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Sour Cream Analogue Supplemented with Red Grape Pomace and Tomato Pomace Extracts: Chemical Composition, Oxidative Stability, and Organoleptic Characteristics

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ABSTRACT

This study was performed to assess the impact of supplementation of red grape pomace and tomato pomace extracts (200, 400, and 600 ppm) on the chemical composition, sensory properties, and oxidative stability of sour cream substitutes kept at 5-8 °C for 4 weeks. Red grape pomace and tomato pomace extracts showed high total phenolic contents (990.60 and 470.20 mg/100g), total flavonoids contains (120.60 and 76.20 mg/100g) and radical scavenging activity (92.40 and 85.30 %), respectively. The supplementation of sour cream with extracts at different concentrations did not appreciably change the levels of fat and total solids, but increased total volatile fatty acids, and slightly decreased the acidity. Treatments with 400 and 600 ppm of grape pomace extract had decreased peroxide, acid, and TBA levels and higher oxidative stability index (Rancimat) at the time of storage at 5°C than other treatments. The study demonstrated that grape pomace and tomato pomace extracts at concentrations of 400 or 600 ppm could be used as natural antioxidants for sour cream analogue. Further studies are recommended to investigate the application of these extracts in other dairy products.

***Keywords*: sour cream, by-products, red grape, tomato pomace, sensory properties, antioxidants.**

INTRODUCTION

Reducing the content of saturated fats in food products by increasing their content of mono and polyunsaturated fatty acids has gained a particular interest recently. Since a result, significant efforts have been complete to incorporate vegetable oils into food designs since their unsaturated fat content may provide dietary and health benefits (Burlingame *et al*. 2009; Sharma *et al*. 2023). Due to their great sensitivity to oxidation and rancidity progression, it has been discovered that raising the rank of unsaturated fatty acids in diet items is difficult (During *et al* , 2000; Islam *et al*, 2023). More unsaturated fats produced a stable and clear mixture that remained stable throughout storage (Naghshineh *et al*., 2010; Roiaini *et al*., 2015; Sharma *et al*., 2023); whereas mixing various vegetable oils results in a new blend with enhanced functional properties. The mixing of vegetable oils changes their physical properties, for instance sensory quality, triacylglycerols profile, solid fat content, density, viscosity, smoke point , and cloud point (Serjouie *et al*, 2010: Cichocki *et al*, 2023). Fresh fermented dairy products like cream and fermented milks are the most common meal delivery method for these combinations (Caleja *et al*., 2016). Sour cream is considered as a fermented dairy product, in which the lactic acid-producing starter cultures are utilized for the souring or acidification of pasteurized cream (US FDA 2011).

Synthetic antioxidants including butylated hydroxyanisole (BHA), , butylated hydroxytoluene BHT) , and tert-butylhydroquinone (TBHQ) have been employed to combat the oxidative stability of oils and fats. Nevertheless, numerous studies have exposed that these compounds are associated with various health risks (Taghvaei and Jafari, 2015). As a result, there is a growing interest among food industry specialists to change these synthetic antioxidants by using safer natural sources (Lourenço *et al* , 2019). Natural antioxidants, such as phenolics and flavonoids, are existed in several plant materials, for instance fruits, seeds, oils and leaves, (Xu *et al*, 2017).

With an estimated 78 million tonnes of grapes processed annually worldwide, the wine industry generates one of the largest sources of agro-waste in the form of pomaces , stems, leaves, and lees (OIV, 2019). Grape pomaces are one of the finest sources of polyphenolics (flavonoids, tannins, and derivatives of benzoic acids) among grape wastes. These biomolecules are useful in both technology and nutraceuticals because they act as antioxidants in biological matrices by inhibiting lipid peroxide radicals and reactive oxygen species (Xu *et al*., 2011; Arboleda Mejia *et al*., 2020). The pomaces also contain bioactive substances that may improve the nutritional value of food components and bioactive complements generated from oenological waste, such as proteins, minerals, essential oils, sugars, dietary fibres, and pectins (De Campos *et al*., 2008; Beres *et al*., 2017). Grape seed and pomace extracts have been shown in several studies to have anti-inflammatory, anti-cancer, and anti-degenerative properties (Teixeira *et al*., 2014; Mohansrinivasan *et al*., 2015; Zhu *et al*., 2015).

