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Using of sugarcane molasses on novel-yoghurt making

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Abstract

Novel molasses-yoghurt was prepared by adding varying concentrations of molasses (0.5, 1.0, 1.5 and 2%) to milk and stored at 6 ± 2°C up to12 days. Results showed that, the molasses is rich in K, Mn, Fe and Cu. It has high of total solids (TS), sugar, total nitrogen (TN) and ash while low of pH values. On the other hand, the TS, acidity, soluble nitrogen (SN), TN, syneresis, firmness, density, fat content and pH values of plain yoghurt and novel molasses-yoghurt found to increase and decrease with increasing of molasses concentrations and during storage periods up to 12 days, respectively. Novel molasses-yoghurt had higher values of K, Ca, Mn, Na, P, Fe, Cu, Mn and Zn contents than that of control samples. All these elements of novel molasses-yoghurt were increased during storage than that of fresh samples in all treatments. Microbiologically, there were increase of total viable bacterial and *Lactobacillus bulgaricus* counts up to 4 days and decreased up to the end of storage periods in control samples and novel molasses-yoghurt. Whilst, there was decrease of *Streptococcus thermophilus* in all treatments up to 12 days of storage in most treatments. Moulds and yeasts were not detected in fresh and after 4 days of storage, whereas they were appeared after 8 days. Organoleptically, novel molasses-yoghurt with 0.5% molasses stored at 8 days had superior scores, followed by 1% stored at the same time, while, novel molasses-yoghurt with 2% molasses without storage had the lowest value of overall scores.

Keywords: yoghurt, sugarcane molasses, sensory quality, acceptability.

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1. Introduction

Molasses is a by-product obtained as a consequence of serial steps of repeated evaporation, crystallization and centrifugation of sugarcane juices in the process of preparation of table sugar in the cane sugar industry. It is a dark viscous fluid comprised of sugars, suspended colloids, amino acids, vitamins, metal ions, salts, *etc*. (Xia *et al*., 2016). Bioavailability of iron available in molasses is around 85% of the total iron (Harris *et al*., 1939). It has been widely advertised for its therapeutic properties believed to be a result of its rich mineral content (Wang *et al*., 2011).It is considered to be generally regarded as safe by the U.S. Food and Drug Administration and a rich source of phenolic compounds (Guimarães *et al*., 2007). Moreover, it could be used as a good dietary supplement in place of refined sugar (Jain and Venkatasubramanian, 2017).The minerals; magnesium, calcium and potassium, abundant in molasses, may play a beneficial role in carbohydrate metabolism (Wright *et al*., 2014). Different minerals such as selenium, iron, magnesium, zinc, potassium and bulk of the vitamin B complex also constitute to the make-up of molasses, which may be effective in reducing the risk to different forms of cancers (Hannah *et al*., 2011). Molasses may be used as a supplement in the human diet to treat numerous diseases such as anemia, constipation, varicose veins, nerve damage, eczema, high blood pressure, dermatitis, anemia, colds, coughs, ear aches, arthritis, ulcers, hair damage, colitis, bladder problems and many other health problems (Rahiman and Pool, 2010). Molasses was used to made madeleines, mini croissants, and mini rolls (Chikhoune *et al.,* 2014). Furthermore, it may potentially be used as a diet supplement to increase testosterone levels and it has an impact on the cytokines regulating humoral immune system and has both inflammatory and anti-inflammatory potential, sugar cane molasses may be favorable in defense against infective pathogens (Rahiman, 2011). Sugarcane molasses can protect DNA from oxidative damage caused by free radicals Asikin *et al.* (2016). Yoghurt is considered as suitable cane molasses-fortifying vehicles because they contain a negligible amount of iron but molasses rich in iron and other essential nutritional elements. Thus, this study was carried out to make a novel dairy product (novel molasses-yoghurt) and to evaluate the effects of adding molasses to yoghurt on the physicochemical, rheological, microbiological and sensory properties.

