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SENSORY, RHEOLOGICAL, PHYSICAL, CHEMICAL AND MICROBIOLOGICAL PROPERTIES OF DIFFERENT TYPES OF YOGHURT

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ABSTRACT

This study was designed to evaluate the quality of yoghurt sold in Assiut city, Egypt, in which a total of 60 samples of Baladi, pasteurized plain and pasteurized flavored (20 each) were collected randomly. The sensory evaluation was based on visual, texture and flavor. Syneresis was applied for rheological properties and pH for physical properties. Chemical analysis was applied through moisture, TS, fat and SNF%. Also, titratable acidity% and starch were detected. The microbiological examination for coliforms, fecal coliforms, *E. coli*, anaerobes and yeasts & molds were counted. The achieved results showed that the sensory evaluation of the pasteurized plain and pasteurized flavored samples was of higher scores than the Baladi samples, however on contrast, syneresis was higher in the Baladi samples. The average values of pH were 4.9, 4.89 and 4.83 for the Baladi, pasteurized plain and pasteurized flavored samples, respectively. For the fat content, the Baladi samples had higher fat%, followed by the pasteurized plain then the pasteurized flavored types. All the examined Baladi samples were starch free, while 70 & 65% of the pasteurized plain and pasteurized flavored types were positive, respectively. The average values of titratable acidity% were 0.91, 0.82 and 0.75, respectively. The microbiological examination cleared that the Baladi samples were more contaminated for coliforms, fecal coliforms and *E. coli*, while, the pasteurized plain and pasteurized flavored samples were more contaminated for anaerobes. It was found that 85% of the total examined samples were unacceptable according to the Egyptian Standards for their content of yeasts and molds.

Key words: Sensory, Rheological, Physical, Chemical, Microbiological, Yoghurt.

INTRODUCTION

Yoghurts can be high in protein, calcium, vitamins, and live culture, or probiotics, which can enhance the gut microbiota. These can offer protection for bones and teeth and help prevent digestive problems. Low-fat yoghurt can be a useful source of protein on a weight-loss diet. Probiotics may boost the immune system.

In order to manufacture a good quality product, the used raw milk must be of low bacterial count, antibiotics free, sanitizing chemicals free, not mastitic milk and not colostrum and the milk also should be bacteriophages free (Thapa, 2000).

Industrial yoghurt quality varied greatly with the chemical composition of the original milk, production method, type of added flavor and post-incubation processing. Yoghurt technology, starter culture microbiology and quality appraisal is the

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prime importance of any yoghurt type (Hui, 1993; Yadav *et al*., 1993).

Egyptian Standards (2005) stated that fungi must not exceed 10 cfu/g; in addition, the maximum count of coliforms is 10 cfu/g but should be *E. coli* free. Also, free from pathogenic bacteria & their toxins. In yoghurt, coliforms are contaminants and are used as indicators of hygienic conditions.

According to the aforementioned, the current investigation was aimed to determine the keeping quality of different types of yoghurt sold in Assiut city; therefore, sensory, rheological, chemical and microbiological properties were evaluated.

MATERIALS AND METHODS

Sampling:
A total of 60 Baladi, pasteurized plain and pasteurized flavored yoghurt samples (20 each) were obtained from different dairy shops and supermarkets in Assiut city, Egypt. The samples were transferred directly to the laboratory to be examined. All the available data were written in designed sheets including batch no., shelf-life etc.

Sensory examination:
The sensory evaluation was applied after direct transportation to the laboratory. All samples were scored by a regular score panel. The score was depending on a 9-points hedonic scale (from 1 as dislike extremely to 9 as like extremely).

The sensory parameters

Attributes								Resultant
Visual		Texture				Flavor		
Color	Whey absence	Firmness	Creaminess	Consistency	Smoothness	Taste	Odor	Overall acceptability (OAA)

Some texture attributes were described according to Gonçalvez *et al*. (2005) as:
Creaminess means the time necessary to dissolve or mix the sample with saliva; Consistency means a homogeneous structure, not watery and not fragile; Smoothness means the absence of gritty texture.

