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LABAN RAYEB AND YOGHURT: SENSORY, RHEOLOGICAL, CHEMICAL AND MICROBIOLOGICAL PROPERTIES

(With 11 Tables and 2 Figures)

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اللبن الرايب والزبادي: الخواص الحسية والسائلية والكيميائية والميكروبيولوجية

محمد سيد

تم إجراء هذا البحث لدراسة بعض الخواص الحسية والسائلية والكيميائية والميكروبيولوجية لبعض منتجات الألبان المتخمرة المباعة في مدينة أسيوط، مصر، والتي تمثلت في اللبن الرايب والزبادي حيث تم تجميع عدد ١٠٠ عينة (بواقع ٥٠ عينة لكل منتج) وذلك بشكل عشوائي من محلات الألبان المختلفة والموزعة بمدينة أسيوط. وقد اعتمد التقييم الحسي على ثلاث خواص رئيسة هي المظهر (ويشمل اللون والشرش الحر) ثم القوام (ويشمل الصلابة والدسامة واللزوجة والملمس الفمي والإتساق والنعومة) ثم النكهة (وتشمل الطعم والرائحة) وكانت محصلة نتائج الثلاث خواص الرئيسة متمثلة في المقبولية العامة والمعروفة بالإختصار (OAA)، أما الخواص السائلية فتمثلت في قياس كمية الشرش المرشح في درجة حرارة الثلاجة، وبالنسبة للتحليل الكيميائي فتم قياس نسب الحموضة العيارية والدهن والجوامد الكلية ومن ثم الجوامد اللادهنية والرطوبة، أما الفحص الميكروبيولوجي فتمثل في عدد الميكروبات القولونية والميكروبات القولونية البرازية والإيشيريشيا كولاي والمكورات المعوية والمكور العنقودي الذهبي والكلوستردیم برفرنجينز والخمائر والفطريات. وأظهرت النتائج أن الجودة الحسية بالنسبة للمنتجات المفحوصة كانت جيدة قليلا بالرغم من أن ٦٦% من عينات اللبن الرايب و ٧٨% من عينات الزبادي كانت بدرجة عالية نسبيا تتراوح من ٥ إلى ٩ بناءا على مقياس التسع نقاط التلذذي. وكان متوسط قيم الشرش المرشح من اللبن الرايب والزبادي تقريبا متساوية حيث ١٠,٤ و١٠,٤٢٩ مل، على الترتيب. وقد أظهر التحليل الكيميائي للبن الرايب أن متوسط قيم الحموضة العيارية ١,٢١% والدهن ٣,٠١% والجوامد الكلية ١١,٣٠% والجوامد الكلية اللادهنية ٨,٢٩% والرطوبة ٨٨,٧٠%، وبالنسبة للزبادي فكان متوسط قيم الحموضة العيارية ١,٢٠% والدهن ٣,٣٤% والجوامد الكلية

١٤,٠٢% والجوامد الكلية اللادهنية ١٠,٦٨% والرطوبة ٨٥,٩٨%. وبالنسبة لكل من اللبن الرايب والزبادي، فكانت أعلى نسبة من العينات الملوثة بالميكروبات كانت بالفطريات حيث وجدت في ٩٢ و٦٠% من العينات على الترتيب، تبع ذلك الخمائر حيث وجدت في ٦٨ و٢٤%، المكورات المعوية في ٣٠ و٢٨%، الميكروبات القولونية في ٢٨ و٢٢%، المكور العنقودي الذهبي في ٦ و٨%، الميكروبات القولونية البرازية في ٤ و٢%، على الترتيب، بينما الإيشيريشيا كولاي والكلوستريديم برفرنجينز لم يتم تحديدها. والخلاصة أن المنتجات التي تم فحصها كانت جيدة من ناحية التحليل الكيميائي بالمقارنة مع المواصفات القياسية الدولية بينما الجودة الميكروبيولوجية كانت أقل من المستوى المطلوب بالنسبة للمواصفات القياسية المصرية والدولية وذلك لمعظم العينات المفحوصة. وقد تمت مناقشة الأهمية الصحية والإقتصادية للملوثات الميكروبية المختلفة، وذلك بالإضافة إلى الطرق الصحية الواجب اتباعها لإنتاج لبن رايب وزبادي عالي الجودة.

الكلمات الكاشفة: *اللبن الرايب، الزبادي، الخواص الحسية، السائلية، الكيميائية، الميكروبيولوجية.*

SUMMARY

This investigation was run to study some sensory, rheological, chemical and microbiological properties of some fermented dairy products sold in Assiut city, Egypt. The products were represented in Laban Rayeb and yoghurt, in which 100 samples (each product 50 samples) were collected randomly from different dairy shops distributed in Assiut city. The sensory evaluation was depend on 3 main attributes as visual (including color and free whey), texture (including firmness, creaminess, viscosity, mouth feel, consistency and smoothness) and flavor (including taste and aroma), moreover, the resultant of the 3 main attributes were expressed in the overall acceptability (OAA). Syneresis was used for the rheological properties. The chemical analysis was run through the percentages of titratable acidity (TA), fat, total solids (TS) and hence solids-non-fat (SNF) and moisture. The microbiological examination was done through counting of coliforms, fecal coliforms, *E. coli*, *Enterococci*, *Staphylococcus aureus*, *Clostridium perfringens*, yeasts and molds. The obtained results revealed that the sensory quality of the examined products was slightly good although 66% of Laban Rayeb samples and 78% of yoghurt samples had a relatively high score ranged from 5 to 9 according the 9 points hedonic scale. The average values of syneresis from Laban Rayeb and yoghurt samples were nearly similar as 10.4 and 10.429 ml, respectively. The chemical analysis of Laban Rayeb revealed the average values of TA as 1.21%, fat as 3.01%, TS as 11.30%, SNF as 8.29% and moisture as 88.70; and for yoghurt the

