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Assessment of physical, chemical, microbiological, and sensory characteristics of global and local cola carbonated soft drink brands in Egypt

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This study aimed to estimate the physical, chemical, microbiological, and sensory characteristics of commercial cola-carbonated soft drink brands in the Egyptian market to evaluate the safety of these drinks. Two commercial drinks brands, global and local cola, were used in the study. Physico-chemical, microbiological, and sensory characteristics of cola soft drinks were affected ($p \leq 0.05$) by the cola brand. The global cola soft drink had higher ($p \leq 0.05$) physico-chemical characteristics than the local cola soft drink after production and for 6 months storage period. In addition, the Global cola soft drink brand had a higher percentage of taste, odour, appearance, and overall acceptability than the local cola soft drink brand by 20%, 22.53%, 12.42%, and 18.55%, respectively, after production. Gradual ($p \leq 0.05$) decline in all sensory scores was detected for 6-month storage period. The global cola soft drink had a much lower total bacterial count (2.3 CFU.100 ml^{-1}) than a local cola soft drink (123 CFU.100 ml^{-1}). Thus, local brands of cola consumption after production could have public health risks due to high microbial load and deteriorated product shelf life. Also, quality control during processing and public health awareness could mitigate risk. During the 6-month storage period, the total bacterial count was completely absent after 3 and 4 months for global and local cola soft drinks, respectively. The global and local cola soft drink brands during the storage period at room temperature for 6 months were completely free of aciduric bacteria, coliform bacteria, and *Escherichia coli*, yeast, and mould as well. The results indicate that the physico-chemical attributes of all tested carbonated soft drinks samples (global & local) are within the European guidelines of carbonated soft drinks but are not compatible with the label of the reported bottle. Also, local brands of cola consumption after production could have public health risks due to high microbial load and deteriorated product shelf life.

Keywords: cola, physico-chemical, microbiological, sensory, *Escherichia coli*

Introduction

A soft drink is a beverage that does not contain alcohol; carbonated soft drinks are commonly known as soda, POP, or soda POP in parts of the United States and Canada, or Fizzy drinks in the U.K. In 2013, sales of carbonated soft drinks reached an annual volume of 196 billion litre, representing 12% of the global drink's volume. Despite the issue of sugar content

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surrounding carbonated soft drinks linked with the obesity epidemic, carbonated soft drinks have still managed to achieve an average annual growth rate of 2.6% (Ashurst, 2016). Also, approximately 5.3 billion litres of carbonates were consumed in the UK. The total volume of carbonated soft drinks consumed in the European Union per capita was 243.6 litres (Garavaglia et al., 2019).

Soft drinks are produced by mixing treated water, carbonated under pressure, with sugar (sucrose or fructose), acids, colouring agents, and preservatives. It contains around 8–12% (w/v) of sugars, 0.05–0.3% (w/v) of acidulant, 3.0–4.5% (w/v) carbon dioxide, and 0.1–0.5% (w/v) of flavouring agent (Sharma, 2018). In many cases, soft drinks contain caffeine, a central nervous system and metabolic stimulant derived from the kola (cola) nut extract, which is added as a flavouring agent, even if the amount which is usually present is less than that which is found in tea and coffee, except for energy drinks. In cola-type beverages, caffeine is considered generally recognized as safe (GRAS) up to a maximum use level of 0.02% (Preedy, 2014). Phosphoric acid is present abundantly in cola soft drinks. There are reports that phosphoric acid concentration in cola soft drinks ranged between 175–200 ppm. WHO/FDA phosphoric acid daily recommended dosage is 1000 ppm.day^{-1} (Helal, 2020). These beverages contain caramel, fruit juice, or caffeine with the addition of carbon dioxide, which contributes to their thirst-quenching effect: they can all be therefore considered under the denomination of 'soft drinks.' All these beverages are also characterized by the absence of ethyl alcohol, and they can be freely consumed by children (Brenna, 2014).

