt sample stored for four weeks at 5 °C.

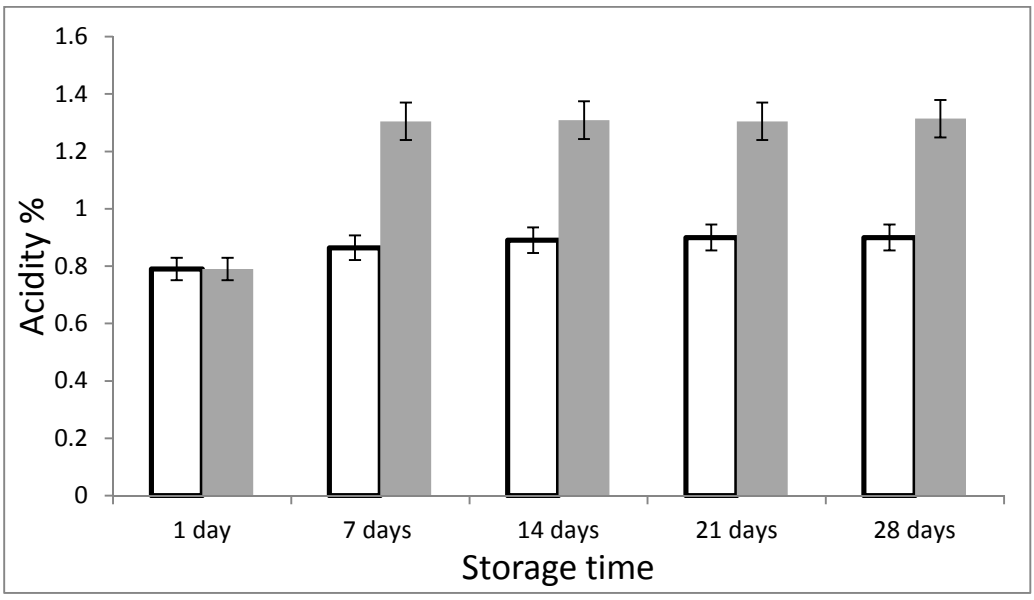

Figure- 2 : Effect of storage time on acidity of cow □ and sheep ■ yoghurt sample stored for four weeks at 5 °C.

Effect of storage on viscosity of cow and sheep milk yoghurt

Changing in viscosity of cow milk yoghurt and sheep milk yoghurt was studied during storage for four weeks at 5 °C.

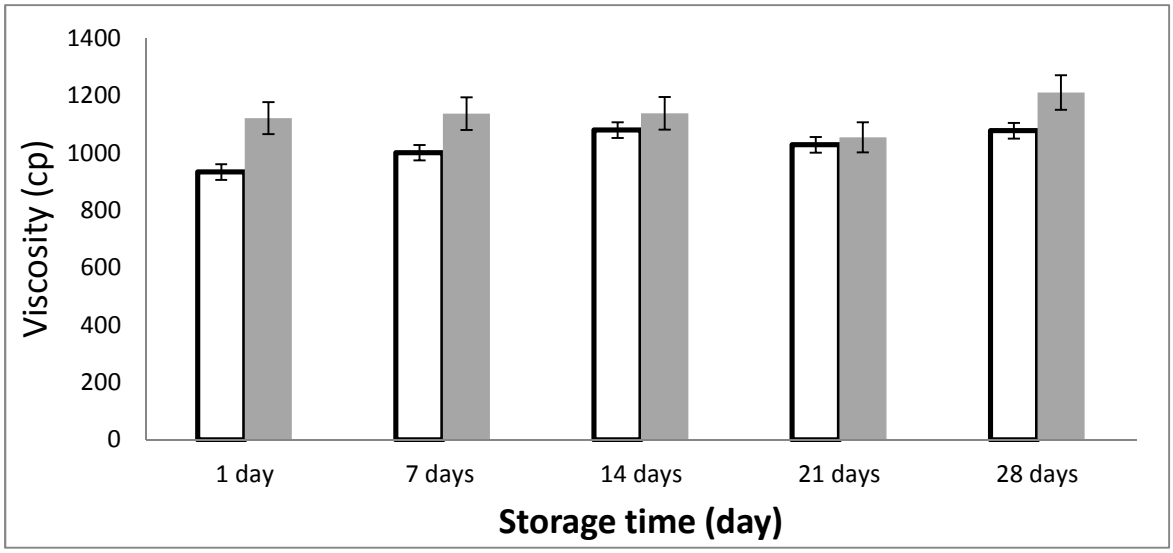

Figure- 3 : Effect of storage time on viscosity of cow □ and sheep ■ yoghurt sample stored for four weeks at 5 °C.