Rheological examination:
1) Syneresis (Dannenberg and Kessler, 1988)was done by placing 25 g of the yoghurt sample over What man filter paper on a funnel top in a graduated cylinder to collect whey (in ml) after 2 h at 5±2° C (refrigeration temperature). The estimated degree of syneresis is expressed as the drained whey amount.

Physical examination:
1) pH value was done according to AOAC (2005), using a pH meter (AD11, Adwa, waterproof pH-Temp pocket tester with replaceable probe, Romania).

Chemical examination:
1) Titratable acidity was done according to AOAC (2005), by titration of the sample against sodium hydroxide using phenolphthalein (indicator).

The total acidity was expressed as lactic acid% and was calculated according to the following equation:

$$\text{Acidity\%} = \frac{0.009 \times \text{ml of N/10 NaOH} \times 100}{\text{Sample weight (g)}}$$

0.009 is equivalent to lactic acid normality

2) Moisture% was done according to AOAC (2000), by drying in an oven at 100° C until constant weight was recorded.

$$\text{Moisture\%} = (W_2 - W_3) / (W_2 - W_1) \times 100$$

W_1 = weight of the empty dish
W_2 = weight of dish with the sample before drying
W_3 = weight of dish with the sample after drying

3) TS% = 100 - moisture%
4) Fat% was estimated by Gerber method according to AOAC (2003).
5) SNF% = TS% - fat%
6) Starch test was done according to Kumar *et al*. (1998) by using 1% iodine solution.

Microbiological examination:

Preparation of serial dilution (APHA, 1992):

After thoroughly mixing of a sample, 10 g was transferred into a sterile wide-mouth container with 90 ml of 0.85% sterile saline solution to provide a dilution of 1:10 then ten-fold serial dilutions were prepared.

1) Coliforms, fecal coliforms and *E. coli* count (MPN) were done according to AOAC (1980).

2) Total yeasts & mold count was done according to ISO 21527-1 (2008).

3) Detection of anaerobic spore-former was done according to Cruickshank *et al*. (1969).

RESULTS

Table 1: Sensory evaluation of the examined Baladi yoghurt samples (no. = 20)

Score	Attributes								Resultant	
	color	whey absence	firmness	cream	consistency	smooth	taste	odor	OAA	
	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples %
1	0	0	0	0	0	0	0	0	0	0
2	0	1	0	0	0	0	0	0	1	0.625
3	0	0	0	0	0	0	0	0	0	0
4	0	1	0	0	2	0	0	0	3	1.875
5	2	1	2	1	2	1	2	1	12	7.5
6	1	8	3	4	5	3	9	2	35	21.875
7	11	4	12	7	8	8	7	14	71	44.375
8	3	4	2	7	3	7	2	3	31	19.375
9	3	1	1	1	0	1	0	0	7	4.375
Total	20	20	20	20	20	20	20	20	160	100

Table 2. Sensory evaluation of the examined pasteurized plain yoghurt samples (no. = 20)

Score	Attributes								Resultant	
	color	whey absence	firmness	cream	consistency	smooth	taste	odor	OAA	
	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples %
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	2	0	0	0	0	0	0	2	1.25
7	0	7	2	2	2	1	4	2	20	12.5
8	11	7	8	8	9	10	9	8	70	43.75
9	9	4	10	10	9	9	7	10	68	42.5
Total	20	20	20	20	20	20	20	20	160	100

Table 3: Sensory evaluation of the examined pasteurized flavored yoghurt samples (no. = 20)

Score	Attributes								Resultant	
	color	whey absence	firmness	cream	consistency	smooth	taste	odor	OAA	
	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples No.	Samples %
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	2	1	0	1	0	0	0	4	2.5
7	1	5	2	0	1	1	4	2	16	10
8	9	8	10	6	7	6	7	6	59	36.875
9	10	5	7	14	11	13	9	12	81	50.625
Total	20	20	20	20	20	20	20	20	160	100