2. Materials and Methods

2.1 Materials

Fresh buffalo's milk was obtained from the Herd of animal production department, faculty of Agriculture, Al-Azhar University (Assiut Branch), Assiut, Egypt. DVS yoghurt starter was obtained from Chr. Hansen, Horsholm, Denmark, under Commercial name type (YO-FAST-88). Concentrated Sugarcane molasses (total soluble solids 86%): They were obtained from Egyptian Sugar Company and Integrated Industries

(Gerga factories-Sohage - Egypt).

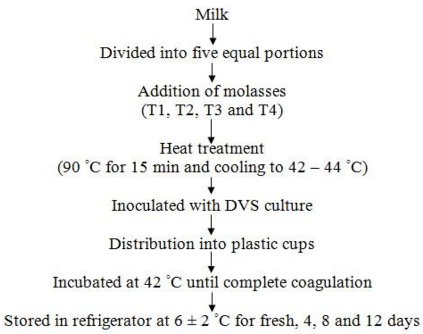
2.2 Methods

2.2.1 Preparation of molasses

Concentrated Molasses (TSS 86%) was diluted by distilled water ratio 1:4 (molasses: water), stirred by hot plate and magnetic stirrer (model MS-300HS, MISUND Scientific Co. LTD Korea) at 60 $^{\circ}$C for 10 minute and settling overnight under cooling to disembarrassed off-odor, then were centrifuged, filtrated and concentrated using water bath at 70°C until total soluble solids reaches 72% to avoid spoilage during storage.

2.2.2 Manufacture of novel molasses - yoghurt

Full cream buffalo's milk (6% fat) was divided into five equal portions; addition the concentrate molasses (72% TSS) as following: C: Leaves as control. T1: Adding 0.5 % (w/w) molasses. T2: Adding 1.0 % (w/w) molasses. T3: Adding 1.5 % (w/w) molasses. T4: Adding 2.0 % (w/w) molasses.



Every part was heated to 90 ± 1°C for 15 min, rapidly cooled to 42 –44°C, and then each part was inoculated with DVS culture. Inoculated milk was equally distributed into plastic cups (100 ml), incubated the mixture at 42°C until complete coagulation. After coagulation, samples were kept in the refrigerator at 6 ± 2°C. The samples were tested at fresh, 4, 8 and 12 days of storage.

2.2.3 Chemical analysis

Total solids and titratable acidity were determined according to AOAC (2000). Total nitrogen and soluble nitrogen content were estimated by the semi micro Kjeldahl as described by IDF (1993). Fat Contents were adopted according to Ling (1963). pH values were measured for different milk products samples using a pH meter model STARTER 300, OHAUS USA. Carbohydrate content was determined according to Dubois *et al.* (1956).

2.2.4 Physical properties

Syneresis was carried out according to Farooq and Haque (1992). Firmness was determined by penetration method described by Shalabi (1987). Density was calculated using the regular equation.

2.2.5 Sensory evaluation

The Sensory evaluation of resultant yoghurt were assessed by a panel of 12 persons of staff members of the Dairy Department, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt according to the scheme described by Pearce and Heap (1974).

2.2.6 Microbiological analysis

Total bacterial counts were determined by the general plate count technique as described by Marshal (1992). Lactobacilli count was estimated on the selective medium for *lactobacilli* (MRS) as suggested by IDF (1997). *Streptococci* count was determined by M17 agar medium as suggested by IDF (1997). Coliform bacteria and moulds and Yeasts were enumerated according to IDF (1985a) and IDF (1985b), respectively.

2.2.7 Statistical analysis

Analysis of variance was performed on the data using the software program; The SAS system for windows, release 8.02 TS level 02M0, SAS Institute Inc., Cary, NC, USA (SAS, 1999).

3. Results and Discussion

3.1 The chemical composition of molasses

Data presented in Table (1) illustrate the chemical composition of molasses. The data revealed that, the total soluble solid (TSS) of molasses was high, this is principally due to the high level of sugars and relatively low moisture content; while, it had low pH values. In addition, the data revealed the total nitrogen and ash contents are high. Moreover, the molasses is rich in potassium, magnesium iron and cupper. These data are in agreement with those reported by Caldwell (1998).

Table (1): Chemical analyses of molasses.