Physical, chemical, and microbiological criteria of treated water used in the production of carbonated soft drinks must comply with drinking water specifications according to World Health Organization (WHO). Also, principal constituent levels such as Brix (TSS), titratable acidity, pH, carbonation ratio, caffeine, and phosphoric acids must be monitored and controlled during processing, and must be confirmed with standard specifications of the global and local authorities (Sarwar, 2016).

The shelf life of carbonated soft drinks is varied, with a low possibility of deterioration due to low pH, carbonation levels, acids regulators, and the presence of natural and/or artificial preservatives. On the other hand, due to the nutrient content and composition, the majority of soft drinks are subjected to microbial spoilage (Hiko and Muktar, 2020).

Soft drinks have been consumed regularly; sugar has a high-calorie content that will give the body energy that it lacks. However, all that energy is short-lived, and it can only give short bust of increased productivity (Lobo and Satish, 2018). Sugar can preserve and enhance the flavour of a drink and gives a satisfying sensation (Kregiel, 2015). Meanwhile, the problem arises due to high consumption of sugary drinks which leads to various health hazards (obesity, diabetes mellitus, or non-alcoholic fatty liver diseases). Sugar-sweetened beverages have contributed to an increase in obesity, hypertension, type 2 diabetes, and other metabolic disorders (Malik et al., 2011). Soft drinks have long been blamed for causing damage to teeth, especially among children. They have the potential to cause erosion. However, there are mitigating factors serving to reduce greatly the damage that soft drinks might at first be thought to cause. Sugar-free drinks are widely available, and are targeted at all age ranges, rather than just at slimmer (a reduction in sugar content would have little effect; is total absence that is necessary) (Ashurst, 2016).

The main objective of this study was to estimate the major constituents, microbial load in commercial brands (global and local) of carbonated cola to reveal the safest cola soft drink brand in the Egyptian market.

Material and methodology

Two different cola soft drinks, namely global and local brands, packaged in 1.0 litre polyethylene terephthalate (PET) bottles were collected after production during the winter season (2016). Global and local cola carbonated soft drinks brands were obtained from local markets of El-Sadat City, Menoufia Governorate, and 6th of October City, Giza Governorate, Egypt, respectively.

Storage of cola soft drink brands: global and local cola carbonated soft drink brands were analyzed after production immediately and during six months storage periods at laboratory temperature (22 °C ±2) to compare their physical, chemical, microbiological, and sensory properties.

Physico-chemical methods

The degassing of cola soft drink brands (global and local) was accomplished according to the method described by (Sagharizade, et al., 2019) using Commercial Somex Degassing Unit Somex Soft Drink Degasser (Bally Vourney CO. Cork, Ireland). The pH was measured using a pH meter (Jenway 3510 pH Meter, England) as described by (Rangana 1977); according to the

manufacture manual; the Anton Paar Carbo Qc (DMA 48/DMA 58, Austira) measuring system for monitoring and measuring CO_2 & O_2 was used (Anton Paar Manual, 2010). Reducing sugars were measured according to Miller (1959). Density was measured as described by (Steinbach et al., 2014). Caffeine was estimated as described by (Amos-Tautua et al., 2014); phosphoric acid was measured as described by (Lozano-Caleroand and Martín-Palomeque, 1996); the titratable acidity, and sugars (ºBrix, refractometer; ATAGO Model 5000 DCX, Research Analytical, Japan) measurements were performed in triplicate (AOAC 2005).

Microbiological methods

A membrane filter procedure for enumerating total bacterial, yeast, mould and aciduric bacteria, total coliform, and *E. coli* counts was developed and evaluated with some modifications as follows: Appropriate volumes (100 mL) of global and local cola carbonated soft drink brands samples were passed through 0.45 µm gridded membrane filters (MCE) using vacuum funnel assembly. Then, samples were allowed to be drawn completely via a vacuum pump through the filter, and the filters then were placed on the selected medium, incubated at the proper temperature and for the appropriate period, then counted to confirm the colonies.

Total bacterial, yeast, mould, and aciduric bacteria viable counts were carried out according to (Braux et al., 1997). The total coliform bacterium was detected with some modifications according to AOAC (2005). *Escherichia coli* detection was carried out according to Downes and Ito (2001).

