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Assessing Bottled Unfortified Natural Yogurt Product Quality of Different Brands or Unbranded Sold in New Valley Governorate, Egypt

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Abstract

Consumers have been more concerned about maintaining a healthy diet. This behavior has affected the dairy products processing industries. Therefore, this study was conducted in the laboratories of the Dairy Departments, Faculty of Agriculture of New Valley University and Assuit University. The aim of this study was to evaluate the physical properties, chemical composition, microbiological parameters, and organoleptic indices of branded yogurt samples (produced from large industrial companies) and unbranded yogurt samples (produced from homemade or small industrial units) offered on the market. The obtained results indicated significant differences in physical properties, chemical composition, microbiological properties and organoleptic indices of physiochemical properties, microbiological parameters, and organoleptic indices of branded unfortified natural yogurt samples and unbranded yogurt samples offered on the market in New Valley Governorate. The microbiological quality of some homemade yogurt being sold and consumed in New Valley Governorate; Egypt is poor. There is a need for the Government to sponsor educational programs for producers so that they can be sensitized on the different branded and unbranded yogurt types found in the market so that there can be uniformity in the end products.

Keywords: *Branded, unbranded, yogurt, microbiological and sensory quality*

Introduction

Consumers have been more concerned about maintaining a healthy diet. The consumer culture affects total yogurt consumption rates. The standard codex of the Food and Agriculture Organization requires the same content for protein and fat in fermented dairy products to be at least 2.7%milk protein and a maximum of 10% milk fat. This behavior has affected the dairy products processing industries **(Prasannan, 2017; Hill, et al., 2017, Standard, 2011 Barkallah, et al. (2017).** Consequently, the demand for nutrient-rich foods for a balanced diet and the search for food products with additional benefits, such as high protein content, and low-fat content, have also increased. Market reports show that the yogurt market is projected to reach $107,209 million by 2023, **(Tane-mura et al., 2017; Plasek and Temesi, 2019; Alirezalu et al., 2019 and Ueland et al., 2020).**

The introduction of style yogurts in the market has attracted consumers' attention since they are healthy and commonly have low-fat content. Consequently, these changes may affect consumer acceptance. Homemade yogurt is preferred by some consumers attributed to its more pleasant sensory properties, such as appearance, flavour, and freshness, compared to branded yogurt. On the other hand, other some consumers have difficulty accepting certain yogurt types due to the original high-fat content of the milk (**Cunha Neto et al., 2005 and Kaminarides et al., 2007**). Lately, there is also a great demand for low-fat yogurt as a result of modern consumers' behavior (**Ahmed, 2014; Akgun et al., 2016 and Dias et al., 2020**).

Quality characteristics of yogurts compared with different chemical components of milk reported in few studies **Pandya, et al., 2004; Narender Raju & Pal, 2009). Romeih and Awad (2014)**. They indicated that milk composition or type has a crucial role in the quality of yogurt, and some important defects in yogurt such as weak body, and poor texture due to wheying off. Syneresis is an undesirable feature in the production of yogurt and negatively effect on consumer acceptance of the product (**Domagala, 2012 and Domagala, et al. 2013).**

Therefore, the aim of this study was to evaluate the physical properties, chemical composition, microbiological parameters, and organoleptic indices of branded yogurt samples (produced from large industrial companies) and unbranded yogurt samples (produced from homemade or small industrial units) offered on the market.

Materials and Methods

During the 2021 working season, this experiment was carried out in the laboratories of Dairy Science Departments, Agriculture Faculties, New Valley and Assuit Universities, to investigate the physiochemical properties, microbiological parameters and organoleptic indices of branded yogurt samples (produced from large industrial companies) and unbranded yogurt samples (produced from homemade or small industrial laboratories) offered on the market in New Valley Governorate, Egypt.