average values of TA as 1.20%, fat as 3.34%, TS as 14.02%, SNF as 10.68% and moisture as 85.98%. For both Laban Rayeb and yoghurt, the highest% of samples contaminated with microorganisms was by molds as found in 92 and 60% of the samples, respectively; followed by yeasts as found in 68 and 24%, *Enterococci* in 30 and 28%, coliforms in 28 and 22%, *Staph. aureus* in 6 and 8%, fecal coliforms in 4 and 2%, respectively; while *E. coli* and *Cl. perfringens* could not detected. In conclusion, the examined products were of a good chemical analysis when compared to the international standards; while, the microbiological quality was lower than the level required by the Egyptian and international standards in most of the examined samples. The public health significance and economical importance of the different microbial contaminants, as well as, the recommended hygienic measures for production of high quality Laban Rayeb and yoghurt were discussed.

Key words: *Laban Rayeb; Yoghurt; Sensory; Rheological, Chemical; Microbiological properties.*

INTRODUCTION

Fermented milks is the most popular fermented dairy products in Egypt and worldwide. It is believed that fermented milks may have originated in Middle East as early as 1300 before century (BC) as means of preserving milk. Nowadays, Laban Rayeb is the popularly known way for surplus milk preservation (Salih *et al.* 2011). In addition, there has been a phenomenal increase in the production of fermented milks in developed countries.

Laban Rayeb is one of the fermented milks consumed by different ages in Egypt and other countries, for its highly nutritive value and therapeutic properties. There are various possible probiotic and therapeutic roles of starter microorganisms in cultured milks as anti-carcinogenic activity, reduction of serum cholesterol levels, alleviation of effects of renal malfunction, maintenance of normal intestinal microflora, alleviation of lactose maldigestion and nutritional enhancement (Varnam and Sutherland, 1994). Laban Rayeb is a type of fermented milk manufactured by Egyptian farmers as fresh milk is placed in an earthenware pot "Matared" and left undisturbed in a warm place until the cream rises and the lower partially skimmed milk coagulates; after removing the cream layer, which mainly made into butter, the remaining curd "Laban Rayeb" is either consumed as

fermented milk or is converted to a soft acid cheese known as Karish (El-Gendy, 1983).

Yoghurt is considered a popular, flavorful and healthful dairy product in Egypt and a traditional food beverage in Balkan and Middle East. Generally, it is one of the most unique, yet universal dairy products (Ebenezer and Vedamuth, 1991). Yoghurt production and consumption is growing continuously due to its therapeutic properties beside its high nutritive value (Karagul *et al.*, 2004; He *et al.*, 2005), in addition to the health promoting properties of live lactic acid bacteria in yoghurt including protection against gastrointestinal upsets, enhanced digestion of lactose by maldigesters, decreased risk of cancer, lower blood cholesterol (Doornbos *et al.*, 2005), improved immune response and help the body assimilate protein, calcium and iron (Perdigeon *et al.*, 1998; Marona and Pedrigon, 2004).

Changes in the physical, chemical, and microbiological structure of yoghurt determine the storage and shelf life of the product (Sofu and Ekinci, 2007). Moreover, Salvador and Fiszman (2004) reported that studies of changes in these quality characteristics during storage would enable producers to predict the shelf life of the product more accurately.

In general, the overall properties of yoghurt, such as acidity level, as well as the sensory profile and nutritional value, are important traits of the product. These aspects are influenced by the chemical composition of the milk base, processing conditions, the activity of starter culture during the incubation period (Bonczar *et al.*, 2002).

Sensory attributes are important factors that influence food acceptance and choices; moreover, sensory properties of foods offer quality control criteria. Texture is one of the main characters that define the quality of yoghurt. The most frequent defects related to yoghurt texture (that may lead to consumer rejection) are apparent viscosity variations and the occurrence of syneresis (Kroger, 1975). Different sensory texture descriptions have been used to characterize the texture of yoghurt (Martin *et al.*, 1998; Tamime and Robinson, 1999) but no standard procedure exists for the sensory evaluation of this fermented product. Firmness, creaminess, viscosity, mouth feel and syneresis are considered the most important descriptors for the textual perception of yoghurt (Muir and Hunter, 1992; Tamime and Robinson, 1999; Gámbaro, 2002).