Sensory method

Global and local cola carbonated soft drink brands were subjected to sensory evaluation directly after production and every month during six months storage periods for appearance, taste, and overall acceptability by a trained panel consisting of ten members (average age mid-30 s) selected from laboratory staff and a team of the sensory test; using Hedonic scale rating 1–9 points (1 = dislike very much; 9 = like very much) to assess the differences. Experts evaluated soft drink samples offered at the same time in a specific area of sensory test in the soft drink samples plant quality assurance laboratory without special lighting. Water was provided for rinsing purposes.

Statistical analysis

Global and local cola-carbonated soft drinks were determined as the mean of ten replicates, while the physicochemical properties of global and local cola-carbonated soft drink brands were determined as the mean of three replications. Two-way Factorial Design analysis of variance was used for global and local cola carbonated soft drinks' physicochemical and sensory properties. The LSD was used for comparison among means, considering significance at 0.05% level, using Costas version 6.311 (Copyright 1998–2005, CoHort software).

Results and discussion

Physicochemical properties of global and local cola carbonated soft drinks brands during 6 months storage period

The CO_2, pH, Density, O_2, TSS, reducing sugars, titratable acidity, phosphoric acid, and caffeine were evaluated, and the data was shown in Table 1. Initially, all parameters were within acceptable quality limits for tested global and local cola brands. Meanwhile, the physicochemical characteristics of cola soft drink brands were affected ($p \leq 0.05$) by the type of cola brand. The global cola soft drink brand had higher ($p \leq 0.05$) physico-chemical characteristics than the local cola soft drink.

After production, physico-chemical characteristics of cola soft drinks brands had carbonation levels of 3.99 ±0.05 (v/v) and 2.83 ±0.20 (v/v), respectively. After 6 months of storage (Table 1), carbonation volume decreased gradually for both brands 1.81 ±0.02 (v/v) and 1.60 ±0.02 (v/v). A value of 4.0 (V/V) of CO_2 in Coca-Cola PET bottles is usually used to guarantee the original characteristics quality and extend the shelf-life of Coca-Cola (Licciardello et al., 2011). After production, the hydrogen ion (2.14 ±0.0) of the local cola soft drink brand recorded an acidic value more than the global cola brand (2.80 ±0.0). During the storage period, pH values were significantly ($p \leq 0.05$) decreased. The decrease in pH values may be due that the interaction between the weak carbonic acid and the strong phosphoric acid. The density of the global cola soft drink (1.0422 $gm.cm^{-3}$) is similar to values reported by Charrondiere et al. (2012) and Jayeola (2001). The density of cola soft drinks was not affected ($p \geq 0.05$) during the storage period. The stability of the density during storage is good because the density increase involves the danger of the increase of the maximum internal gas pressure. Global cola soft drink brands had a higher ($p \leq 0.05$) O_2 value in bottled packages (1.8 ppm) than the local brand (0.5 ppm). This difference is due to O_2 ingress rates which imparted

Table 1 Physical characteristics of cola soft drink brands during storage at room temperature for 6 months

Physical characteristics	Brands	Storage period (months)						
		0	1	2	3	4	5	6
CO_2 (V/V)	global	3.99 ±0.05	3.74 ±0.01	3.47 ±0.05	3.17 ±0.02	2.8 ±1.20	2.63 ±0.34	1.81 ±0.02
	local	2.83 ±0.20	2.39 ±0.16	1.50 ±0.02	1.65 ±0.02	1.54 ±0.02	1.17 ±0.14	1.60 ±0.02
pH	global	2.80 ±0.0	2.70 ±0.02	2.51 ±0.04	2.44 ±0.04	2.33 ±0.03	2.25 ±0.02	2.12 ±0.04
	local	2.14 ±0.0	2.05 ±0.02	1.96 ±0.02	2.02 ±0.03	1.9 ±0.13	1.8 ±0.02	1.63 ±0.04
Density ($gm.cm^{-3}$)	global	1.0483 ±0.0007	1.0450 ±0.0003	1.0432 ±0.0002	1.0411 ±0.0004	1.0401 ±0.0002	1.0395 ±0.0005	1.0382 ±0.0003
	local	1.0224 ±0.0004	1.0221 ±0.0001	1.0222 ±0.0001	1.0222 ±0.0000	1.0222 ±0.0000	1.0222 ±0.0002	1.0222 ±0.0001
O_2 (ppm)	global	1.80 ±0.0	2.00 ±0.0	7.0 ±0.0	10.60 ±1.15	13.60 ±0.57	17.30 ±1.15	26.60 ±1.52
	local	0.5 ±0.2	2.00 ±0.0	11.0 ±0.0	7.3 ±1.15	8.0 ±0.0	10.3 ±0.5	17.0 ±1.7