Table 4: Rheological and physical evaluation of the examined samples

Samples type	Samples no.	Syneresis			pH		
		Min	Max	Avg	Min	Max	Avg
Baladi	20	6	9.7	7.77	4.5	5.3	4.9
Pasteurized plain	20	0.1	8.5	5.24	4.3	5.2	4.89
Pasteurized flavored	20	0	9.6	5.37	4.2	5.1	4.83

Table 5: Chemical evaluation of the examined samples

Samples type	Fat%			SNF%			TS%			Moisture%			Acidity%		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Baladi	0.7	4.4	2.63	5.95	12.05	9.6	9.95	15.73	12.23	84.73	90.05	87.82	0.675	1.22	0.91
Pasteurized plain	0.4	4.2	2.14	8.38	19.28	10.97	10.45	20.98	13.12	79.02	89.55	86.88	0.657	0.945	0.82
Pasteurized flavored	0	2.8	0.65	13.9	20.5	18.65	14	20.9	19.3	79.10	86	80.7	0.63	0.9	0.75

Table 6: Starch detection in the examined samples

Samples type	Samples no.	Positive samples	
		No.	%
Baladi	20	0	0
Pasteurized plain	20	14	70
Pasteurized flavored	20	13	65
Total	60	27	45

Table 7: Incidence of coliforms in the examined samples

Samples type	Samples no.	Positive* samples	
		No.	%
Baladi	20	5	25
Pasteurized plain	20	2	10
Pasteurized flavored	20	2	10
Total	60	9	15

*Positive means gas production in BGLB broth

Table 8: Frequency distribution of coliforms count in the examined samples

Samples type	Samples no.	Coliforms count			
		<3	>10-10^2	>10^2-10^3	>10^3
Baladi	20	15	1	1	3
Pasteurized plain	20	18	2	0	0
Pasteurized flavored	20	18	1	1	0
Total	60	51	4	2	3
Acceptability upon Egyptian Standards (2005)*		85% Acceptable	15% Unacceptable		

*Coliforms count in yoghurt is not >10 CFU/g

Table 9: Incidence of fecal coliforms in the examined samples

Samples type	Samples no.	Positive* samples	
		No.	%
Baladi	20	5	25
Pasteurized plain	20	2	10
Pasteurized flavored	20	2	10
Total	60	9	15

*Positive means gas production in EC broth

Table 10: Frequency distribution of fecal coliforms count in the examined samples

Samples type	Samples no.	Fecal coliforms count				
		<3	3-10	>10-10^2	>10^2-10^3	>10^3
Baladi	20	15	0	1	1	3
Pasteurized plain	20	18	1	1	0	0
Pasteurized flavored	20	18	0	1	1	0
Total	60	51	1	3	2	3
Acceptability upon Egyptian Standards (2005)*		85%Acceptable		15% Unacceptable		

*Yoghurt must be free from fecal coliforms

Table 11: Incidence of *E. coli* in the examined samples

Samples type	Samples no.	Positive* samples	
		No.	%
Baladi	20	5	25
Pasteurized plain	20	0	0
Pasteurized flavored	20	1	5
Total	60	6	10

*Positive means colonies growth on EMB plates

Table 12: Frequency distribution of *E. coli* count in the examined samples

Samples type	Samples no.	*E. coli* count			
		<3	>10-10^2	>10^2-10^3	>10^3
Baladi	20	15	3	0	2
Pasteurized plain	20	20	0	0	0
Pasteurized flavored	20	19	0	1	0
Total	60	54	3	1	2
Acceptability upon Egyptian Standards (2005)*		90% Acceptable	10% Unacceptable		

*Yoghurt must be free from *E. coli*

Table 13: Anaerobes detection in the examined samples

Samples type	Samples no.	Positive samples	
		No.	%
Baladi	20	1	5
Pasteurized plain	20	7	35
Pasteurized flavored	20	6	30
Total	60	14	23.3

Table 14: Incidence of yeasts & molds in the examined samples

Samples type	Samples no.	Positive* samples	
		No.	%
Baladi	20	16	80
Pasteurized plain	20	16	80
Pasteurized flavored	20	19	95
Total	60	51	85