The tomato is one of the most important vegetable crops raised globally. Tomato pomace is an unused product that is created after tomato processing. Unsaturated and saturated fatty acids, benzyl alcohol, carotenoids, and other non-phenolic chemicals with excellent redox characteristics are abundant in tomato pomaces (Pinela *et al*., 2016 Allison *et al*., 2017, Lu *et al*., 2019, Sarno &Iuliano, 2019). Skin, pulp, and seeds make up tomato pomace, a vegetable crop produced during the

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processing of tomatoes. Previous research has shown that tomato pomace has the potential to be used as a favorable source of environmentally approachable organic compounds and antioxidants (Pinela *et al*., 2016), nutrient-rich antioxidant ingredients (Sarno &Iuliano, 2019), and an inhibitor of tin corrosion (Grassino *et al*., 2016), all of which could be used as functional compounds in a variety of chemical technologies (Vorobyova *et al.,* 2022).Therefore, the current study designed to estimate the impact of grape pomace and tomato pomaces extract on the chemical , oxidative stability, and organoleptic characteristics of sour cream analogues manufactured by using a blend of corn oil and palm oil .

MATERIALS AND METHODS

Materials

From Arma Co. in Egypt's 10th of Ramadan city, we obtained maize and palm oils. MERO Co. (Egypt) supplied the skim milk powder (SMP). The Mefad Company in Egypt provided the mono-di-glyceride fatty acids (E471). The microbiological resources center (MIRCEN, Faculty of Agriculture, Aim Shams University, Egypt) provided the *Lactococcus lactis subsp. lactis biovar diacetilactis* . Red grape (Romy) and tomato (*Lycopersicum esculentum*) were purchased from a local market (Zagazig, Egypt). BHA, 3,4,5-trihydroxybenzoic acid (gallic acid), 1,1-diphenyl-2-picrylhydrazyl (DPPH●), and quercetin were acquired from Sigma Aldrich (St. Louis, MO, USA). Other reagents and chemicals used in the current study were of high purity and of analytical grade.

Preparation of red grape pomace (GPE) and tomato pomace extract (TPE)

Red grape pomace and tomato pomace were separated from the fruits after extraction the juice, washed, dried at 50 °C in an oven before being ground to a powder, and then saved at 4 °C .The powders were combined in closed vessels with Ethyl alcohol (70%) at a rate of 1:10 (w/v), stirred at room temperature for 4 hours, and then filtered through Whatman No. 1 filter paper. Re-extraction of the leftovers took place in comparable conditions. In order to prevent light degradation during extraction, all containers were covered with aluminium foil (Yu et al. 2005). The resultant extracts were under vacuum evaporated at 40 °C using a rotary evaporator , and then freeze-dried .Finally, the freeze-dried extracts were saved at −20 °C.

Total phenolic content (TPC) determination

According to Kaur and Kapoor (2002), the TPC of the extracts was assessed using the Folin-Ciocalteu assay with gallic acid as the reference. The calibration curve for gallic acid was used to convert the total phenol concentration to gallic acid equivalents (mg GAE/100g dry weight basis).

Determination of total flavonoid content (TFC)

The TFC of the extracts was calculated in accordance with Chang *et al*.,(2002) Using the calibration curve, the TFC was determined and represented as mg of quercetin equivalent (mg QE/100g dry weight basis). The calibration curve's quercetin linearity range was 10–1000 mg/ml.