Values are expressed as the mean of triplicate measurements

Table 2 Statistical analysis of physical characteristics of cola soft drink brands during storage at room temperature for 6 months

Physical characteristics	Brands		Storage period (months)						
	global	local	0	1	2	3	4	5	6
CO_2 (V/V)	3.99^{a}	2.83^{b}	3.41^{a}	3.06^{b}	2.41^{c}	2.21^{d}	1.90^{e}	1.80^{ef}	1.70^{f}
LSD	0.08					0.15			
pH	2.80^{a}	2.14^{b}	2.47^{a}	2.36^{b}	2.24^{c}	2.25^{c}	2.11^{d}	2.02^{e}	1.86^{f}
LSD	0.01					0.03			
Density ($gm.cm^{-3}$)	1.0422^{a}	1.0285^{b}	1.0353^{a}	1.0335^{a}	1.0326^{a}	1.0315^{a}	1.0310^{a}	1.0307^{a}	1.0301^{a}
LSD	0.01					0.01			
O_2 (ppm)	1.80^{a}	0.50^{b}	1.15^{e}	2.00^{e}	9.00^{d}	9.00^{d}	10.83^{c}	13.83^{b}	21.83^{a}
LSD	0.12					1.01			

Means with different letter in the same row are significantly different ($p \leq 0.05$). LSD: least significant difference

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Table 3 Chemical characteristics of cola soft drink brands during storage at room temperature for 6 months

Chemical characteristics	Brands	Storage period (months)						
		0	1	2	3	4	5	6
Total soluble solids (%)	global	10.87 ±0.03	10.84 ±0.05	10.65 ±0.0	10.51 ±0.01	10.45 ±0.02	10.40 ±0.05	10.30 ±0.01
	local	6.0 ±0.06	5.96 ±0.05	6.06 ±0.03	6.04 ±0.01	6.03 ±0.02	6.0 ±0.05	5.99 ±0.02
Reducing sugars (%)	global	0.035 ±0.05	0.058 ±0.01	0.068 ±0.03	0.084 ±1.15	0.10 ±0.02	0.116 ±0.04	0.128 ±0.01
	local	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Titratable acidity (%)	global	13.5 ±0.6	11.72 ±0.2	11.76 ±0.38	12.38 ±0.13	12.95 ±0.21	13.50 ±0.07	13.72 ±0.06
	local	12.0 ±0.18	14.08 ±0.16	14.26 ±0.11	14.84 ±0.05	15.20 ±0.0	15.30 ±0.0	15.56 ±0.02
Phosphoric acid (ppm)	global	15.85 ±0.02	15.87 ±0.06	15.80 ±0.01	15.80 ±0.01	15.82 ±0.04	15.83 ±0.05	15.81 ±0.02
	local	15.79 ±0.05	15.80 ±0.5	15.8 ±0.0	15.81 ±0.05	15.80 ±0.0	15.78 ±0.09	15.74 ±0.08
Caffeine (ppm)	global	30.33 ±0.01	28.3 ±0.02	14.42 ±0.39	22.80 ±0.04	17.81 ±0.17	14.94 ±0.02	11.58 ±0.02
	local	15.52 ±0.04	5.15 ±0.06	9.56 ±0.05	3.76 ±0.42	3.20 ±0.06	2.86 ±0.12	1.68 ±0.51