*Positive means colonies growth on the plates

Table 15: Frequency distribution of yeasts & molds count in the examined samples

Samples type	Samples no.	Yeasts & molds count					
		<10^2	10^3-<10^4	10^4-<10^5	10^5-<10^6	10^6-<10^7	≥10^7
Baladi	20	4	6	4	3	3	0
Pasteurized plain	20	4	5	9	1	0	1
Pasteurized flavored	20	1	8	9	1	1	0
Total	60	9	19	22	5	4	1
Acceptability upon Egyptian Standards (2005)*		15% Acceptable	85% Unacceptable				

*Yeasts & molds count in yoghurt is not >10 CFU/g

DISCUSSION

All different parameters for sensory properties such as color, appearance, texture, aroma, etc. are equally important for product acceptability (Pagliarini *et al*., 1991). The 3 main parameters of sensory evaluation (visual, texture and flavor) were studied in the current investigation as shown in Tables 1, 2 & 3 for the Baladi, pasteurized plain and pasteurized flavored yoghurt samples, respectively, showing high percentages of the examined samples with good scores for the sensory attributes especially in the

pasteurized plain and pasteurized flavored yoghurt samples.

Table 4 showed the syneresis values, in which the average syneresis value of the Baladi yoghurt samples was higher than those of the pasteurized plain and pasteurized flavored yoghurt samples. For the Baladi yoghurt samples, the syneresis values along the total examined 20 samples were of a minimum value of 6 ml and a maximum value of 9.7 ml with an average value of 7.77 ml. Higher syneresis average value was demonstrated by Sayed (2012)as 10.429 ml.

It was remarkable that some of the pasteurized flavored yoghurt samples were without whey as the syneresis value was zero ml (Table 4), and that may be attributed to the added flavoring agent which increased the total solids revealing no whey drainage.

The pH values of the three groups of the yoghurt samples were similar as cleared in Table 4, with averages of 4.9, 4.89 and 4.83 for the Baladi, pasteurized plain and pasteurized flavored yoghurt samples, respectively; which were low than 5.36 that obtained by Fahmid *et al*. (2016).

Regarding the acidity, which affects the flavor of the examined products, Table 5 showed the average values of titratable acidity for the Baladi, pasteurized plain and pasteurized flavored yoghurt samples as 0.91, 0.82 and 0.75%, respectively. Higher results were detected by Sayed (2012) as 1.2% and by Fahmid *et al*. (2016) at 1.21%. Dalles and Kechagias (1989) reported the acidity of commercial yoghurt ranged from 1.02 to 2.15%.

When through the light towards the chemical analysis of the examined yoghurt samples, it was found that the Baladi yoghurt was higher in fat content than the pasteurized plain and pasteurized flavored yoghurt (Table 5). It was noticed that the fat% was low or even undetected in the examined pasteurized flavored yoghurt samples with an average value of 0.65% (Table 5).

Unfortunately, starch was detected in 70% of the examined pasteurized plain yoghurt samples and 65% of the examined pasteurized flavored yoghurt samples; while all the examined Baladi yoghurt samples were starch free (Table 6). The Egyptian Standards documented that additives shall be in accordance with the legislation issued in this regard, and in the absence of decisions for any of the added materials, they shall be in accordance with what is issued by the International Alimentarius Committee.

Regarding the microbiological examination, Tables 7, 8, 9, 10, 11 and 12 gave a picture of the degree of microbial contamination with coliforms, fecal coliforms and *E. coli*. Overall the examined yoghurt samples in the current study, the Baladi yoghurt was more contaminated than the pasteurized plain and the pasteurized flavored yoghurt. This result was similar to Dardashti *et al*. (2001) who found the contamination rate with coliforms in traditional processing was higher than in industrial processing because of practice differences among different manufacturers.

The Egyptian Standards (2005) stated that the coliforms count in yoghurt must not more than 10 CFU/g. Therefore, 15% of the total examined yoghurt samples were unacceptable (Table 8). Furthermore, the contaminated milk with high coliform count may become an endogenous source of coliforms in dairy products in the lack of proper sanitary measures. The presence of coliforms in yoghurt is considered an index of unsatisfactory sanitation and the possible presence of enteric pathogens (Frazier and Westhoff, 1983). Thenon-complying samples might indicate a low level of hygiene during the processing of yoghurt (Birollo *et al*., 2001).