Components		Ratio
Moisture (%)		26.4
Total soluble solids (%)		72.00
Carbohydrates (%)		60.31
Fat (%)		0.0
Total nitrogen (%)		0.84
Ash (%)		8.09
pH		4.60
Density gm/cm^3		1.43
Major mineral elements (on wet basis) (mg/100 gm)	Potassium (K)	2970
	Calcium (Ca)	794
	Magnesium (Mg)	350
	Sodium (Na)	265
	Phosphorus (P)	98
Trace elements (on wet basis) (mg/100 gm)	Iron (Fe)	29.9
	Copper (Cu)	6.863
	Manganese (Mn)	3.5
	Zinc (Zn)	2.3

3.2 The chemical composition of novel molasses-yoghurt

Data presented in Table (2) illustrate the chemical composition of novel molasses-yoghurt. The data observed that, the chemical composition of novel molasses-yoghurt was affected by the percentages of added molasses and during storage periods at refrigerator temperature up to 12 days.

3.3 Total solid contents

The data in Table (2) showed that, the total solid (TS) content of novel molasses-yoghurt has increase significantly ($p<0.05$) with increasing of molasses concentration and with progression of storage periods at refrigerator temperature up to 12 days in all treatments. In addition, the control samples had lower values of TS than that of novel molasses-yoghurt in all treatments. These results are in agreement with those reported by Salman *et al*. (2012) and Tammam *et al*. (2013), who stated that the same trend of bio yoghurt using date syrup.

Table (2): Effect of different molasses concentrations on chemical composition of novel molasses-yoghurt held at 6 ± 2 °C for 12 days.

Components	Storage (days)	Control	Percentage of Molasses				Mean
			0.5	1.0	1.5	2.0	
Total solids %	Fresh	17.11	17.24	17.45	17.85	18.30	17.59^{D}
	4	17.38	17.78	17.92	18.25	18.66	18.00^{C}
	8	18.05	18.17	18.42	18.63	19.03	18.46^{B}
	12	18.16	18.35	18.73	19.05	19.45	18.75^{A}
Mean		17.68^{D}	17.88^{CD}	18.13^{C}	18.45^{B}	18.86^{A}	
L.S.D 0.05		Time = 0.282			Treatments = 0.3153		
Fat %	Fresh	6.10	6.07	6.07	6.03	6.00	6.05^{AA}
	4	6.07	6.07	6.03	6.03	5.96	6.03^{AB}
	8	6.00	6.00	5.93	5.90	5.87	5.94^{B}
	12	5.90	5.83	5.83	5.77	5.73	5.81^{C}
Mean		6.02^{A}	5.99^{AB}	5.97^{AB}	5.93^{AB}	5.89^{B}	
L.S.D 0.05		Time = 0.0938			Treatments = 0.1049		
Acidity %	Fresh	0.73	0.85	0.85	0.85	0.86	0.84^{C}
	4	0.80	0.85	0.86	0.90	0.91	0.87^{B}
	8	0.85	0.85	0.86	0.90	0.93	0.88^{BB}
	12	0.86	0.91	0.91	0.91	0.95	0.91^{A}
Mean		0.82^{D}	0.87^{C}	0.87^{CC}	0.89^{B}	0.92^{A}	
L.S.D 0.05		Time = 0.014			Treatments = 0.0156		
pH	Fresh	4.75	4.73	4.71	4.70	4.70	
	4	4.70	4.63	4.63	4.62	4.61	
	8	4.50	4.49	4.48	4.48	4.47	
	12	4.49	4.46	4.44	4.43	4.43	
Soluble nitrogen %	Fresh	0.036	0.036	0.036	0.036	0.037	0.036^{C}
	4	0.039	0.039	0.039	0.040	0.041	0.040^{B}
	8	0.039	0.041	0.041	0.040	0.044	0.041^{BB}
	12	0.041	0.043	0.044	0.044	0.046	0.043^{A}
Mean		0.039^{B}	0.039^{BB}	0.040^{BB}	0.040^{BB}	0.042^{A}	
L.S.D 0.05		Time= 0.0016			Treatments = 0.0018		
Total nitrogen %	Fresh	0.785	0.789	0.795	0.806	0.813	0.797^{A}
	4	0.752	0.755	0.760	0.775	0.792	0.767^{B}
	8	0.689	0.699	0.699	0.701	0.725	0.703^{C}
	12	0.617	0.622	0.639	0.651	0.660	0.638^{D}
Mean		0.711^{C}	0.716^{CC}	0.723^{CB}	0.733^{BB}	0.747^{A}	
L.S.D 0.05		Time = 0.0114			Treatments = 0.0127		