Values are expressed as the mean of triplicate measurements

Table 4 Statistical analysis of chemical characteristics of cola soft drink brands during storage at room temperature for 6 months

Chemical characteristics	Brands		Storage period (months)						
	global	local	0.0	1	2	3	4	5	6
Total soluble solids (%)	10.87^{a}	6.00^{b}	8.43^{a}	8.38^{b}	8.34^{c}	8.26^{d}	8.23^{d}	8.19^{e}	8.14^{f}
LSD	0.05					0.03			
Reducing sugars (%)	0.035^{a}	0.00^{b}	0.017^{g}	0.029^{f}	0.034^{e}	0.042^{d}	0.050^{c}	0.058^{b}	0.064^{a}
LSD	0.01					0.002			
Titratable acidity (%)	13.5^{a}	12.00^{b}	12.75^{g}	12.90^{f}	13.07^{e}	13.61^{d}	14.07^{c}	14.4^{b}	14.64^{a}
LSD	0.11					0.05			
Phosphoric acid (ppm)	15.84^{a}	15.79^{b}	15.81^{a}	15.83^{a}	15.80^{a}	15.81^{a}	15.81^{a}	15.79^{a}	15.79^{a}
LSD	0.02					0.31			
Caffeine (ppm)	20.34^{a}	15.52^{b}	17.93^{a}	16.72^{b}	13.28^{c}	11.99^{d}	10.50^{e}	8.90^{f}	8.63^{f}
LSD	0.14					0.27			

Means with different letter in the same row are significantly different ($p \leq 0.05$). LSD: least significant difference

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to the packaging (bottle weight reduction, cap change, new bottle shape, etc.).

Total soluble solids and caffeine of cola soft drinks decreased ($p \leq 0.05$) by increasing the storage period. Reducing sugars and titratable acidity of cola soft drinks had an opposite trend. However, the phosphoric acid of cola soft drinks was not affected ($p \geq 0.05$) during the storage period. Regarding the global cola brand, the hydrolysis of sucrose during the storage period resulted in a decrease in TSS and increased reducing sugar. A similar reduction in TSS of cola soft drinks was reported by Idris et al. (2016) during 10 months of storage. Bubnik et al. (1995) revealed that the increase in the storage period caused an increase in the inversion of sucrose in fresh and stored soft drinks. Birkhed (1984) reported that the TSS of cola soft drinks ranged from 9.8 to 9.3% during the storage period. Sharma (2018) found that the concentration of reducing sugar was found in all the sets of Pepsi-cola containing 0.023%. Results of TSS and reducing sugars of local cola brand didn't show inversion. This could be explained by the fact that the local cola soft drink brand contains sweeteners without using sucrose in the manufacturing. Also, this is due to variations in recipes and formulations. Local cola soft drink TSS was 6.00% hence, it could be categorized as a calorie-reduced soft drink that contains less than 50% of the total sugars in the corresponding regular beverages (4.41–5.91%), mainly as fructose. The titratable acidity of cola soft drinks increased from 12.75 to 14.64% after 6 months of storage. The increase in titratable acidity could be explained by the formation of weak acids in cola soft drinks. Also, variation in titratable acidity during the storage period could be explained by hydrolysis, oxidation, and fermentation processes (Nilugin and Mahendran, 2010).

Phosphoric acid levels were found in global and local cola soft drink brands at concentrations of 15.84 ppm and 15.79 ppm, respectively. These values represented about 8% of the values (175–200 ppm) reported by Grenby et al. (1989). Caffeine contents of global and local cola soft drink brands were 20.34 and 15.52 ppm, respectively. These values are less than those reported by Walker et al. (1997), who recorded that caffeinated cola contains 33.0 ppm caffeine. Amos-Tautua and Diepreye (2013) revealed that caffeine content in soft drinks varies from 10 : 50 mg per serving, however, the US Food and Drug Administration (FDA 2006) limits the maximum amount in carbonated soft drinks to 6 $mg.oz^{-1}$. Therefore, the allowed caffeine content in soft drinks may be ranged between 30 : 72 $mg.355\ mL^{-1}$. The caffeine of cola soft drinks decreased from 17.93 to 8.63 ppm after 6 months of storage. Thus, the present results of phosphoric acid and caffeine concentrations follow USA soft drinks standards that can be used for formulating health policy.