Materials and yogurt sampling

Commercial branded and unbranded samples of unfortified natural yogurt (C, D & E companies) and unbranded (F, G & H homemade laboratories) from fortified natural yogurt product (thirty packs each) were collected and randomly purchased at different market and stores and sellers hawking in the market in both of El.Kharga Oasis and El.Dakhla Oasis during the October 2021 season in 100g press-to- close sterilized plastic containers. The unbranded samples were collected without any registration and the labeling on these samples did not have any manufacturing date and expiration date. The samples were immediately taken to the laboratory in ice containers, under aseptic conditions, where analysis was carried out immediately. These samples were labeled C to

H. The labels on branded yogurt samples provided little information about the products, which included only production date, expiry date, batch number and registration number.

Analytical determinations

Physicochemical measurements

The physicochemical measurements of yogurts, i.e. moisture, ash, pH, titratable acidity, fat, proteins, pH value, viscosity were determined according to the modified procedures and described by **Horwitz (1975)** and **Gilliland (2016**). Non-Fat Solids% = Total Solids% - Fat%. Concentrations of calcium and iron were measured by atomic absorption spectroscopy. Mineral composition (sodium, potassium, calcium and magnesium) was determined, where sodium and potassium contents were determined by emission spectroscopy using a Perkin-Elmer atomic absorption spectrophotometer. Calcium, magnesium, phosphors and iron were determined by atomic absorption spectroscopy. Minerals were estimated by spectrophotometry according to the modified procedures and described by **Poitevin (2016)**.

Spontaneous syneresis (SS)% of yogurt was evaluated according to the method of **Isanga and Zhang (2009)**. SS % = (V1/V2) x 100

Where: V1 = Whey volume collected after drainage; V2 = Yogurt sample volume.

Water holding capacity (WHC) of yogurts was measured by the centrifugation of 5 g at 4500 xg for 15 min at 4 ^{0}C. WHC (%) = (1 - W1/W2) x 100,

where, W1 = Whey weight after centrifugation, W2 = Yogurt weight as described in the method reported by **Isanga & Zhang, (2009**).

Microbiological studies

Tenfold dilution of 10 g each of the samples (randomly selected) were made to achieve dilution factor of 10^{-4} and 10^{-7}. Exactly 0.1 ml of the diluents was pour plated in triplicate plates on nutrient agar for total bacteria counts. Testing yeast & molds were enumerated using Chloramphenicol Yeast Extract Glucose agar (Merck) at 25 o C for 4 d according to **Harrigan, (1998**). Dilutions were plated on Salmonella Shigella (SS) agar and incubated, after enrichment in SFB medium, for 24 to 48 h at 37°C. Coliform bacteria were enumerated using Violet Red Bile agar (Merck) at 37 OC for 24-48 h according to **Al-Kadamany et al., (2002**). The count of were expressed as colony forming units per g of yogurt (CFU/g), and the *Salmonella sp*. expressed as present or absent in 25 g of yogurt. Three aliquots of each formulation were used as representative samples.

Organoleptic indices

A 10-point hedonic scale was used to measure the sensory qualities, that is appearance, taste, texture, flavor and overall acceptability of the product. 40 panelists from the staff and students at the agriculture college who are familiar with the characteristics of the yogurt product were employed to ascertain or detect any difference between branded and unbranded purchased commercialized products. These samples were coded differently and served to the panelists with a glass of water and were instructed to rinse their mouth in between the tasting period. The scale of preference ranges from 10 representing like extremely to 1 representing dislike extremely. The scores received by each sample were then averaged and compared (using statistical method) with the average score received by other sample in the series as mentioned in **Çelik, et al. (2010) and Dutcosky (2015)**.

Statistical analysis

The results obtained were subjected to analysis of variance (ANOVA) using Costat software (version 6.400) at 5 % according to **Montgomery, (2017)**.

Results and Discussion

Nutritional quality of unfortified natural yogurt.