Radical scavenging activity (RSA %)

According to Brand Williams et al. (1995), the DPPH test was used to measure the antioxidant activity. This is how the scavenging activity percentage (AOA%) was calculated:

$$\text{DPPH}^{\bullet}\ \text{scavenging activity (\%)} = [(A_0 - A_1)/A_0] \times 100$$

where, **A_0 is the control reaction absorbance, and A_1 refers to the extract absorbance.**

Preparation of sour cream analogues (SCA) supplemented with red grape pomace and tomato pomace extract

Sour cream analogues (7.5% solids not-fat, 25% fat and 2% Lacta) were manufactured by blending of corn oil and palm oil (1:1, v/v) . The non-fat milk solids were sourced from skim milk powder. After reconstituting the necessary quantity of SMP in water at 40 °C, the oil mixture was included, and a mixer set to its highest speed (15000 rpm) was used to combine it. The resulting cream was heated at 65 °C for 30 minutes before being cooled to 30 °C. The cream was then homogenised using a twin stage homogenizer at pressures of 150 and 80 kg/cm2, respectively. The cream was then split into 8 equal amounts after it had cooled. The first serving served as a control (C1) and was not altered in any way. The second half received a 200 ppm addition of BHA, a synthetic antioxidant (Bu-200). Then, 200, 400, and 600 ppm of TPE (To-200, 400, and 600, respectively) and 200, 400, and 600 ppm of GPE (Gr-200, 400, and 600, respectively) were added to each of the remaining 6 sections. The final cream mimics of all sections were packaged in a 250 g plastic container and kept at 5 to 8 °C for four weeks after being inoculated with 2% of the starter culture and incubated at 30 °C for 18 hours to attain a pH value of 4.5 to 4.6. A fresh cream sample made from buffalo milk that was standardised to contain 25% fat was also generated, utilised as a comparison, heated at 65 °C for 30 minutes, cooled to 30 °C, and inoculated with 2% of the starter cultures found in analogues of sour cream (C). When they were still fresh and once every week for 4 weeks of storage in the refrigerator at 5 to 8 °C, samples were acquired for oxidative stability, chemical composition and organoleptic analysis.

as stated by Titratable acidity, total solids and fat contents were measured according to AOAC (2007). The total volatile fatty acids (TVFAs) content was determined as stated by the method described by Kosikowski (1978).

Determinations of peroxide, acid and TBA values and, Rancimat

According to AOAC (2007), the acid value (AV) and peroxide value (PV) of sour cream analogues augmented with TPE and GPE were calculated. The method described by Keeney and Smith (1971) was used to determine thiobarbituric acid (TBA). Using the 743 Rancimat instrument (Metrohm, Herisau, Switzerland), the resistance to the auto-oxidation process was evaluated at 120 °C with an airflow rate of 20 L/hr. According to AOAC (2007), the induction period (hours) was used to express the oxidative stability of sour cream analogue treatments.

Organoleptic properties of sour cream analogues (SCA)

The sensory evaluation of SCA treatments was accomplished by 10 panel members of the staff from the Department of Food Science, Faculty of Agriculture, Zagazig University for flavor (60), body and texture (30) and appearance (10) as reported by Bodyfelt *et al*, (1988).

Statistical analysis

The obtained data were exposed to the analysis of variance test by (SAS, 1990) software. The analyses were carried out in triplicate. The outcomes were stated as mean ± SD, and the variances were reflected to be statistically significant for *P* values of less than 0.05.

RESULTS AND DISCUSSION

Characterization of grape and tomato pomace extracts (TPC, TFC and RSA)

Table 1 show that the TPC of GPE and TPE are 2278.0 and 284.0 mg/100g on the dry weight (DW), respectively. GPE contained higher TPC than TPE. The results in Table 1 also show that GPE contains higher TFC than TPE (58.60 and 6.20 mg/100 g DW, respectively). The RSA (%) of the GPE and TPE were 92.24 and 87.32 %, respectively. The variations in the contents of the bioactive compounds detected in this study and those reported in other literature may be attributed to several factors, such as fruit species and the methods of extraction. The results of GPE are in agreement with the results reported by Xu *et al*, (2016). The results of TPE are in consistent with the findings of Vorobyova *et al*, (2022).

Table 1. Total phenolic, flavonoid compounds, and radical scavenging activity of Tomato and grape pomace extracts.