Rheological properties determine product texture, thereby affecting sensory perception and ultimately the acceptance of a product by the consumer (Aichinger *et al.*, 2003). The rheological properties

included syneresis (the quantity of whey which has separated from yoghurt samples after 2 h at 5°C) (Dannenberg and Kessler, 1988), firmness (the depth to penetrate into the yoghurt curd is measured after 5 sec at 15°C using cone and a standardized rod; total weight 82.5 g using Koehler K 19500, Penetrometer, Syamore AVE, USA) (Kammerlehner and Kessler, 1980) and shear stress (through rotary viscometer, Rheotest II, 50 Hz, Germany) (Toledo, 1980).

An important aspect of a milk gel is whey separation, which refers to the appearance of a liquid (whey) on the surface of milk gel. It is a common defect in fermented milk products such as yoghurt (Lucey, 2001). Syneresis is an important defect in yoghurt (Lucey, 2002), and defined as the shrinkage of gel and this occurs concomitantly with expulsion of liquid or whey separation and is related to instability of the gel network resulting in the loss of the ability to entrap all the serum phase (Walstra, 1993). According to Lucey (2001) some possible causes of wheying-off in acid gels are very high incubation temperatures, excessive treatment of the mix, low TS content (protein and/or fat) of the mix, movement or agitation during or just after gel formation, very low acid production (pH≥ 4.8), and the extent of wheying-off will depend on the combinations of these conditions.

The formulation of yoghurt products with optimum consistency and stability to syneresis is of primary concern to the dairy industry (Biliaderis *et al.*, 1992). Factors influencing yoghurt texture and syneresis include TS content, milk composition (proteins, salts), homogenization, type of culture, acidity resulting from growth of bacterial cultures and heat pretreatment of milk (Harwalkar and Kalab, 1986).

Chemical composition of the milk base especially TS has the major effect on the acceptability of concentrated yoghurt. The amount of TS in the base milk, to a large extent, determines the visual and textual properties of the final yoghurt product (Baig and Prasad, 1996; Jaros and Rohm, 2003). Concentrated yoghurt containing < 20% TS was assessed as thin and tasteless and that with > 25% TS became gummy and bitter (Robinson, 1977).

The microbiological examination is of a major interest in the quality evaluation of the fermented products of the present work, as their short shelf life is mainly due to mold growth. Thus, the total yeasts & molds count in such products is considered as a standard test for checking factory sanitation. Molds cause economic losses by discoloration, poor appearance and off flavor during cold storage. Some

molds are capable of producing toxic metabolites known as mycotoxins causing serious public health concern, like aflatoxins, in addition to their stability during processing and storage of yoghurt (Kivanc, 1992; Egmond, 1994; Roy *et al.*, 1996; Shibario *et al.*, 1998; Hassanin, 1999; Galvano *et al.*, 2000; Mishra and Das, 2003; Elena *et al.*, 2004).

Because of spoilage, storage stability and flavor quality is a very important aim for people working in dairy industry and dairy hygiene, the purpose of this research came to evaluate the different quality properties of most consumed marketed fermented dairy products represented in Laban Rayeb and yoghurt that sold in different dairy shops in Assiut city.

MATERIALS and METHODS

Samples:

A total of 100 random samples of locally manufactured Laban Rayeb and small scale plain yoghurt (50 samples each) were collected from different dairy shops distributed in Assiut city. Each sample was obtained in its plastic bags as sold to the public and transferred to the laboratory with a minimum of delay. Preparation of samples and serial dilutions were done according to APHA (1992). Each sample was opened under complete aseptic conditions and then thoroughly mixed and divided into 4 portions for each of the following examinations:

I) Sensory (organoleptic) evaluation:

Laban Rayeb and yoghurt samples were sensory evaluated freshly after direct transportation to the laboratory. All samples were scored by a regular score panel. The score was based on hedonic scale provided in a score card comprising the 9 points hedonic scale (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, 9 = like extremely).

The sensory properties were evaluated depending on 3 main attributes in addition to their resultant expressed in overall acceptability (OAA). The sensory attributes were the same for both Laban Rayeb and yoghurt except little bit differences in some sensory items owing to the physical nature of the product, in which, Laban Rayeb is in a liquid form and yoghurt is in a semi-solid form. The differences in the sensory items were shown in Table 1.

All the available data printed on the plastic packages and also non printed data were recorded in designed formed sheets including purchasing date, production date, shelf-life duration, market, weight, recommendation to store in a cold place...etc.

Table 1. Differences situated in the sensory parameters.

Product	Three main attributes										Resultant
	Visual		Texture						Flavor		
	Color	Free whey	Firmness	Creaminess	Viscosity	Mouth feel	Consistency	Smoothness	Taste	Aroma	Overall acceptability (OAA)
Laban Rayeb	√	-	-	√	√	√	√	√	√	√	√
Yoghurt	√	√	√	√	-	√	√	√	√	√	√

Some texture attributes were described according to Gonçalvez *et al.* (2005) as:
Creaminess = time necessary to dissolve or mix the sample with saliva.
Viscosity = force necessary to stirred with a spoon.
Mouth feel = evaluation of the lay that covers the palate and tongue after swallowing the sample.
Consistency = homogeneous structure, not watery, not fragile.
Smoothness = absence of gritty texture.

II) Rheological properties:

Syneresis was used for the rheological properties for both Laban Rayeb and yoghurt. Syneresis means the quantity of whey which has drained from a known weight of the sample (25g placed over Whatman filter paper on the top of a funnel introduced in a graduated cylinder to collect the whey) after 2 h at 5±2°C (refrigeration temperature). Syneresis was determined according to Dannenberg and Kessler (1988). The estimated degree of syneresis expressed as the amount of the drained whey in ml.