Physical properties of unfortified natural yogurt. It could be noted from data listed in Table 1, that there were significant differences in physical properties of the studied unfortified natural yogurt samples, i.e., pH value, viscosity, water holding capacity (WHC)%, and spontaneous syneresis (SS) % between branded and unbranded samples. Moreover, the results revealed that branded yogurt samples had the higher values of pH value, viscosity, & WHC% (4.74, 1135.56 centipoise, and 68.32%) and lower value of SS% (0.18%). While, unbranded yogurt samples had the lower values of pH value, viscosity, and WHC% (4.58, 928.89 centipoise and 60.50%) and the lower value of SS% (3.06%), respectively. The differences in viscosity were because of the differences in total solids% of yogurts samples between branded and unbranded. These results were found to be in accordance with **Eissa et al., (2010).** Here too, WHC varied greatly among the studied different yogurt samples because the total solids% of the studied yogurt samples was different. These findings were in agreement with **Sakandar et al., (2014).** Lower pH values of unbranded yogurt samples or the higher titratable acidity are as a result of uncontrolled fermentation. In addition, there is no proper system of culture dosage in unbranded yogurt, which largely affects the acidity of the final yogurt. Lowered SS% of branded yogurt samples is due to higher its water holding capacity that absorbed the whey released by the gel structure. Similar findings were reported by **Costa, et al. (2016)** who revealed that the branded yogurt sample was semisolid, and whey was absent.

The results in the same previous Table indicated that there were significant differences in all physical properties of the studied unfortified natural yogurt samples among the different studied companies' yogurt samples. Moreover, the data showed that the E company yogurt sample had the highest pH value (4.81), the C company yogurt sample had the highest value of viscosity (1182.00 centipoises), the D company yogurt sample had the highest value of WHC% (71.69%,) and the lowest value of SS% (0.00%) was recorded in C and E companies yogurt samples. These differences might be attributed to that yogurt generally has similar characteristics to the milk it is made from, especially in values of nutritional parameters. The increase in viscosity was due to the increase of total solids and the globules of fat in the network of protein improved WHC (**Tamime & Robinson, 2007**). In this respect, total solids% and protein% as well as milk type affect yogurt syneresis% (**Domagala, 2009**). Similar results were reported by **Kucukcetin et al. (2011)** who indicated that the WHC of yogurt was affected by the milk type made from it. It is noted that SS is not desirable in yogurt and can negatively relationship in the acceptance of product by consumers (**Domagala, 2012**).

Whey separation, known as syneresis, an undesirable property in yogurt quality, is considered the first indices of the most important parameters indicating the quality of yogurt. Syneresis occurs due to the weakening of the gel network of yogurt, leading to whey separation (**Lucey, 2004 Amatayakul et al., 2006**).

Statistically, a significant interaction was found between the type of samples and company name for the studied physical properties (pH value, viscosity, WHC%, and SS% of the unfortified natural yogurt samples as shown in Table 1. Branded C company yogurt sample had the highest value of viscosity (1182.00 centipoises) and the lowest value of SS% (0.00%). However, the unbranded H company yogurt sample had the lowest values of pH value (4.33), viscosity (637.33 centipoises), WHC (50.87%), and the highest value of SS% (6.16%). Our findings are in correspondence with those obtained by **Achanta, et al. (2007) and Vareltzis et al. (2016)** who showed that total solids content

(fat and/or protein), composition of milk (salts and protein), and acidity resulting from the bacterial cultures growth are responsible for the firmness or style of the produced yogurt and affecting the syneresis.