Seed extracts	Tomato pomace extract	Grape pomace extract
Total phenolics (mg gallic equivalent / 100 g DW)	284±0.36	2278±0.25
Total flavonoids (mg catechin equivalent / 100 g DW)	6.20±0.87	58.60±0.45
DPPH Inhibition (100 μL/mL) 100 ppm	87.32±0.51	92.24±0.14

DW, dry weight

Chemical composition of SCA

Tables 2 and 3 demonstrates that the addition of GPE and TPE to SCA had no discernible impact on the final sour cream's fat or total solids (TS) composition. With the passage of time throughout the storage period, the TS content of all treatments marginally raised (Atwaa and El-Araby, 2020). The control sour cream (C) had the maximum amount of acidity in the SCA.

Table 2. Chemical composition (Total solids and fat) of sour cream analogues supplemented with tomato or grape pomaces extract during storage at 5−8 °C for 4 weeks.^{a}

Treatments ^{b}	TS (%)					Fat (%)				
	Storage period (week)					Storage period (week)				
	Fresh	1	2	3	4	Fresh	1	2	3	4
C	32.50 ±0.11^{aB}	32.64 ±0.23^{aB}	32.94 ±0.51^{aB}	33.22 ±0.21^{aA}	33.50 ±0.72^{aA}	25.3 ±0.22^{aA}	25.1 ±0.04^{aA}	24.9 ±0.18^{aAB}	24.5 ±0.06^{aB}	24.5 ±0.30^{aB}
C1	32.40 ±0.05^{aB}	32.60 ±0.14^{aB}	32.92 ±0.30^{aA}	33.18 ±0.06^{bA}	33.54 ±0.04^{aA}	25.3 ±0.58^{aA}	25.1 ±0.31^{aA}	24.7 ±0.25^{aA}	24.4 ±0.43^{aAB}	24.1 ±.010^{aB}
Bu-200	32.50 ±0.34^{aB}	32.66 ±0.21^{aB}	32.96 ±0.60^{aA}	33.25 ±0.02^{aA}	33.52 ±0.50^{aA}	25.3 ±0.35^{aA}	24.9 ±0.50^{bA}	24.8 ±0.07^{aA}	24.5 ±0.15^{aAB}	24.2 ±0.43^{aB}
TO-200	32.44 ±0.16^{aB}	32.62 ±0.27^{aB}	32.98 ±0.02^{aB}	33.24 ±0.17^{bA}	33.55 ±0.02^{aA}	25.3 ±0.03^{aA}	24.8 ±0.02^{bA}	24.7 ±0.15^{aAB}	24.2 ±0.24^{aB}	24.1 ±0.05^{aB}
TO-400	32.50 ±0.31^{aB}	32.63 ±0.15^{aB}	32.98 ±0.51^{aA}	33.30 ±0.33^{aA}	33.56 ±0.34^{aA}	254 ±0.01^{aA}	24.9 ±0.32^{bA}	24.7 ±0.23^{aA}	24.4 ±0.08^{aB}	24.3 ±0.20^{aB}
TO-600	32.48 ±0.20^{aB}	32.66 ±0.46^{aB}	32.96 ±0.11^{aB}	33.14 ±0.26^{bA}	33.43 ±0.51^{aA}	25.3 ±0.61^{aA}	24.7 ±0.65^{bB}	24.6 ±0.54^{aB}	24.3 ±0.03^{aB}	24.1 ±0.49^{aB}
Gr-200	32.42 ±0.05^{aB}	32.64 ±0.02^{aB}	32.94 ±0.08^{aB}	33.16 ±0.07^{bA}	33.40 ±0.36^{aA}	25.4 ±0.07^{aA}	24.9 ±0.28^{bA}	24.8 ±0.18^{aA}	24.5 ±0.21^{aB}	24.2 ±0.19^{aB}
Gr-400	32.88 ±0.11^{aB}	32.64 ±0.22^{aB}	32.90 ±0.02^{aB}	33.10 ±0.20^{bA}	33.44 ±0.53^{aA}	25.3 ±0.30^{aA}	24.8 ±0.11^{bA}	24.6 ±0.43^{aAB}	24.2 ±0.03^{aB}	24.1 ±0.35^{bA}
Gr-600	32.50 ±0.32^{aB}	32.60 ±0.10^{aB}	32.90 ±0.25^{aA}	33.22 ±0.01^{aA}	33.48 ±0.21^{aA}	25.5 ±0.05^{aA}	24.9 ±0.34^{bA}	24.7 ±0.03^{aAB}	24.4 ±0.40^{aB}	24.2 ±0.03^{aB}