3.4 Fat contents

The data in Table (2) revealed that, the fat content of novel molasses-yoghurt found to decrease and significantly differences with increasing the storage periods at refrigerator temperature up to 12 days in most treatments. In addition, the fat contents of control samples had higher values of fat than that of novel molasses-yoghurt. On the other hand, the fat content of novel molasses-yoghurt found to decrease with increasing of molasses concentration in most treatments. This may be due to nonfat contents in molasses. Similar results were obtained by El-Shobery *et al.* (2012), who stated that the same trend of yoghurt using date syrup.

3.5 Acidity and pH values

The data Table (2) revealed that, the acidity of novel molasses-yoghurt found to increase with increasing of molasses concentrations and during storage periods at refrigerator temperature up to 12 days. This may due to the high content of sugars in molasses which converted into acids during fermentation process. In addition, the control sample had lower values of acidity than that of novel molasses-yoghurt. On the contrary, the pH values of novel molasses-yoghurt found to decrease with increasing of molasses concentration and during storage periods at refrigerator temperature up to 12 days. This may be due to the higher carbohydrate content of molasses being converted into acid in fermentation process. These results are in agreement with those reported by El-Shobery *et al.* (2012); who stated that the same trend of yoghurt using date syrup.

3.6 Soluble and total nitrogen

The data in Table (2) revealed that, the soluble nitrogen of novel molasses-yoghurt found to increase and significantly differences with increasing the storage periods at refrigerator temperature up to 12 days in all treatments. In addition, the control samples had lower values of soluble nitrogen than that of novel molasses-yoghurt in most samples. On the other hand, the total nitrogen values of novel molasses-yoghurt found to decrease with increasing the storage periods at refrigerator temperature up to 12 days in all treatments. The total nitrogen values of novel molasses-yoghurt found to increase with increasing molasses concentrations. The data showed significant difference effect of storage periods and treatments. In addition, the control samples had lower values of total nitrogen than that of novel molasses-yoghurt, this due to the high content of nitrogen in molasses.

3.7 Total contents of major minerals

Data presented in Table (3) shows that, the novel molasses-yoghurt had higher values of potassium, calcium, magnesium, sodium, phosphorus, iron, copper, manganese and zinc contents than that of control samples. Furthermore, values of iron, copper and manganese were increased about six folds, 4.5 folds and three folds in the novel molasses-yoghurt (T2) compared with control samples. In addition, all these elements of novel molasses-yoghurt were increase in the samples stored at refrigerator temperature for 12 days than that of fresh samples in all treatments due to the increasing of total solids.

Table (3): Effect of molasses addition on minerals contents (mg/100 gm) of novel molasses-yoghurt (1% molasses) at fresh and after held at 6 ± 2 °C for 12 days.

Treatments	Storage (days)	Components								
		K	Ca	Mg	Na	P	Fe	Cu	Mn	Zn
Control	Fresh	174.48	157.33	12.1	55.91	78.62	0.054	0.020	0.019	0.250
	12	180.20	164.80	12.2	59.60	88.00	0.060	0.020	0.020	0.261
T2 (1%) molasses	Fresh	203.03	164.87	15.4	57.96	79.49	0.350	0.089	0.053	0.270
	12	208.00	173.30	15.7	61.00	90.00	0.353	0.090	0.055	0.274

3.8 Rheological properties

Data presented in Table (4) illustrate the rheological properties (syneresis, firmness and density) of novel molasses-yoghurt. The data observed that, the rheological properties of novel molasses-yoghurt was affected by the percentages of added molasses and during storage periods at refrigerator temperature up to 12 days. The data observed that; the syneresis, firmness as well as density of novel molasses-yoghurt was increased significantly ($p<0.05$) with increasing of molasses concentration and with progression of storage periods at refrigerator temperature up to 12 days in all treatments. The high values of syneresis may be due to high acidity resulting in shrinkage of the protein matrix and separation of whey (Kale *et al.,* 2011). A similar trend was found by Farooq and Haque (1992) and Katsiari *et al.* (2002). The increasing of density with increasing of molasses concentration may be due to the high density in molasses.