Chemical composition of unfortified natural yogurt samples

In order to understand the relationship between branded and unbranded yogurt quality and processing efficiency, it is necessary to know the chemical constituents of yogurt. The data represented in this work (Table,2) indicated that there were significant differences in the chemical composition of the studied unfortified natural yogurt samples, (protein, fat and titratable acidity (TA)%) and insignificant differences in moisture, non-fat solids, fiber and ash% between branded and unbranded samples. Branded yogurt samples had the higher values of protein (3.49%), fat (3.12%), and the lower value of TA (0.64% as lactic acid). While unbranded yogurt samples had lower values of protein (2.93%) and fat (2.89%) and a higher value of TA (0.85%). Unbranded yogurt is low in fat because it is only processed from bovine milk found in New Valley Governorate, Egypt. These differences might be attributed to the differences in milk type, source, and composition as well as the processing method used in yogurt production. Similar findings were scored **by Rodriguez et al. (2009), Ceballos et al. (2009), and Moh, et al. (2017)** who indicated that many types of unfortified natural yogurt are available in the market varying in protein, fat, nutritional status of the animals, environmental factors and feeding. From a technological point of view, protein, and lipids% of milk are important factors in order to achieve the required texture and viscosity of the yogurt and affect the rheological properties of the final product.

Data in the same aforementioned Table 2, clarified that there were significant differences in the studied chemical components of unfortified natural yogurt samples among the different companies' yogurt samples, except moisture was non-significant. Data showed that the C company yogurt sample had the highest protein value (3.62%), the H company yogurt sample had the highest value of non-fat solids (9.73%) & TA (0.88%), and the F company yogurt sample had the highest value of ash (0.80%). The increase in acidity is due to the activity of lactic acid bacteria that converts lactose into lactic acid. Acidity varied greatly among the studied unfortified natural yogurt samples due to the differences in total solid contents. **Tamime & Deeth(1980)** reported that the contents of fat, protein, and ash will affect the solids-not fat content, so it is very important for this to be taken into consideration during the standardization of milk in order to fix the level to an acceptable standard. The above-obtained findings are in general line with those found by **Kucukcetin et al., (2011) and Krzeminski et al., (2011)** who showed that bovine milk yogurt exhibited low protein content and that the quantity and quality of fat globules and protein influence yogurt quality properties.

Statistically, a significant interaction was scored between the type of yogurt samples and company name with regard to the studied chemical components (non-fat solids, protein, fat, ash, and TA%) of unfortified natural yogurt samples as shown in Table 2. Branded C company yogurt sample had the highest protein value (3.62%), and the unbranded H company yogurt sample had the highest value of non-fat solids (9.73%) and TA (0.88%). The decrease in pH value was association with the increase in TA might be attributed to the yogurt microorganisms activity (**Prasanna et al., 2013**), where the lactic acid is produces from the lactose fermentation (**Costa et al, 2015 and 2016**).

Minerals composition of unfortified natural yogurt samples

The results tabulated in Table 3, indicated that there were significant

differences in minerals composition of the studied unfortified natural yogurt samples, i.e., Ca, Mg, K, Na, P mg/100g, and Fe ppm, between branded and unbranded samples. Unbranded yogurt samples had higher values of Ca, Mg, K, Na, P, and Fe (95.13, 8.64, 143.24, 38.76, 91.71 mg/100g, and 0.44 ppm), however, branded yogurt samples had lower values (89.54, 8.04, 125.92, 33.42, 87.25 mg/100g, and 0.18 ppm), respectively. This might be due to the unbranded yogurt being higher in minerals. Similar findings were obtained by **Costa, et al. (2016)** who demonstrated that unfortified natural yogurt is a rich source of calcium, phosphorus, and potassium. Our results are in disagree with those obtained by **Moh, et al. (2017)** who clarified that there were significant differences in the Fe content of samples within and among the different studied places. In addition, they revealed that the iron content of most locally or unbranded samples was significantly lower than those of the commercial branded type. This difference might be due to the differences in the studied sample types and environmental conditions.

Data in Table 3 showed that there were significant differences in the studied mineral composition (Ca, Mg, K, Na, P mg/100g, and Fe ppm) of unfortified natural yogurt samples among the different companies' yogurt samples. F company yogurt sample had the highest values of Ca and P (96.76 and 92.91 mg/100g), the G company yogurt sample had the highest values of Na and Fe (40.20 mg/100g and 0.70 ppm), and the H company yogurt sample had the highest values of Mg and K (8.92 and 147.62 mg/100g), respectively. Similar findings were revealed by **Chine Cherem-Ndudim, et al. (2022)** who indicated that yogurt is rich in potassium, calcium, phosphorus, and other minerals.