^{a} Means with the same lowercase letters in the same column are not significantly different, and means with the same uppercase letters in the same row are not significantly different.^{b} Treatments [C, control sour cream; C1, sour cream analogue without any additives; Bu-200, sour cream analogue treated with 200 ppm BHA (positive control); TO-200, sour cream analogue treated with 200 ppm tomato pomace extract; To-400, sour cream analogue treated with 400 ppm tomato pomace extract; To-600, sour cream analogue treated with 600 ppm tomato pomace extract; Gr-200, sour cream analogue treated with 200 ppm grape pomace extract; Gr-400, sour cream analogue treated with 400 ppm grape pomace extract; Gr-600, sour cream analogue treated with 600 ppm grape pomace extract].

Table 3. Acidity TVFAs of sour cream analogues supplemented with tomato or grape pomaces extract during storage at 5−8 °C for 4 weeks.^{a}

Treatments ^{b}	Acidity (%)					TVFA (mL 0.1N NaOH/100g)				
	Storage period (week)					Storage period (week)				
	Fresh	1	2	3	4	Fresh	1	2	3	4
C	0.74 ±0.41^{aB}	0.78 ±0.11^{aB}	0.84 ±0.22^{aB}	0.88 ±0.09^{aA}	0.92 ±0.53^{aA}	550 ±0.41^{aD}	95.4 ±0.03^{aC}	135.5 ±0.51^{aB}	169.7 ±0.22^{aA}	180.3 ±0.05^{aA}
C1	0.65 ±0.08^{bB}	0.72 ±0.18^{bB}	0.76 ±0.01^{bAB}	0.80 ±0.11^{bA}	0.84 ±0.08^{bA}	45.5 ±0.24^{cC}	60.6 ±0.22^{dBC}	72.2 ±0.30^{dB}	81.4 ±0.48^{cA}	89.2 ±0.33^{dA}
Bu-200	0.64 ±0.30^{bC}	0.67 ±0.20^{cBC}	0.72 ±0.63^{bB}	0.78 ±0.31^{bA}	0.82 ±0.21^{bA}	45.8 ±0.40^{cD}	65.9 ±0.09^{cC}	77.6 ±0.11^{dB}	93.8 ±0.46^{bcA}	997 ±0.28^{cdA}
TO-200	0.64 ±0.11^{bB}	0.66 ±0.12^{cB}	0.67 ±0.49^{cB}	0.70 ±0.04^{cdB}	0.76 ±0.39^{bcA}	50.0 ±0.03^{bD}	693 ±0.21^{cC}	83.4 ±0.50^{cB}	95.2 ±0.30^{bA}	103.4 ±0.08^{cdA}
TO-400	0.64 ±0.21^{bB}	0.65 ±0.20^{cB}	0.67 ±0.06^{cB}	0.72 ±0.37^{cA}	0.74 ±0.05^{cA}	50.2 ±0.46^{bD}	77.6 ±0.03^{bC}	89.8 ±0.03^{b}B	103.4 ±0.29^{bA}	115.6 ±0.16^{bcA}
TO-600	0.60 ±0.42^{cB}	0.62 ±0.39^{dB}	0.65 ±0.21^{cB}	0.69 ±0.20^{cdA}	0.72 ±0.22^{cA}	50.6 ±0.01^{bD}	80.7 ±0.50^{bC}	95.4 ±0.49^{bBC}	107.6 ±0.40^{bB}	127.3 ±0.71^{bA}
Gr-200	0.66 ±0.05^{bB}	0.69 ±0.04^{bcB}	0.70 ±0.28^{bcB}	0.72 ±0.33^{cAB}	0.78 ±0.19^{bcA}	49.2 ±0.03^{bD}	65.8 ±0.29^{cC}	77.6 ±0.22^{dB}	93.3 ±0.17^{bcA}	95.8 ±0.26^{cA}
Gr-400	0.65 ±0.21^{bB}	0.67 ±0.11^{cB}	0.72 ±0.02^{bA}	0.74 ±0.09^{cA}	0.76 ±0.04^{cA}	49.6 ±0.02^{bD}	73.4 ±0.30^{bcC}	85.2 ±0.50^{bB}	99.2 ±0.25^{bA}	107.4 ±0.30^{cA}
Gr-600	0.62 ±0.22^{bcB}	0.64 ±0.52^{cdB}	0.66 ±0.08^{cAB}	0.70 ±0.21^{cdA}	0.74 ±0.18^{cA}	49.9 ±0.11^{bD}	75.3 ±0.09^{bC}	91.6 ±0.27^{bBC}	101.5 ±0.30^{bB}	113.2 ±0.27^{cA}