From figure 3, we noted that the viscosity of cow and sheep milk yoghurt which were 933.67 cp and 1122 cp, respectively after one day of storage and these values were increased during the storage until two weeks. These results were increased to 1078 and 1211 cp after four weeks of storage at 5 °C for cow milk yoghurt and sheep milk yoghurt, respectively. These results are similar with what have been found by Yazici and Akgun (2004) *[26]*. The increment in sheep milk yoghurt viscosity was statically significant than cow milk yoghurt viscosity after four weeks storage at 5 °C. This may be relative to higher total solid in sheep milk in comparison with cow milk *[22]*.

Effect of storage on spontaneous whey separation of cow and sheep milk yoghurt.

Spontaneous whey separation was determined by measuring the volume of whey separation on the top of yoghurt sample. Fig 4, showed that spontaneous whey separation after one day of manufacturing was 3.6 ml and 0.3 ml of cow and sheep milk yoghurt respectively. These values changed with the storage time until they reach to 4.5 and 1.5 for cow and sheep milk yoghurt, respectively, after four weeks of storage at 5 °C. These results are close to the result founded by Salvador and Fiszman (2004) *[31]*.

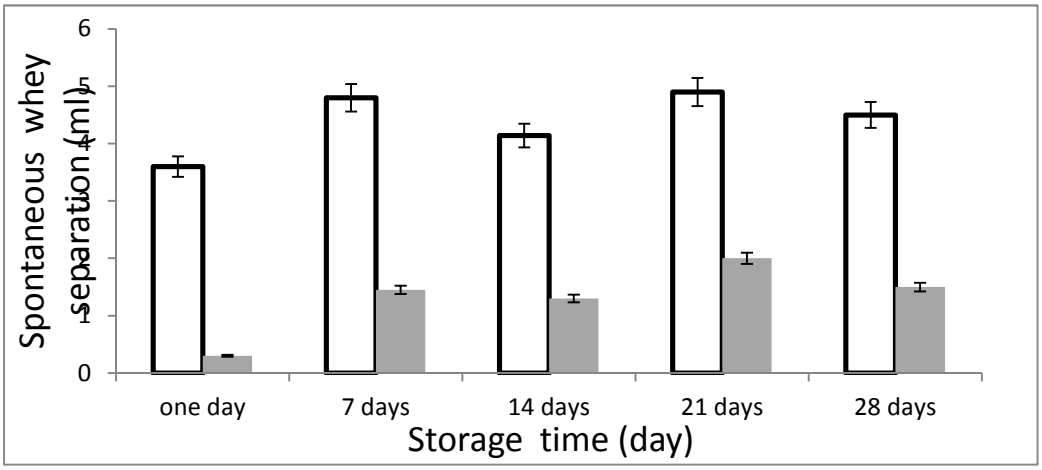

Figure- 4: Effect of storage time on spontaneous whey separation of cow □ and sheep ■ yoghurt sample stored for four weeks at 5 °C.