Statistical analysis indicated a significant interaction between the type of yogurt samples and company name with regard to the studied minerals (Ca, Mg, K, Na, P mg/100g, and Fe ppm) of unfortified natural yogurt samples as shown in Table 3. Unbranded F company yogurt sample had the highest value of Ca (96.76 mg/100g) and the unbranded G company yogurt sample had the highest value of Fe (0.70 ppm). **Moh, et al. (2017)** indicated that food is considered good if the Ca/P ratio is above 1 and poor if the ratio is less than 0.5. In the present study the Ca/P ratio was above 1, indicating that these yogurt samples will serve as good sources of minerals, especially calcium for bone formation.

Microbial quality of unfortified natural yogurt

The results presented in Table 4, noticed that there were significant differences in total bacterial and mold & yeast counts as well as insignificant differences in *Salmonella spp* and coliform bacterial counts of the studied unfortified natural yogurt between branded and unbranded samples. Branded yogurt samples had a higher value of total bacterial count (9.51×10^7 CFU /g) and a lower value of mold & yeast count (16.44 CFU). On the other hand, unbranded yogurt samples had a lower value of total bacterial count (6.49×10^7 CFU /g) and the higher value of mold & yeast count (56.49 CFU). Coliform bacterial count was not detected in any of the branded yogurt samples. The absence of these microorganisms showed that the products were clean and safe. This indicates that the yogurt processing was manufactured under good hygienic conditions. Coliform bacterial count was < 10 CFU /g in the unbranded yogurt samples, which is within the established limits (10 CFU /g) for Egyptian Standards (**ES, 2005). FAO/WHO, (2007) and Costa, et al. (2016)** revealed that the low pH value of yogurt limits the growth of pathogenic microorganisms, but yeast and molds are still able to grow in yogurt. With regard to contamination of yogurt such as coliform bacteria, this might be due to the quality and source of milk; contaminations may

deteriorate the quality or degree of yogurt and may have negative effects on health of consumer. Similar results were obtained by **Gharaibeh, (2017)** who showed that the transfer of yogurt, especially unbranded yogurt samples, from production places to storage and marketplaces might also cause microbial contamination.

From Table 4, data showed that there were significant differences in total bacterial and mold & yeast counts as well as insignificant differences in *Salmonella spp* and coliform bacterial counts among the different companies' yogurt samples. The C company yogurt sample had the highest value of total bacterial count ($9.65x10^7$ CFU) and the D company yogurt sample had the lowest value of mold & yeast count (10.33 CFU). However, the G company yogurt sample had the lowest value of total bacterial count ($5.43x10^7$ CFU) and the highest value of mold & yeast count (78.00 CFU). Only the F company yogurt sample contained *Salmonella* spp. count (15 CFU), which is without the established limits (0.00 CFU/g) according to **ES, (2005).** The inefficiency of the pasteurization process during the manufacture might be the cause that the F company yogurt sample contained *Salmonella spp* or during the transfer of yogurt, especially unbranded yogurt samples, from production places to storage and marketplaces may also cause the microbial contamination (**Chumchuere& Robinson, 1999 and Rodriguez et al.,2009)**. In addition, unbranded F, G, and H companies' yogurt samples contained coliform bacterial count (< 10 CFU/g). Therefore, the present formulations of branded and unbranded yogurt samples are satisfactory, except the yogurt sample contained *Salmonella spp*, which defines the product's shelf life. So, the traditional dairy products consumption manufactured from raw milk, such as yogurt is related to numerous health risks (**Rayser, 2001**). The detection of coliform bacteria and pathogens in yogurt shows the spoilage of yogurt (**Bonfoh et al., 2003**). In yogurts, the coliform tolerable limit is a value less than 10 CFU/ml. Water, or the equipment used in processing might be the source of contamination as mentioned by **Karagul, &White (2001) and Kawo, et al, (2006), and Sofu and Ekinci, (2007).** These results are in agreement with other workers such as **Costa, et al. (2016)** who remarked that yogurts should contain no more than 10 yeast cells.