III) Chemical analysis: All samples were analyzed for the followings:
III-1) Fat% was determined by the Gerber method using Gerber butyrometer tubes as cited in the British Standard Institution method (British Standard Institution, 1988).

III-2) Total solids% (TS%) was determined using hot air oven following the procedures described by AOAC (1990).
III-3) Titratable acidity% (TA%) was estimated by titrating 10 g of the sample with 0.1N NaOH using phenolphthalein as the indicator following the procedures described by AOAC (1990).
III-4) Solids-non-fat% (SNF%) = TS% - fat%.
III-5) Moisture% = 100 - TS%.

IV) Microbiological examination: All samples were examined for the followings:
IV-1) Coliforms count using MPN/g technique according to AOAC (1980).
IV-2) Fecal coliforms count using MPN/g technique according to AOAC (1980).
IV-3) *E. coli* count using MPN/g technique according to AOAC (1980).
IV-4) *Clostridium perfringens* count using MPN/g technique according to Beerens *et al.* (1980).
IV-5) *Enterococci* count according to Deibel and Hartman (1982).
IV-6) *Staphylococcus aureus* count according to Finegold and Martin (1982).
IV-7) Yeasts count according to Harrigan and MeCance (1976).
IV-8) Molds count according to Harrigan and MeCance (1976).

RESULTS

Table 2: Number of Laban Rayeb samples scored for sensory evaluation.

Score range	Color	Creaminess	Viscosity	Mouth feel	Consistency	Smoothness	Taste	Aroma	OAA
1 - <2	0	0	0	0	3	1	2	1	1
2 - <3	0	1	2	0	2	1	3	5	4
3 - <4	0	7	3	8	3	3	8	8	7
4 - <5	4	11	9	8	6	7	10	9	5
5 - <6	5	15	9	6	7	9	10	13	14
6 - <7	9	12	11	13	6	7	8	7	9
7 - <8	22	4	13	13	16	14	8	4	9
8 – 9	10	0	3	2	7	8	1	3	1
Total	50	50	50	50	50	50	50	50	50

Table 3: Number of yoghurt samples scored for sensory evaluation.

Score range	Color	Free whey	Firmness	Creaminess	Mouth feel	Consistency	Smoothness	Taste	Aroma	OAA
1 - <2	0	1	1	0	0	2	0	0	0	0
2 - <3	0	6	2	1	4	4	2	1	1	1
3 - <4	1	5	3	4	7	2	3	3	4	3
4 - <5	0	7	7	7	12	4	3	10	6	7
5 - <6	2	13	7	12	11	7	6	8	8	7
6 - <7	14	11	7	17	8	14	4	8	9	12
7 - <8	22	5	10	6	6	11	11	15	13	12
8 -- 9	11	2	13	3	2	6	21	5	9	8
Total	50	50	50	50	50	50	50	50	50	50

Table 4: Sensory scores values of the examined products.

Product	Value	Color	Free whey	Firmness	Creaminess	Viscosity	Mouth feel	Consistency	Smoothness	Taste	Aroma	OAA
Laban Rayeb	Minimum	4	-	-	2.3	2	3	1	1	1	1	1.7
	Maximum	8	-	-	7	8	8	8	8.25	8	8	8
	Average	6.64	-	-	4.93	5.57	5.52	5.67	5.79	4.74	4.67	4 96
Yoghurt	Minimum	3	1	1	2	-	2	1.3	2.7	2	2	2
	Maximum	8.3	8	9	8	-	8.3	9	9	8	8.3	8.3
	Average	6.94	4.91	6.03	5.53	-	4.89	5.72	6.71	5.78	5.97	5.99

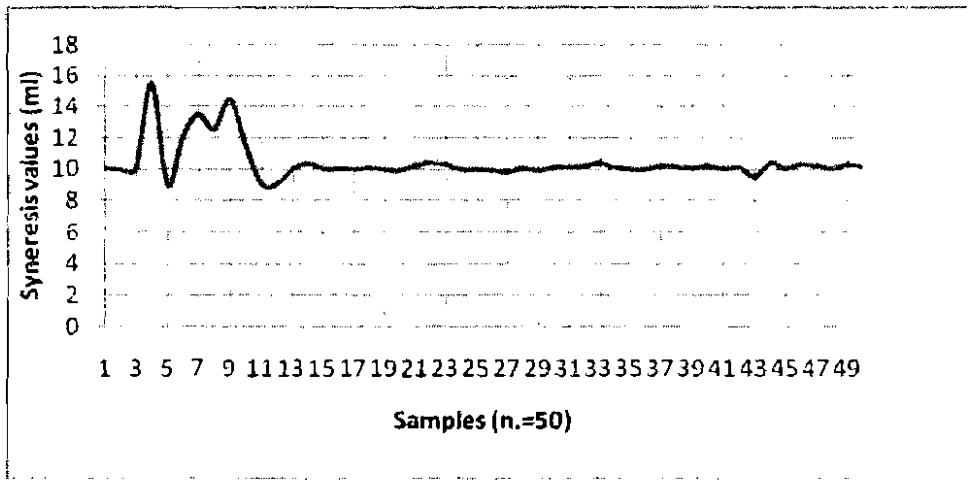

Figure 1: Syneresis values of Laban Rayeb samples.