^{a} Means with the same lowercase letters in the same column are not significantly different, and means with the same uppercase letters in the same row are not significantly different.^{b} For treatment abbreviations, see Table 2.

In comparison to the control sour cream counterpart, the addition of pomace extracts to SCA somewhat reduced the acidity during storage. The acidity in all treatments gradually rose over the course of storage owing to the activity of starter cultures and the formation of lactic acid. These outcomes concur with those that were reported by Fayed *et al*, (2006) : Atwaa and El-Araby , (2020).The average content of TVFAs in SCA as affected by GPE and TPE is presented in Table 2 and 3. It could be noted that the control sour cream had the greatest content of TVFAs. The supplementation of SCA with pomace extract was more effective in the development of these compounds in this product than the control SCA during storage period. TVFAs of all SCA treatments increasingly during the storage period. These results may be due to the lipolytic and proteolytic actions of sour cream starter cultures during the processing and storage of the manufactured cream (Mehanna *et al*, 2000).

Oxidative stability of sour cream analogues

Peroxide value (PV)

Table 4 showed that during the storage period at 5-8°C for 4 weeks, peroxide values increased in all treatments. When compared to the sample without the addition of extracts, the changes in peroxide levels occur in the SCA that contains GPE and TPE at a somewhat slower rate. When compared to TPE, this observation with GPE was more noteworthy. In contrast, the addition of extracts at greater concentrations (400 and 600 ppm) both in the case of GPE and TPE was more successful in slowing the progress of peroxide value. Additionally, the effectiveness of GPE and TPE's antioxidants was comparable to that of BHA. Similar results have already been published by Nadeem *et al* (2017). The results highlighted the effect of GPE and TPE as a natural antioxidant in retarding lipid oxidation in sour cream analogues.

Acid value (AV)

Table 4 evident that during the storage period, there are substantial differences ($p \leq 0.05$) between the SCA treatments. For all samples, including the control one, significant increases in acid value were seen up until the conclusion of the SCA storage period at 5-8°C. Referring to the strong effect of GPE and TPE in postponing SCA hydrolysis, GPE and TPE at rates of 400 and 600 ppm exhibited the lesser increase in AV of SCA compared with synthetic antioxidants. When compared to the control, GPE and TPE were both more effective. According to Plaza *et al.* (2023) and Vaeková *et al.* (2020), GPE and TPE were effective antioxidant agents. These results agreed with the findings of Asha *et al* (2015); Atwaa and El-Araby , (2020) .

Thiobarbituric (TBA) test

Data donated in Table (4) indicated that the addition of GPE and TPE to SCA delayed the oxidative changes throughout the storage at 5-8°C. The TBA values of the SCA treated with GPE and TPE were both lower than those of the untreated sample and were also on par with those of the samples treated with BHA. It was clear from these findings that control SCA samples displayed greater TBA values during the course of the storage period. Throughout the storage period, GPE sour cream analogue samples at various concentrations displayed lower TBA values than TPE. These findings concur with those described in earlier works (Taghvaei and Jafari 2015; Atwaa and El-Araby 2020).