Statistically, the analysis indicated a significant interaction between the type of yogurt samples and company name with regard to total bacterial and mold & yeast counts of unfortified natural yogurt samples as shown in Table 4. Branded C company yogurt sample had the highest value of total bacterial count ($9.65x10^7$ CFU/g) and branded D company yogurt sample had the lowest value of mold & yeast count (10.33 CFU/g). The unbranded F company yogurt sample contained a *Salmonella spp* count (15 CFU/g). In addition, unbranded F, G, and H company yogurt samples contained coliform bacteria count (< 10 CFU/g). This result could be attributed to the unsanitary conditions prevailing at the time of the manufacturing process and indicating some types of mishandling even in the industry. At low pH (4.2- 3.8) yogurt is not a hospitable medium for pathogens which will not grow in an acidic medium and will not survive well either. Yogurt seems to be a selective medium for molds and yeasts due to its acidic content that has acidic content (**Kilara & Shahani, 1978**). The microbial yogurt quality reflects the acceptability of the yogurt quality. This might be due to unhygienic conditions, where there is possibility microbial contamination or pathogens such as Salmonella spp, which may have serious effect on the consumers health (**Abd El. Rahim, 2019**).

Organoleptic quality of unfortified natural yogurt

Significant differences in organoleptic indices, i.e., appearance, taste, texture, flavor,

and overall acceptability, of the studied unfortified natural yogurt between branded and unbranded samples are shown in Table 5. Branded yogurt samples had a higher value of appearance (8.60), texture (9.27), and overall acceptability (8.69). On the other hand, unbranded yogurt samples had a higher value of taste (8.30) and flavor (8.30). This might be attributed to the differences in the chemical constituents of yogurt. Some consumers prefer homemade or unbranded yogurt products due to their more pleasant organoleptic indices, such as taste compared to branded yogurt (**Ahmed, 2014**). However, other consumers have difficulty accepting homemade or unbranded yogurt because of its more pleasant sensory properties, such as weak texture (**Cunha Neto et al., 2005)**. These results in texture points of yogurt samples were thought to result from the milk type and total solid content of the milk (**Kaminarides et al., 2007)**. Yogurt structure and sensory profile are modifiable by milk protein enrichment (**Costa, et al. 2016)**. Similar findings were reported by **Lesme, et al., (2020)** who revealed that the branded yogurt sample was sour with the characteristic yogurt flavor.

Data in Table 4 showed that there were significant differences in organoleptic indices, i.e., appearance, taste, texture, flavor, and overall acceptability, among the different companies' yogurt samples. C company yogurt sample had the highest values of appearance (8.89) and overall acceptability (8.91), the E company yogurt sample had the highest value of texture (9.34) and the G Company yogurt sample had the highest value of taste (8.68). Lactic acid plays a specific role in the aroma and flavor of yogurt. The acid-forming activity of the starter culture depends on its strains, (Beshkova **et al., 1998**). Therefore, we considered these criteria when selecting strains.

Statistical analysis indicated a significant interaction between the type of yogurt samples and company name with regard to taste, appearance, flavor, texture, and overall acceptability, as shown in Table 5. Branded C company yogurt sample had the highest values of appearance (8.89) and overall acceptability (8.91), branded E company yogurt sample had the highest value of texture (9.34) and the unbranded G company yogurt sample had the highest value of taste (8.68). Although appearance represents an important parameter of yogurt, the textural property is considered the major sensory attribute impacting the yogurt's overall liking. Therefore, a low value in consistency attributes potentially motivated the low product acceptance (**Amatayakul et al., 2006**). Similar findings were reported by **Costa, et al. (2016)** who indicated that many types of unfortified natural dairy products are available in the market varying in texture, and flavor.