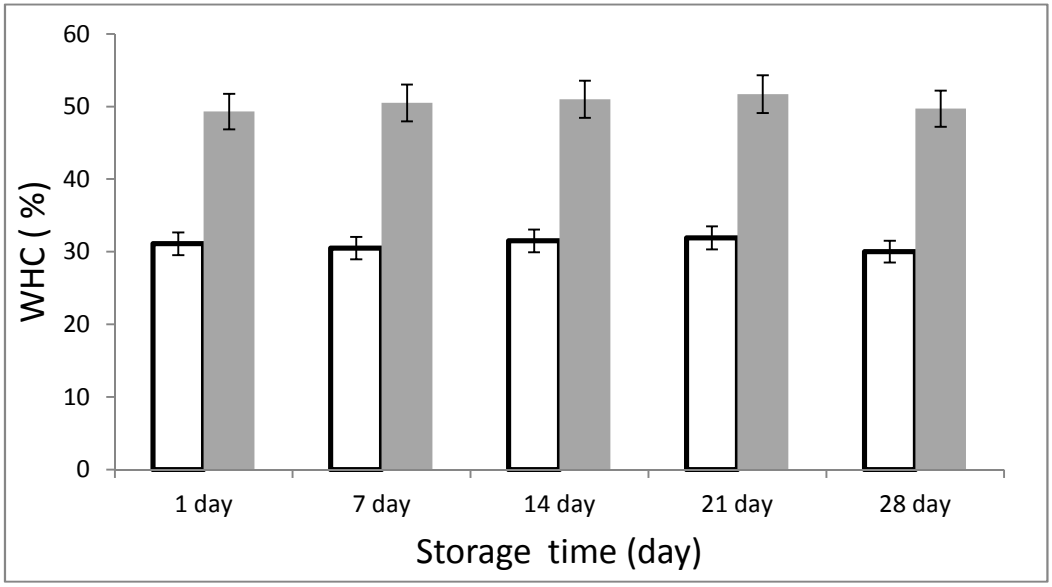

Figure- 5: Effect of storage time on water holding capacity of cow ☐ and sheep ▩ yoghurt sample stored for four weeks at 5 °C.

The differences between SWS of cow milk yoghurt and sheep milk yoghurt were statically significant in all storage days and this is may be related to the higher protein ratio in sheep milk in comparison with cow milk*[30]* which make sheep milk to have higher ability to create protein network to hold whey on it.

Water Holding Capacity of cow and sheep milk yoghurt during storage.

Water holding capacity means the capacity of gel to hold water, and with the increment of WHC the quantity of water in gel will be increase.

Fig. 5, showed that WHC after one day of manufacturing for cow and sheep milk yoghurt were 31.1% and 49.3%, respectively, these values were changed with the storage time until they reach to 30% and 49.7% in cow and sheep milk yoghurt after four weeks of storage at 5 °C, respectively.

The difference between WHC of cow and sheep milk yoghurt was statically significant in all storage days. This is may be related to the higher total solids specially proteins in sheep milk which have higher ability to create protein network to hold water *[22; 23]*.

Effect of storage on the hardness of cow and sheep milk yoghurt.

Hardness is the force necessary to attending deformation in gel, its common measure to indicate the strength of gel network.

From Table 2, it has realized that hardness for cow and sheep milk yoghurt were 70g and 52g after one day of storage. The hardness increase gradually with the increment of storage time until they reach 85g and 58.5g for cow and sheep milk yoghurt after twenty eight days of storage at 5 °C, respectively, and the difference was statically significant in all storage time.

Table-2: Effect of storage on the hardness of cow and sheep milk yoghurt during the storage at 5 °C for 28 days.

Time of storage	Type	Hardness(g)
1st	Cow	70
	Sheep	52
7th	Cow	76
	Sheep	55
14th	Cow	79
	Sheep	53.5
21th	Cow	80
	Sheep	53
28th	Cow	85
	Sheep	58.5
LSD(P≤0.05)		8.52

The higher hardness of cow milk yoghurt in comparison with sheep milk yoghurt may be related to the differences between the proteins fraction of both milk type. The result obtained with this experiment was close to the result founded by Samson *et al.* (2014) *[30]* who investigation that cow milk yoghurt hardness is higher than sheep milk yoghurt.

Sensory evaluation

Sensory evaluation was conducted for cow and sheep milk yoghurt to estimate the acceptability of yoghurt sample from 11 panelists.

Table- 3: Effect of storage on sensory evaluation of cow and sheep milk yoghurt during the storage at 5 °C for 28 days.

Time of storage	type	Flavor (40)	Texture (30)	Acidity (20)	Appearance (10)	Total (100)
7th	cow	38.54	23.91	12.82	8.54	83
	sheep	37.73	25.73	11.91	9.0	84
14th	cow	39.45	25.63	13.54	8.91	87
	sheep	39.45	27.7	11.91	9.27	88
21th	cow	38.63	24.82	12.73	8.82	85
	sheep	38.54	28.54	10.64	9.54	87
28th	cow	38.94	26.82	13.45	8.09	87.3
	sheep	39.36	28.8	11.1	9.73	88.8
LSD(P≤0.05)		2.61	2.78	2.009	0.812	2.4

Table 3 shows that total score of sheep milk yoghurt after 7, 14 ,21 and 28 days of storage at 5 °C were higher than cow milk yoghurt and this was related to the properties of texture and appearance who got higher sensory evaluation degrees in sheep milk yoghurt in comparison with cow milk yoghurt in all weeks of storage.