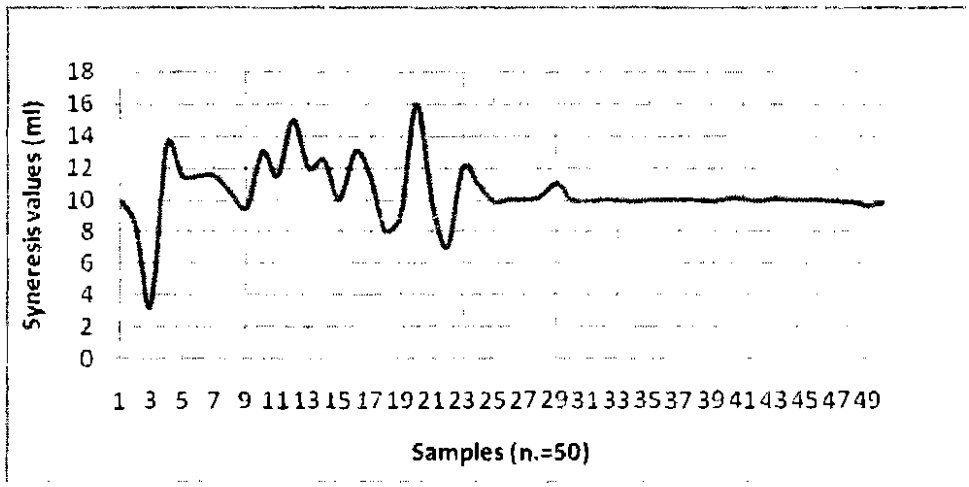

Figure 2: Syneresis values of yoghurt samples.

Table 5: Chemical composition of the examined products.

Product	Value	Titratable acidity%	Fat%	TS%	SNF%	Moisture%
Laban Rayeb	Minimum	0.10	1.10	5.00	3.00	86.40
	Maximum	2.40	4.50	13.60	10.60	95.00
	Average	1.21	3.01	11.30	8.29	88.70
Yoghurt	Minimum	0.75	0.95	7.60	6.50	76.60
	Maximum	1.88	7.10	23.40	19.90	92.40
	Average	1.20	3.34	14.02	10.68	85.98

Table 6: Some recorded studies in some countries referring the chemical composition of yoghurt.

Reference	Product type	Country	TA%	Fat%	TS%	SNF%	Moisture%
Musa (1997)	Yoghurt (fresh cow's milk)	Sudan	-	3.20	19.39	16.19	80.61
Musaiger *et al.* (1998)	Yoghurt whole milk	Bahrain	1.00	3.90	14.60	10.70	85.40
Bahout and El-Shawaf (1999)	Commercial yoghurt	Egypt	-	2.07	19.50	17.43	80.50
Younus *et al.* (2002)	Yoghurt brand A	Pakistan	0.89	3.50	14.96	11.46	85.04
	Yoghurt brand B		0.87	2.99	12.93	9.94	87.07
	Yoghurt brand C		1.13	2.94	15.73	12.79	84.27
El-Bakri and El-Zubeir (2009)	Plain yoghurt	Sudan	-	3.18	14.04	10.86	85.96
The present study	Plain yoghurt	Egypt	1.20	3.34	14.02	10.68	85.98

Table 7: Statistical analytical results of the examined microorganisms using plate technique.

Product	*Enterococci*			*Staph. aureus*			Yeasts			Molds		
	Positive samples		Average count (cfu/g)	Positive samples		Average count (cfu/g)	Positive samples		Average count (cfu/g)	Positive samples		Average count (cfu/g)
	No.	%		No.	%		No.	%		No.	%	
Laban Rayeb	15	30	1.19×10^3	3	6	1.10×10^2	34	68	3.07×10^4	46	92	3.76×10^4
Yoghurt	14	28	9.38×10^4	4	8	6.68×10^2	12	24	1.25×10^3	30	60	1.63×10^4

Table 8: Incidence of positive samples recovered microorganisms using MPN/g technique.

Product	Positive samples recovered coliforms		Positive samples recovered fecal coliforms		Positive samples recovered *E. coli*		Positive samples recovered *Cl. perfringens*	
	No.	%	No.	%	No.	%	No.	%
Laban Rayeb	14	28	2	4	0	0	0	0
Yoghurt	11	22	1	2	0	0	0	0

Table 9: Frequency distribution of the examined samples based on their coliforms count.

Range	Laban Rayeb samples		Yoghurt samples	
	No.	%	No.	%
<3*	36	72	39	78
3 - <10	6	12	1	2
10 - $<10^2$	4	8	5	10
10^2 - $<10^3$	1	2	1	2
10^3 - $>10^3$	3	6	4	8
Total	50	100	50	100

*<3 means negative LS broth tubes otherwise BGLB broth tubes.

Table 10: Frequency distribution of the examined samples based on their fecal coliforms count.