Conclusion

There were significant differences in physical properties, chemical composition, microbiological properties and organoleptic indices of physiochemical properties, microbiological parameters, and organoleptic indices of branded unfortified natural yogurt samples (produced from large industrial companies) and unbranded yogurt samples (produced from homemade or small industrial laboratories) offered on the market in New Valley Governorate can be attributed to several factors such as type of milk used, method of preparation, type, and proportion of ingredients used. The microbiological quality of some yogurt samples being sold and consumed in New Valley Governorate; Egypt is poor. This could be attributed to the unsanitary conditions prevailing at the time of the manufacturing process and indicating some types of mishandling even in the industry. There is a need for the Government to sponsor educational programs for producers so that they can be sensitized on the different branded and unbranded yogurt types found in the

market so that there can be uniformity in the end products.

Conflicts of Interest/ Competing Interest

All authors declare that they have no conflicts of interest.

Data Availability Statement

All data sets collected and analyzed during the current study are available from the corresponding author on reasonable request.

List of Abbreviations

AOAC	Association of Official Analytical Chemists	ND	Not Detected
TBC	Total bacterial count	WHC	Water holding capacity.
FAO	Food and Agriculture Organization	NS	Non-Significant
WHO	World Health Organization	SS%	Spontaneous syneresis%
CFU	Colony forming unit.	TA	Titratable acidity.
		HACCP	Hazard analysis and critical control point
		ES	Egyptian Standards

Table 1: Physical properties for branded and unbranded samples of unfortified natural yogurt product.

Type of samples (A)	Company Name (B)	Physical properties of unfortified yogurt product			
		pH value	Viscosity (Centipoise)	WHC%	Spontaneous syneresis%
Branded	C	4.67	1182.00	67.93	-
	D	4.74	1059.00	71.69	0.55
	E	4.81	1165.67	65.33	-
Mean		4.74	1135.56	68.31	0.18
Unbranded	F	4.55	724.67	51.40	6.05
	G	4.40	804.67	55.76	5.60
	H	4.33	637.33	50.87	6.16
Mean		4.43	722.22	52.68	5.93
Overall mean		4.58	928.89	60.50	3.06
F value A		**	**	**	**
B		*	**	**	**
AB		**	**	**	**
LSD at 5% A		0.03	4.10	0.27	0.04
B		0.02	3.91	0.28	0.03
AB		0.04	5.53	0.39	0.06

Notes: Values in the same row with different superscripts are statistically significant from each other ($p < 0.05$). NS= non-Significant

Table 2: Chemical composition of branded and unbranded samples of unfortified natural yogurt product.

Type of samples (A)	Company Name (B)	Chemical composition of unfortified yogurt product						
		Moisture%	Non –fat solids%	Protein %	Fat %	Fiber%	Ash %	TA*
Branded	C	87.22	9.56	3.62	3.22	0.00	0.68	0.60
	D	87.26	9.63	3.34	3.11	0.00	0.71	0.67
	E	87.25	9.70	3.50	3.04	0.00	0.75	0.64
Mean		87.24	9.63	3.49	3.12	0.00	0.71	0.64
Unbranded	F	88.46	9.72	2.89	2.82	0.00	0.80	0.73
	G	88.54	9.37	2.82	3.09	0.00	0.78	0.85
	H	88.52	9.73	3.07	2.75	0.00	0.65	0.88
Mean		88.51	9.61	2.93	2.89	0.00	0.74	0.85
Overall mean		87.88	9.62	3.21	3.01	0.00	0.73	0.82
F value A		NS	NS	**	**	NS	NS	**
B		NS	*	**	**	NS	**	**
AB		NS	*	**	**	NS	**	**
LSD at 5% A		-	-	0.04	0.05	-	-	0.01
B		-	0.13	0.03	0.04	-	0.02	0.01
AB		-	0.23	0.05	0.23	-	0.03	0.02

Notes: Values in the same row with different superscripts are statistically significant from each other ($p < 0.05$). TA* determined as % of lactic acid. NS= non-Significant.