Table (4): Effect of molasses concentrations on rheological properties of novel molasses-yoghurt held at 6 ± 2 °C for 12 days.

Components	Storage (days)	Control	Percentage of molasses				Mean
			0.5	1.0	1.5	2.0	
Syneresis (ml/100 gm)	Fresh	31.00	32.33	33.00	33.00	34.67	32.60^{C}
	4	35.00	36.67	37.33	38.00	39.50	37.30^{B}
	8	37.00	37.50	38.83	40.00	40.83	38.83^{BB}
	12	39.00	40.67	40.83	41.30	42.16	40.80^{A}
Mean		35.50^{C}	36.79^{BC}	37.50^{AB}	37.83^{AB}	39.29^{AA}	
L.S.D 0.05		Time = 1.7301			Treatments = 1.9343		
Firmness (gm)	Fresh	35.57	35.94	36.52	36.55	36.62	36.24^{B}
	4	36.52	39.44	41.11	41.96	42.55	40.32^{A}
	8	37.45	40.99	41.59	42.03	43.45	41.10^{AA}
	12	37.53	41.72	42.52	42.90	45.63	42.06^{AA}
Mean		36.77^{C}	39.53^{B}	40.44^{AB}	40.86^{AB}	42.06^{AA}	
L.S.D 0.05		Time =1.9156			Treatments = 2.1417		
Density (gm/cm^3)	Fresh	1.130	1.130	1.134	1.144	1.144	1.136D
	4	1.152	1.153	1.160	1.162	1.164	1.158C
	8	1.159	1.160	1.169	1.173	1.182	1.169B
	12	1.161	1.177	1.180	1.189	1.191	1.179A
Mean		1.150^{C}	1.154^{CC}	1.161^{B}	1.167^{AB}	1.170^{AA}	
L.S.D 0.05		Time = 0.0056			Treatments = 0.0063		

3.9 Microbiological properties

Data presented in Table (5) illustrate the microbiological properties (Total bacterial, *Lactobacillus bulgaricus*, *S. thermophiles*, moulds and yeasts and Coliform bacteria counts) of novel molasses-yoghurt. The data observed that; total bacterial, *L. bulgaricus* and *Streptococcus thermophilus* as well as moulds and yeasts counts of novel molasses-yoghurt were affected by the percentages of molasses concentrations and during storage periods at refrigerator temperature up to 12 days. The total viable bacterial as well as *L. bulgaricus* counts were increased up to 4 days and decreased up to the end of the storage periods in control samples and novel molasses-yoghurt. In addition, the counts of *Str. thermophilus* in control samples and novel molasses-yoghurt were decreased up to 12 days of storage in most treatments. Furthermore, novel molasses-yoghurt with 0.5% molasses (T1) was higher counts of total bacterial, *L. bulgaricus* as well as *Str. thermophilus* than that of control samples and other treatments. Moulds and yeasts were not detected in fresh and after 4 days of storage in control samples and novel molasses-yoghurts, whereas they were appeared after 8 days and increased up to12 days of storage in all treatments. In addition, their counts were increased with an increase of molasses concentrations. Additionally, the coliform bacteria were not detected in both fresh and stored novel molasses-yoghurt in all treatments which may be due to the severity of heat treatments of milk and the preventive action of lactic acid bacteria and their metabolites on the growth of coliforms. These results are in harmony with those of Fayed *et al.* (2001) and El-Nagar and Brennan (2001).

Table (5): Effect of different molasses concentration on microbiological properties (Log cfu/ml) of novel molasses-yoghurt held at 6 ± 2 °C for 12 days.