This is may be related to higher total solids content in sheep milk (table 1) in comparison with cow milk which make sheep milk more appropriate for yoghurt manufacturing .

Conclusions

Local sheep milk was distinguished with by its higher protein and fat ratio. Viscosity and water holding capacity of sheep milk yoghurt was higher than cow milk yoghurt, while spontaneous whey separation and hardness were higher in cow milk yoghurt in comparison with sheep milk yoghurt during the storage for 28 days at 5 °C.

References

[1] Sahan, N., Yasar, K. and Hayaloglu, A.A *"Physical, chemical and flavour quality of non-fat yoghurt as affected by a β-glucan hydrocolloidal composite during storage",* Food Hydrocolloids, Vol. (22), No. 7, pp. 1291-1297. (2008).

[2] Serra, M., Trujillo, J.A., Guamis, B. and Ferragut, V.*"Flavour profiles and survival of starter cultures of yoghurt produced from high-pressure homogenized milk",* International Dairy Journal, Vol. (19), No. 2, pp. 100-106. (2009).

[3] Patel S. *"Evaluating the Effect of Milk Protein Concentrates (MPC) Fortification on Rheological Properties of Nonfat Set Yogurt Using Vane Rheometry",* Thesis, Master of Science Degree Food and Nutritional Sciences, The Graduate School, University of Wisconsin-Stout. (2001).

[4] Fadela, C., Abderrahim, C. and Ahmed, B. *"Sensorial and physico-chemical characteristics of yoghurt manufactured with ewe's and skim milk",* World Journal of Dairy and Food Science, Vol. (4), No. 2, pp. 136-140 (2009).

[5] Harwalkar, V. R. and Kalab, M. *"Relationship between microstructure and susceptibility to syneresis in yoghurt made from reconstituted nonfat dry milk",* Food Microstructure, Vol. (5), No. 2, pp. 287-294(1986).

[6] Mottar, J., Bassier, A., Joniau, M. and Baert, J. *"Effect of heat-induced association of whey proteins and casein micelles on yogurt texture",* Journal of Dairy Science. Vol. (72), No. 9, pp. 2247-2256. (1989).

[7] Rasic, J. L. and Kurmann, J. A. *"Yoghurt: Scientific Grounds, Technology, Manufacture and Preparation. Berne, Switzerland"*. Technical Dairy Publishing House (1978).

[8] Wong, N. P., Jenness, R. Keeney, M. and Marth, E. H. *"Fundamentals of Dairy Chemistry".* (3rd) Ed. New York, NY.: Van Nostrand Reinhold Co. Inc (1988).

[9] El Zubeir, I. E.M., Basher, M.A.E., Alameen, M. H., Mohammed, M.A.S. and Shuiep, E.S. *"The processing properties, chemical characteristics and acceptability of yoghurt made from non-bovine milks",* Livestock Research f or Rural Development, Vol. (24), No.3, (2012).

[10] Jumah, R.Y., Shaker, R.R. and Abu-Jadayil, B. *"Effect of milk source on the rheological properties of yogurt during the gelation process."* International Journal of Dairy Technology, Vol. (54), No.3, pp.89-93. (2001).

[11] AL-Alaq, M. M., Al-Fahad, Y. T. and Abass, T. *"The Statistical Atlas Agricultural Roadmap for Agricultural Development (Green Economy) the Ministry of Planning (Central organization of Statistics) and Agriculture"*. Iraq (2011).

[12] Alkass, L. E and Juma, K.H. "*Small Ruminant Breeds of Iraq*": Characterization of small Ruminant Breeds in West Asia and North Africa (Ed.L. Iniguez). INCARDA, Syria (2005).

[13] British Standard Institution. *"Gerber method of determination of fat in milk product"*. Part 2, B.S. 696(1969).

[14] AOAC. *"Association of Official Analytical Chemistry). Official method of Analysis"*. Washington DC: Association of Official Chemists, 17th edition (2000).