Table 3: Some minerals composition of branded and unbranded samples of unfortified natural yogurt product.

Type of samples (A)	Company Name (B)	Minerals of unfortified yogurt product					
		Ca (mg/100g)	Mg (mg/100g)	K (mg/100g)	Na (mg/100g)	P (mg/100g)	Fe (ppm)
Branded	C	89.85	7.88	114.48	31.72	86.81	0.55
	D	92.71	8.69	134.83	35.22	90.58	-
	E	86.07	7.55	128.45	33.32	84.34	-
Mean		89.54	8.04	125.92	33.42	87.25	0.18
Unbranded	F	96.76	8.15	142.93	38.70	92.91	-
	G	95.25	8.86	139.18	40.20	91.66	0.70
	H	93.39	8.92	147.62	37.38	90.55	0.62
Mean		95.13	8.64	143.24	38.76	91.71	0.44
Overall mean		92.34	8.34	134.58	36.09	89.48	0.31
F value A		**	**	**	**	**	**
B		**	**	**	**	**	**
AB		**	**	**	**	**	**
LSD at 5% A		0.40	0.05	1.12	0.05	0.58	0.01
B		0.63	0.04	1.52	0.04	0.63	0.02
AB		0.90	0.05	2.14	0.23	0.89	0.02

Notes: Values in the same row with different superscripts are statistically significant from each other ($p < 0.05$).

Table 4: Microbial quality (CFU /g) of branded and unbranded samples of unfortified natural yogurt product.

Type of samples (A)	Company Name (B)	Microbial quality (log CFU/g) of yogurt product			
		Total bacterial count	*Salmonella spp* count	Coliform bacterial count	Molds &yeast count
Branded	C	9.65×10^7	-	ND	14.33
	D	9.50×10^7	-	ND	10.33
	E	9.38×10^7	-	ND	24.67
Mean		9.51×10^7	-	-	16.44
Unbranded	F	6.87×10^7	15.00	< 10	37.67
	G	5.43×10^7	-	< 10	78.00
	H	7.18×10^7	-	< 10	53.33
Mean		6.49×10^7	5.00	< 10	56.49
Overall mean		8.00×10^7	2.50	-	36.39
F value A		**	NS	NS	**
B		**	NS	NS	**
AB		**	NS	NS	**
LSD at 5% A		0.10	-	-	2.45
B		0.09	-	-	2.76
AB		0.14	-	-	3.91

Notes: Values in the same row with different superscripts are statistically significant from each other ($p < 0.05$). CFU= Colony forming unit. ND= Not Detected

Table 5: Organoleptic indices of branded and unbranded samples of unfortified natural yogurt product.

Type of samples	Company Name	Organoleptic indices of unfortified yogurt product				
		Taste (10 points)	Appearance (10 points)	Flavor (10 points)	Texture (10 points)	Overall acceptability (10 points)
Branded	C	7.83	8.89	7.20	9.32	8.91
	D	7.90	8.60	7.67	9.15	8.43
	E	7.73	8.32	7.11	9.34	8.71
Mean		7.82	8.60	7.32	9.27	8.69
Unbranded	F	8.15	7.07	8.23	6.60	7.25
	G	8.68	7.49	8.05	6.33	8.08
	H	8.07	7.23	8.63	6.06	7.51
Mean		8.30	7.26	8.30	6.33	7.61
Overall mean		8.06	7.93	7.81	7.80	8.15
F value A		**	**	**	**	**
B		**	**	**	*	**
AB		**	**	**	**	**
LSD at 5% A		0.02	0.02	0.05	0.06	0.03
B		0.04	0.03	0.05	0.16	0.03
AB		0.05	0.04	0.07	0.23	0.04

Notes: Values in the same row with different superscripts are statistically significant from each other ($p < 0.05$).

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