Microbial type (Counts)	Storage (days)	Control	Percentage of molasses			
			0.5	1.0	1.5	2.0
Total bacterial	Fresh	9.05	9.09	9.07	9.07	9.04
	4	9.23	9.26	9.25	9.21	9.13
	8	9.17	9.20	9.20	9.18	9.13
	12	9.09	9.12	9.10	9.08	9.08
Lactobacillus bulgaricus	Fresh	8.53	8.56	8.49	8.48	8.48
	4	8.96	8.98	8.94	8.93	8.91
	8	8.94	8.96	8.93	8.92	8.90
	12	8.94	8.95	8.93	8.92	8.90
Streptococcus thermophilus	Fresh	9.12	9.13	9.10	9.05	9.03
	4	9.03	9.06	9.06	9.02	9.00
	8	8.91	8.95	8.96	8.92	8.91
	12	8.98	9.00	8.91	8.90	8.90
Moulds and yeasts	Fresh	ND	ND	ND	ND	ND
	4	ND	ND	ND	ND	ND
	8	3.63	4.12	4.13	4.17	4.19
	12	4.53	4.53	5.11	5.21	5.21
Coliform bacteria	It does not detected in all treatments					

3.10 Organoleptic properties

Data presented in Table (6) illustrate the organoleptic properties of novel molasses-yoghurt. The data observed that, the sensory properties of novel molasses-yoghurt was affected by the percentages of molasses concentrations and during storage periods at refrigerator temperature up to 12 days. Mean values of the organoleptic scores within each treatment, were examined by panel test and score were awarded for flavor (50), body and texture (30) and appearance and color (20 points) according to Pearce and Heap (1974).

Table (6): Effect of molasses concentrations on organoleptic properties of novel molasses-yoghurt held at 6 ± 2 °C for 12 days.

Properties	Storage (days)	Control	Percentage of molasses			
			0.5	1	1.5	2
Flavor (50)	Fresh	44.00	37.88	39.75	35.88	33.13
	4	43.50	44.75	43.25	42.50	40.00
	8	44.63	44.13	44.50	40.38	36.88
	12	45.83	40.17	44.50	42.33	38.33
Body and texture (30)	Fresh	26.75	26.25	24.75	20.63	19.38
	4	25.50	27.50	26.75	27.00	25.50
	8	26.75	27.38	27.00	26.38	23.50
	12	27.17	25.67	26.50	26.50	24.00
Appearance and color (20)	Fresh	18.50	16.75	16.00	14.50	13.75
	4	18.75	16.50	17.25	15.25	13.50
	8	18.88	18.13	17.38	17.25	15.00
	12	18.83	17.33	17.33	17.00	15.00
Overall scores (100)	Fresh	89.25	80.88	80.50	71.00	66.25
	4	87.75	88.75	87.25	84.75	79.00
	8	90.25	89.63	88.88	84.00	75.38
	12	91.83	83.17	88.33	85.83	77.33

The plain yoghurt had higher flavor than that in novel molasses-yoghurt at any concentrations of molasses in fresh and after storage up to 12 days in most treatments. In addition, novel molasses-yoghurt with 0.5% molasses and stored for 4 days had the higher flavor, While, novel molasses-yoghurt with 2% molasses and fresh had lower flavor than that in other concentrations of molasses. This may be due to further increase in concentration of molasses resulted in increasing the alcoholic aroma and acidic taste of yoghurt. Regarding body and texture, the data shows that novel molasses-yoghurt gained variable scores for body and texture. The samples with high concentration of molasses (2%) had lower values than that in other concentrations. The higher level of molasses concentration reduced the score for body and texture. This may be due to separation of whey at high level of molasses and production of acids, to give the reduced coagulation and formation of soft and loose textured curd. Regarding appearance and color, the data revealed that, novel molasses-yoghurt was less in appearance and color as compared to control samples in all treatments. The samples with high concentration of molasses (2%) had lower values than that in the other treatments. The higher level of molasses concentration was reduced the score for appearance and color. This may be due to reduction in water holding capacity of the curd mass as it affects the protein interaction during coagulation process, resulting into more yield of syneresis. Regarding overall acceptability, as shown in Table (6) novel molasses-yoghurt with 0.5% molasses stored at 8 days had superior scores, followed by 1% stored at the same time, while, novel molasses-yoghurt with 2% molasses without storage had the lowest value of overall scores. Generally, novel molasses-yoghurt with 2% molasses had lower overall score than that of other treatments, whilst the control samples had higher scores than that of novel molasses-yoghurt in most treatments.

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