The decreasing caffeine content during the storage period could be explained by using caffeine as a source of antioxidants, and antimicrobials against a broad range of foodborne pathogens, microorganisms and could be used as alternative preservative, with the potential of enhancing the safety and quality of drinks. Also, caffeine could be affected by O_2 permeability during the PET-packages storage period (Helal, 2020).

Microbial analysis

Bacterial counts of global and local cola soft drink brands during the storage period at room temperature for 6 months are shown in Table 5. The microbial contaminations in carbonated soft drinks are prevented by the combined influences of high sugar levels, acidity, carbonation, and good facilities and sanitation procedures (Ayres et al., 1980). The global cola soft drink had a much lower total bacterial count (2.3 $CFU.100\ ml^{-1}$) than a local cola soft drink brand (123 $CFU.100\ ml^{-1}$). The total bacterial count of global cola soft drinks was comparable with the value (less than 50 $CFU.100\ ml^{-1}$) reported by the Saint Lucia Bureau of Standards (2004) for carbonated beverages. However, the total bacterial count of local cola soft drinks was much higher than global cola brands where bacterial growth can tolerate lower pH due to poor quality control and bad manufacturing practices and non-conformities during processing. Oranusi et al. (1994) reported that the total bacterial count of the cola soft drink brand was 26 $CFU.100\ ml^{-1}$. The total bacterial counts of global and local cola soft drinks increased after one month of storage period. The total bacterial counts of global and local cola soft drinks decreased after two and three months of the storage period, respectively. However, the total bacterial count was absent after three and four months for global and local cola soft drinks, respectively. This effect is due to the effectiveness of the acidic pH of cola soft drinks on microorganism colonies. The global and local cola soft drink brands during the storage period at room temperature for 6 months were completely free from aciduric bacteria, coliform bacteria, and *E. coli*. The coliform bacteria count should be less than 1.0 $CFU.100\ ml^{-1}$ and *E. coli* count must be absent (ISO, 2004). Yeast and mould of global and local cola soft drinks during the storage period at room temperature for 6 months are shown in Table 5. Yeast and mould were not detected in global and local cola soft drinks

Table 5 Bacterial, yeast and mould counts (CFU.100 ml^{-1}) of cola soft drink brands during storage at room temperature for 6 months

Storage periods	Control		1		2		3		4		5		6	
Brand	**Pepsi**	**Sina**	**Pepsi**	**Sina**	**Pepsi**	**Sina**	**Pepsi**	**Sina**	**Pepsi**	**Sina**	**Pepsi**	**Sina**	**Pepsi**	**Sina**
Total count	2.3	123	3	158	1	110	0.0	205	1.6	TNTC	0.0	0.0	0.0	0.0
Yeast	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mould	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Acid. Bacteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coliform	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E. coli	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blank	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TNTC: too numerous to count

Table 6 Sensory properties of cola soft drink brands during storage at room temperature for 6 months

Sensory characteristics	Brands	Storage period						
		0	1	2	3	4	5	6
Taste	global	8.52 ±1.24	7.7 ±2.13	7.2 ±1.89	5.6 ±1.11	4.8 ±1.99	4.00 ±2.15	3.50 ±2.10
	local	7.10 ±0.05	6.75 ±1.29	6.50 ±2.15	5.25 ±1.18	4.80 ±2.22	3.90 ±1.95	3.20 ±0.94
Odour	global	8.7 ±0.33	7.7 ±0.48	7.6 ±0.92	7.00 ±0.94	6.20 ±1.39	5.90 ±0.87	5.30 ±1.05
	local	7.10 ±0.84	6.80 ±0.84	6.10 ±1.28	5.30 ±1.11	5.10 ±1.51	4.60 ±0.98	3.80 ±1.22
Appearance	global	8.87 ±0.31	8.7 ±0.52	8.9 ±0.31	8.2 ±0.47	8.10 ±0.81	7.50 ±0.46	7.00 ±0.24
	local	7.89 ±0.99	7.80 ±1.14	7.20 ±0.97	7.30 ±1.25	7.20 ±1.03	7.00 ±0.60	5.90 ±3.30
Overall acceptability	global	8.69 ±0.62	8.03 ±1.04	7.90 ±1.03	6.93 ±0.84	6.36 ±1.39	5.80 ±1.16	5.26 ±1.13
	local	7.33 ±0.64	7.11 ±0.90	6.60 ±1.46	5.95 ±1.18	5.70 ±1.58	5.16 ±1.17	4.30 ±1.82