Table 13 reflected the presence of anaerobes in the examined yoghurt samples; where 35% of the pasteurized plain yoghurt samples and 30% of the pasteurized flavored

yoghurt samples were contaminated with anaerobes; but found in 5% of the Baladi yoghurt samples. Moreover, overall the examined yoghurt samples, anaerobes were detected in 23.3% of the total samples; and according to the legal requirements of the Egyptian Standards (2005), all the examined samples should be free from anaerobes. Sadek *et al*. (2014) could not detect anaerobes in raw and pasteurized milk yoghurt.

For yeasts and molds (Tables 14 & 15), the obtained high counts may be due to the acidic conditions that favor yeasts & molds growth. Fungal growth predominates in dairy products with high water activity, acidity, processing or packing conditions encourage their growth over bacteria (Cousin *et al*., 1992). In a similar manner, yeasts and molds are the most predominant spoilage organisms that tolerate the low pH. The Egyptian Standards (2005) stated that yeasts & molds count in yoghurt must not more than 10 CFU/g. unfortunately, 85% of the total examined yoghurt samples were unacceptable (Table 15).

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الخواص الحسية والسائلية والفيزيائية والكيميائية والميكروبيولوجية لأنواع مختلفة من الزبادي

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تم تصميم هذه الدراسة لتقييم الجودة للزبادي المباع في مدينة أسيوط، مصر،حيث تم جمع ٦٠ عينة من الزبادي بشكل عشوائي شملت البلدي والمبستر السادة والمبسترالمنكهة (٢٠ عينة لكل نوع). وقد إعتمد التقييم الحسي على المظهر والملمس والنكهة. وتم تقييم كمية الشرش للخصائص السائلية والأس الهيدروجيني للخصائص الفيزيائية. وتم إجراء التحليل الكيميائي من خلال نسبة كل من الرطوبة والمواد الصلبة الكلية والدهون والمواد الصلبة اللادهنية. كما تم تقييم نسبة الحموضة العيارية والكشف عن وجود النشا. وقد تم الفحص الميكروبيولوجي للقولونيات والقولونيات البرازية والإيشيريشيا كولاي واللاهوائيات والخمائر والأعفان. وقد أظهرت النتائج أن التقييم الحسي للعينات المبستر السادة والمبسترالمنكهة كان أعلى من العينات البلدي. وفي المقابل، كان الشرش المرشح أعلى في عينات الزبادي البلدي. وبلغت متوسطات قيم الأس الهيدروجيني ٤,٩ و ٤,٨٩ و ٤,٨٣ للعينات البلدي والمبستر السادة والمبسترالمنكهة، على التوالي. وبالنسبة لمحتوى الدهن، كانت العينات البلدي أعلى في نسبة الدسم، تليها الأنواع المبستر السادة ثم المبسترالمنكهة. وكانت جميع عينات الزبادي البلدي خالية من النشا بينما ٧٠٪ و٦٥٪ من الزبادي المبستر السادة والمبسترالمنكهة، على التوالي كانت تحتوي على النشا. وأظهرت متوسطات الحموضة العيارية النسب التالية ٠,٩١ و ٠,٨٢ و ٠,٧٥%، على التوالي. وبالنسبة للفحص الميكروبيولوجي فإن العينات البلدي كانت أكثر تلوثا بالقولونيات والقولونيات البرازية والإيشيريشيا كولاي، بينما كانت العينات المبستر السادة والمبسترالمنكهة أكثر تلوثًا باللاهوائيات. وقد وجد أن ٨٥٪ من إجمالي العينات التي تم فحصها غير مقبولة طبقاً للمواصفات القياسية المصرية لمحتواها من الخمائر والأعفان.

الكلمات المفتاحية: الخواص الحسية ، السائلية ، الفيزيائية ، الكيميائية ، الميكروبيولوجية ، الزبادي.