Range	Laban Rayeb samples		Yoghurt samples	
	No.	%	No.	%
<3*	48	96	49	98
3 - <10	2	4	1	2
Total	50	100	50	100

*<3 means negative EC broth tubes.

Table 11: Some recorded studies referring the microbiological quality of Laban Rayeb and yoghurt.

Reference		Product	Coliforms		*E. coli*		*Enterococci*		Yeasts		Molds	
			%*	Count**	%	Count	%	Count	%	Count	%	Count
Madeha (1991)	Laban Rayeb	Laban Rayeb	94	-	21.27	-	-	-	-	-	-	-
Ahmed and Abdel-Sater (2003)	Laban Rayeb	Raw type	-	-	-	-	-	-	36	1087	72	9.8×10^4
Salama & Enan (2005)	Laban Rayeb	Raw type	24	6.2×10^4	-	-	-	-	56	1.7×10^6	24	2.9×10^3
The present study	Laban Rayeb	Laban Rayeb	28	-	0	-	30	1.19×10^3	68	3.07×10^4	92	3.76×10^4
Madeha (1991)	Yoghurt	Yoghurt	76	-	51.11	-	-	-	-	-	-	-
Bahout and El-Shawaf (1999)	Yoghurt	Commercial type	5	23	-	-	-	-	-	-	-	-
Al-Hawary (2000)	Yoghurt	Dairy shops plain type	-	-	-	-	77	15.37×10^3	-	-	-	-
Al-Hawary *et al.* (2005)	Yoghurt	Small scale plain type	82	5.94×10^3	40	6.97×10^2	-	-	94	5.3×10^5	84	2.23×10^5
Abdel-Aal (2008)	Yoghurt	Plain type	-	-	20	7.6×10^2	20	1.4×10^3	-	-	-	-
The present study	Yoghurt	Plain type	22	-	0	-	28	9.38×10^4	24	1.25×10^3	60	1.63×10^4

%* means the percentage of positive samples.
Count** means the average count (cfu).

DISCUSSION

All the different parameters contributing to the determination of sensory properties (color, appearance, texture, aroma...etc) are equally important for the product acceptability (Pagliarini *et al.*, 1991). As the overall acceptability (OAA) is the resultant of the examined 3 main sensory attributes, the average OAA scores of Laban Rayeb and yoghurt samples were 4.96 and 5.99, respectively (Table 4). These obtained data referred to the sensory quality of the examined products was slightly good.

Although 66% of Laban Rayeb samples had a relatively high score ranged from 5 to 9 (Table 2), the average OAA (4.96) referred to neither like dislike according the 9 points hedonic scale. Moreover, 78% of yoghurt samples had a relatively high score ranged from 5 to 9 (Table 3), but the average OAA (5.99) referred to like slightly according the 9 points hedonic scale.

With regards to the 1st examined sensory attribute i.e. visual, Tables 2 and 3 showed that most of the examined Laban Rayeb and yoghurt samples were of good visual that appeared normal for the consumers. With pointing to the 2nd examined sensory attribute i.e. texture, most of the highest percentages lied within a high score range; for Laban Rayeb samples, 30% with creaminess score 5 - <6; 26% with viscosity score 7 - <8; 52% with mouth feel score 6 - <8; 32% with consistency score 7 - <8; 28% with smoothness score 7 - <8 (Table 2); and for yoghurt samples, 26% with highest firmness score 8 - 9; 34% with creaminess score 6 - <7; 24% with mouth feel score 4 - <5; 28% with consistency score 6 - <7; 42% with highest smoothness score 8 - 9 (Table 3). Viscous properties are of primary importance with respect to the quality of the products (Magenis *et al.*, 2006). As the flavor represented the 3rd examined sensory attribute, 20 and 26% of Laban Rayeb samples with taste and aroma score 5 - <6, respectively (Table 2); 30 and 26% of yoghurt samples with a very high taste and aroma score 7 - <8, respectively (Table 3).

Why rheological properties were studied in the present investigation? Because of they are important for foods (such as fermented dairy products) in the design of flow processes, quality control, storage and processing and in predicting the texture of foods (Benezech and Maingonnat, 1994; Aichinger *et al.*, 2003).

Figure 1 presented the syneresis values of Laban Rayeb samples along the total examined 50 samples with a minimum value of 9 ml in 3 samples and a maximum value of 15.5 ml in 1 sample and the average value was 10.4 ml. For yoghurt samples, Figure 2 illustrated the syneresis values along the total examined 50 samples with a minimum value of 3.25 ml in 1 sample and a maximum value of 16 ml in 1 sample and the average value was 10.429 ml. Mahdian and Tehrani (2007) concluded that degree of syneresis decreased with increasing TS significantly. Samples with higher TS had better textural properties than those with lower TS. Haj *et al.* (2007) concluded that the overall picture of stirred yoghurt quality evaluation needs emphasis on quality control during processing and storage.