Values are expressed as the mean of triplicate measurements

Table 7 Statistical analysis of sensory properties of cola soft drink brands during storage at room temperature for 6 months

Sensory properties	Brands		Storage period (months)						
	global	local	0.0	1	2	3	4	5	6
Taste	8.52^{a}	7.10^{b}	7.80^{a}	7.20^{ab}	6.85^{b}	5.40^{c}	4.80^{cd}	3.95^{de}	3.35^{e}
LSD	0.40					0.87			
Odour	8.70^{a}	7.10^{b}	7.90^{a}	7.25^{ab}	6.85^{bc}	6.15^{cd}	5.65^{d}	5.25^{de}	4.55^{e}
LSD	0.51					0.95			
Appearance	8.87^{a}	7.89^{b}	8.40^{a}	8.25^{a}	8.05^{ab}	7.75^{ab}	7.65^{ab}	7.25^{bc}	6.45^{c}
LSD	0.62					0.86			
Overall acceptability	8.69^{a}	7.33^{b}	8.01^{a}	7.55^{a}	7.35^{a}	6.45^{b}	6.05^{bc}	5.50^{cd}	4.75^{d}
LSD	0.43					0.86			

Means with different letter in the same row are significantly different ($p \leq 0.05$). LSD: least significant difference

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during the storage period at room temperature for 6 months. Cola soft drinks had a low pH value and a high carbonation and low levels of nutrients, these conditions are sufficient to inhibit the low levels of organisms (Ashurst and Hargitt, 2009).

Sensory properties

Sensory properties of global and local cola soft drinks during the storage period at room temperature for 6 months are shown in Table 6 and 7. The sensory properties of cola soft drinks were affected ($p \leq 0.05$) by the type of cola brand and storage period. The global cola soft drink had higher ($p \leq 0.05$) sensory properties than the local cola soft drink. Jayeola (2001) reported that no significant differences were observed between global and local cola soft drinks in sensory properties. In general, the sensory properties were not affected ($p \leq 0.05$) up to the second month of the storage period followed by a gradual decreased ($p \leq 0.05$) up to the sixth month of storage. Although the sensory properties of cola soft drinks gradually decreased from the second month to the end of the storage period, and still acceptable. These results agreed with those reported by Abeker (2009), who reported that carbonated soft drinks' sensory characteristics start to decline by increasing the storage period.

Conclusion

Global cola soft drink brands had higher percentage contents of carbon dioxide, pH, density, and total soluble solids, reducing sugars, titratable acidity, phosphoric acid, and caffeine values than local cola soft drink brands after production. Also, global cola soft drinks revealed a low total bacterial count compared with local cola soft drinks after production. Although, both cola brands are free from aciduric bacteria, coliform, and *E. coli* as well as yeast and moulds. Global cola soft drink brands had a higher percentage of taste, odour, appearance, and overall acceptability than local cola soft drink brands by 20%, 22.53%, 12.42%, and 18.55%, respectively after production. Gradual ($p \leq 0.05$) decline in the all-sensory scores can be seen for the 6-month storage period. Both cola brands were acceptable in terms of taste, odour, appearance, and overall acceptability up to 3rd, 5th, 6th, and 5th, respectively. The variation present in major constituents, microbial load, and sensory properties among tested commercial cola carbonated soft drink brands gives it the characteristics that determine its selection by the customers. Hence, the global cola soft drink brand samples were in the complaint with the standard limit present by USA soft drinks standards.

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