[15] Dubois, M., Gillis, K. A., Hamilton, K., Rebers, P. A. and Smith, F. *"Colorimetric method for determination of sugars and related substances",* Analytical Chemistry Vol. (28), No.3, PP. 350-356. (1956).

[16] Tamime, A. Y. and Robinson, A. K. *"Yogurt: science and technology"*. London, UK. Woodhead Publishing Limited (1999).

[17] International Dairy Federation (IDF/ISO Standard). *"Yoghurt Determination of titratable acidity"*. (C.F.Lorenzen et.al.2002) (1991).

[18] Rawson, H. L. and Marshall, V. M. *"Effect of 'ropy' strains of Lactobacillus delbrueckii ssp.bulgaricus and Streptococcus thermophilus on rheology of stirred yogurt",* International Journal of Food Science and Technology. Vol. (32), No 3, pp. 213-220. (2007).

[19] Amatayakul, T., Sherkat, F. and Shah, N.P. *"Physical characteristics of set yoghurt made with altered casein to whey protein ratios and EPS producing starter cultures at 9 and 14% total solids",* Food Hydrocolloids, Vol. (20), No. 2, pp. 314-324. (2006).

[20] Harte F., Luedecke, L, Swanson, B. and Barbosa-Canovas, G.V. *"Low fat set yoghurt made from milk subjected to combinations of high hydrostatic pressure and thermal processing",* Journal of Dairy Science, Vol. (86), No. 4, pp. 1074-1082. (2003).

[21] Bonczar, G., Wszolek, M. and Siuta, A. *"The effects of certain factors on the properties of yoghurt made from ewes milk",* Food Chemistry, Vol. (79), No.1, pp.85-91. (2002).

[22] Park, Y.W., Juarez, M., Ramos, M. and Haenlein, G.F.W. *"Physico-chemical characteristics of goat and sheep milk",* Small Ruminant Research, Vol. (68), No. 1, pp. 88-113. (2007).

[23] Pandya, A.J. and Ghodke, K.M. *"Goat and sheep milk products other than cheeses and yoghurt",* Small Ruminant Research, Vol. (68), No. 1, pp. 193-206. (2007).

[24] Haenlein, G.F.W. and Wendorff, W.L. "Sheep milk": Handbook of milk of non-bovine mammals (ed. by Park, Y.W., Haenlein, G.F.W.), Iowa, USA. Blackwell Publishing (2006).

[25] Musaiger, A. O., Al-Saad, J. A., Al-Hooti, D. S. and Khunji, Z. A. *"Chemical composition of fermented dairy products consumed in Bahrain",* Food Chemistry, Vol. (61), No. 1, pp. 49–52. (1998).

[26] Yazici.F. and Akgun, A. *"Effect of some protein based fat replacers on physical, chemical, textural, and sensory properties of strained yoghurt",* Journal of Food Engineering, Vol. (62), No.3, pp. 245–254. (2004).

[27] Donkor, O. N., Henriksson, A., Vasiljevic, T. and Shah, N. P. *"Effect of acidification on the activity of probiotics in yogurt during cold storage",* International Dairy Journal, Vol. (16), No. 10, pp.1181-1189. (2006).

[28] Eissa E.A., Mohamed Ahmed, I.A., Yagoub, A.E.A. and Babiker, E.E. *"Physicochemical, microbiological and sensory characteristics yoghurt produced from goat milk"*, Lives tock Research for Rural Development, Vol. (22), No. 8, pp. 281-286. (2010).

[29] Guler, Z. and Sanal, H. *"The essential mineral concentration of Torba yoghurts and their whey compared with yoghurt made with cow's, ewes' and goat's milks",* International Journal of Food Science and Nutrition, Vol. (60), No. 2, pp. 153–164. (2009).

[30] Samson. A., Ammar, O., Baghdadi, O. K. and Imad, T. *"The characterization of the physicochemical and sensory properties of full-fat, reduced-fat and low-fat bovine, caprine, and ovine Greek yogurt (Labneh)",* Food Science & Nutrition; Vol. (2), No. 2, pp. 164–172. (2014).

[31] Salvador, A. and Fiszman, S.A. *"Textural and sensory characteristics of whole and skimmed flavored set type yogurt during long storage"*, Journal of Dairy Science, Vol. (87), No. 12, pp. 4033-4041. (2004).