In the present investigation, the chemical composition was of interest to be analyzed, not only for the nutritional value significance but also for the effect on the sensory and rheological properties. Robinson (1983) reported that the aim of TS content is consistency improvement imparted to the yoghurt coagulum. Mahdian and Tehrani (2007) found that texture acceptability increased with increasing TS significantly. It could be due to the effect of high TS content on increasing firmness of the gel and decreasing degree of syneresis (Mohammeed *et al.*, 2004). More focusing, the firmness of yoghurt is dependent on TS content (Tamime and Deeth, 1980; Gastaldi *et al.*, 1997; Penna *et al.*, 1997; Kristo *et al.*, 2003); and that was clear in the obtained result, as the average value of the firmness of the examined yoghurt samples as 6.03 (Table 4) was in compatible with the average value of TS content as 14.02% (Table 5). The obtained TS% was in agreement with Musaiger *et al.* (1998); El-Bakri and El-Zubeir (2009) as presented in Table 6, as yoghurt usually contains 12-14% total milk solids and has soft friable custard like consistency and a clean distinct flavor.

Mahdian and Tehrani (2007) found TS content of the yoghurt samples had significant effect on degree of syneresis. Reduction of free water and increasing the proportion of TS content, which occur during concentration, are 2 main factors which decreased rates of wheying off in the samples with high TS. Similarly, Shaker *et al.* (2000) indicated that the increase in viscosity of yoghurt with highest fat content may be due to increase of TS of the milk which has a significant effect on the firmness of yoghurt gel and decreasing degree of syneresis.

According to the some recorded studies shown in Table 6, the average fat% (3.34%) of the examined yoghurt samples was in accordance to most of the listed references. While, Musaiger *et al.* (1998) mentioned the yoghurt available in Bahrain had higher fat content than the

yoghurt available in Egypt (Dagher, 1991), but lower level of moisture. These data are consistent with the obtained result of the present study (Table 6); but these chemical differences are mainly due to the method of preparation of yoghurt in both countries.

Also, Musaiger *et al.* (1998) analyzed 4 types of fermented dairy products commonly consumed in Bahrain for physical, proximate and mineral composition. The findings revealed that acidity, TS and SNF were found to be higher in yoghurt and Labenah (thick yoghurt) compared to low and full fat Laban (diluted yoghurt). These findings were in somewhat agreement with the obtained result in the present work (Table 5), if we put in consideration the comparison between yoghurt (as thick) and Laban Rayeb (as drinkable).

Regarding acidity%, it has a direct effect on the flavor of the examined products. Through our community contact, many people refuse Laban Rayeb and yoghurt consumption because of their sourness. Therefore, El-Bakri and El-Zubeir (2009) mentioned the kind of uses of yoghurt in Sudan (particularly in Khartoum) requires yoghurt with such mild acidity as the consumer desires.

As presented in Table 5, the average value of titratable acidity (TA) for both the examined products was about 1.2%. These obtained findings were higher than all TA% of the recorded studies listed in Table 6; and also higher than those of Madeha (1991) who found the average TA% of Laban Rayeb and plain yoghurt were 0.956 and 1.049 %, respectively. Also, lower results by Kim *et al.* (1998) who found TA% was 0.95 - 0.99% of Yam–yoghurt and Collado *et al.* (1994) who found the yoghurt drink and yoghurt like products had acidity% of 0.56 and 0.58%, respectively. The relatively high acidity in the examined Laban Rayeb and yoghurt samples may be due to increased starter culture and/or long incubation period.

When through the light towards the microbiological examination, Tables 7, 8, 9 and 10 gave a picture about the degree of microbiological contamination especially with *Enterococci*, coliforms, fecal coliforms, yeasts and molds. Most of the examined samples appear to be microbiologically not acceptable when compared to the Egyptian and International Standards. This may be attributed to the examined products were purchased from dairy shops whose using the traditional processing in manufacturing of these products. Dardashti *et al.* (2001) found that the rate of contamination in traditional processing with coliforms was higher than in industrial processing because of the differences in the practices between different manufacturers.

The examined Laban Rayeb and yoghurt samples (30 and 28%) were contaminated with *Enterococci*, with average counts of 1.19×10^3 and 9.38×10^4 cfu/g, respectively (Table 7). Higher incidence of *Enterococci* in yoghurt was detected by Al-Hawary (2000) but Abdel-Aal (2008) found lower incidence as stated in Table 11. The obtained results expressed that about third of the examined samples were contaminated with *Enterococci*. These bacteria are comparatively heat resistant, salt tolerant, grow at wide range of temperatures, low pH and more resistant to drying, detergents and disinfectants; and considered a definite index of fecal contamination (ICMSF, 1982), and useful indicators of the possible presence of enteric pathogens (Rao *et al.*, 1986). Additionally, some of them may help in assessment of the hygienic standard in dairy farms and factories of fermented milks as they are sometimes causing food poisoning (Sinigaglia *et al.*, 1997; Roushdy *et al.*, 1998).

Table 8 showed high incidences of coliforms as 28% of Laban Rayeb samples and 22% of yoghurt samples were contaminated. Moreover, high frequencies distribution was prominent in Table 9 as 6 and 8% of the examined samples of Laban Rayeb and yoghurt, respectively, had coliforms count in the range 10^3 - $>10^3$. Madeha (1991) found higher incidences of coliforms and *E. coli* in plain yoghurt and Laban Rayeb than the obtained findings, as shown in Table 11. El-Bakri and El-Zubeir (2009) found 43.75% of samples had coliforms count lower than 10^2 which is the maximum determined in most of the International Standards (Kucukoner and Tarakci, 2003).

Egyptian Standards (1990; 1991; 2005) reported that yoghurt must be free from coliforms; therefore, 22% of examined samples were not statutory with this standard and of inferior quality. Presence of coliforms in yoghurt is considered as an index of unsatisfactory sanitation and possible presence of enteric pathogens (Frazier and Westhoff, 1983). The non-complying samples might indicate the low level of hygiene during processing of yoghurt (Birollo *et al.*, 2001).

Our microbiological findings of coliforms and *Enterococci* in both of the examined products were in agreement with the results of Khalafalla *et al.* (1988), as they examined Laban Rayeb, Zabady, yoghurt, Laban Zeir and Kishk for chemical and microbiological analysis and found high incidence of coliforms, in addition to, *Enterococci* were identified as the most predominant species.

Coliforms and *Enterococci* are considered as indicators of insufficient sanitation and the carelessness for both principles of hygiene and good manufacturing practices (Batish *et al.*, 1980; ICMSF, 1982). While, a greater resistance of *Enterococci* when compared with classical

indicators of coliforms under unfavorable condition has led to an increasing tendency to include *Enterococci* in microbiological criteria as an indication of direct fecal contamination in various food products (Jay, 1992; Knudtson and Hartman, 1993; Audicana *et al.*, 1995).

Madeha (1991) reported a presence of negative correlation between titratable acidity of fermented milk products and coliforms count. This correlation was obvious in the 4 Laban Rayeb samples had coliforms in the range 10^2 - $>10^3$ (1 sample in the range 10^2 - $<10^3$ + 3 samples in the range 10^3 - $>10^3$) (Table 9), in which all these 4 samples with titratable acidity <1%. But this correlation did not match with the yoghurt samples which had high coliforms range. Therefore, their presence indicates faulty hygiene in production, handling and plant sanitation. Furthermore, the use of milk with high coliforms count may become endogenous source of coliforms in dairy products in the absence of proper sanitary measures.

Laban Rayeb and yoghurt should be free from fecal coliforms, but the revealed results in Table 8 showed that 4 and 2% of the examined products, respectively, had fecal coliforms with a count lied in frequency distribution of the range 3 - <10 for both products (Table 10).

According to the revealed results in Table 7, *Staph. aureus* was detected in low incidence and count values in the examined products. These results may be attributed to that yoghurt culture reduces the concentration of *Staph. aureus* (Pazakova *et al.*, 1997). Moreover, such organism was inhibited after few days during storage of fermented product (Estrada *et al.*, 1999).

Yeasts and molds are the most predominant spoilage organisms that tolerate the low pH. Unfortunately, it was noticeable high average counts of yeasts and molds as listed in Table 7 in both the examined Laban Rayeb and yoghurt products. The obtained high counts may be attributed to the acidic conditions that favor the growth of spoilage yeasts and molds. Economically, presence of yeasts and molds in dairy products is undesirable even found in few numbers because they rapidly grow in a wide range of temperature, pH and humidity resulting in objectionable changes that render the product of inferior quality or even unmarketable (Mossel, 1982). Fungal growth predominate in dairy products with high water activity, acidity, processing or packing conditions enhance their growth over bacteria (Cousin *et al.*, 1992).

Table 7 showed that 68 and 92% of Laban Rayeb samples were contaminated with yeasts and molds, respectively. These obtained incidences were higher than those obtained by Ahmed and Abdel-Sater (2003); Salama and Enan (2005) as mentioned in Table 11. While, 24 and

60% of yoghurt samples were contaminated with yeasts and molds, respectively. El-Bakri and El-Zubeir (2009) found 68.75% of samples had yeasts & molds count lower than 10^3 determined in the International Standards. When the yoghurt are produced under good manufacturing conditions, it should contain <10 yeast/g (but preferably <1 yeast/g); and if refrigerated at 5°C or less, it should not undergo spoilage by yeast (Fleet, 1990).

Consuming yoghurt containing yeasts and molds constitutes a public health hazard among consumers (Varnam and Sutherland, 1994). Fungal contamination indicated improper plant sanitation and/or neglected hygiene during production, packing or storage.

Concerning *Cl. perfringens*, Table 8 showed that none of the examined samples recovered it. Our obtained results were in harmony with Abdel-Aal (2008) who examined 50 yoghurt (25 plain+25 fruit) samples in Germany and failed to isolate *Cl. perfringens*.

The microbiological picture of the present examined Laban Rayeb samples may be attributed to the fact that no heat treatment is applied during its preparation. Also, poor hygiene during milking, storage and handling of Laban Rayeb are factors responsible for its contamination (Madeha, 1991).

The conclusion of the present investigation was in agreement with the conclusion of the study of El-Bakri and El-Zubeir (2009); who concluded that the commercially available yoghurt has a good chemical quality when compared to the International Standards; however, the microbiological quality was lower than that required by the International Standards in most of yoghurt samples.

More emphasizing to the aforementioned conclusion, a recent study in Sudan by Mohammad and El-Zubeir (2011) concluded that the plain set yoghurt agrees with the Sudanese Standards for yoghurt chemical composition.

Hence, it is recommended the implementation of HACCP (Hazard Analysis Critical Control Point) practices during processing and storage to obtain good quality products.

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