Table 4. Oxidative stability of sour cream analogues supplemented with tomato or grape pomaces extract

Treatments[b]	Storage period (weeks)														
	Peroxide value (meq O2/kg)					Acid value (mg KOH/g)					TBA (O.D 532 nm)				
	Fresh	1	2	3	4	Fresh	1	2	3	4	Fresh	1	2	3	4
C	0.78 ±0.21bE	1.46 ±0.01bcD	2.20 ±0.43bC	2.60 ±0.50bB	3.16 ±0.51bA	0.07 ±0.04abC	0.24 ±0.58abB	0.26 ±0.22bB	0.28 ±0.13bB	0.36 ±0.02bA	0.10 ±0.19aC	0.14 ±0.07aBC	0.18 ±0.51bB	0.22 ±0.36bB	0.30 ±0.12bA
C1	0.90 ±0.02aD	2.56 ±0.22aC	3.36 ±0.08aB	3.88 ±0.39aAB	4.32 ±0.04aA	0.12 ±0.42aD	0.30 ±0.33aC	0.36 ±0.19aB	0.40 ±0.19aB	0.47 ±0.44aA	0.12 ±0.24aC	0.18 ±0.28aC	0.26 ±0.07aB	0.34 ±0.13aA	0.38 ±0.33aA
Bu -200	0.86 ±0.43aD	2.22 ±0.50aC	3.00 ±0.03abB	3.30 ±0.18aAB	4.02 ±0.57abA	0.10 ±0.67aC	0.26 ±0.09aB	0.30 ±0.53bAB	0.36 ±0.22abA	0.40 ±0.11bA	0.08 ±0.59aC	0.12 ±0.16aB	0.14 ±0.11bB	0.18 ±0.09cB	0.26 ±0.72bA
To -200	0.82 ±0.40bD	2.66 ±0.51aC	3.38 ±0.21aB	3.56 ±0.25cB	4.40 ±0.11aA	0.12 ±0.08aD	0.30 ±0.22aC	0.38 ±0.47aB	0.42 ±0.27aA	0.47 ±0.41aA	0.12 ±0.35aC	0.16 ±0.07aC	0.20 ±0.38bC	0.2 6±0.77bB	0.34 ±0.48aA
To -400	0.84 ±0.47abE	2.02 ±0.05bD	2.46 ±0.46bC	2.68 ±0.15bB	3.16 ±0.07abA	0.11 ±0.57aC	0.27 ±0.07aB	0.32 ±0.19aA	0.36 ±0.06aA	0.38 ±0.09bA	0.11 ±0.66aC	0.14 ±0.80aBC	0.18 ±0.17aB	0.22 ±0.05bB	0.30 ±0.20bA
To -600	0.80 ±0.02bC	1.76 ±0.39bB	2.00 ±0.05cAB	2.22 ±0.16bcA	2.60 ±0.01bA	0.10 ±0.03aD	0.20 ±0.53bC	0.30 ±0.24bB	0.34 ±0.50aA	0.36 ±0.48bA	0.09 ±0.03aB	0. 12 ±0.16aB	0.16 ±0.51bAB	0.18 ±0.10cA	0.24 ±0.15bA
Gr -200	0.84 ±0.47abD	2.46 ±0.03aC	3.16 ±0.37aB	3.60 ±0.46aB	4.18 ±0.71aA	0.12 ±0.02aD	0.28 ±0.16aC	0.34 ±0.28aB	0.38 ±0.47aB	0.44 ±0.39aA	0.10 ±0.68aB	0.14 ±0.49aB	0.17 ±0.52bB	0.22 ±0.26bAB	0.29 ±0.06bA
Gr -400	0.82 ±0.11bC	1.84 ±0.24bB	2.14 ±0.41bAB	2.38 ±0.57bA	2.50 ±0.54cA	0.10 ±0.26aC	0.24 ±0.39abB	0.26 ±0.04bAB	0.32 ±0.12abA	0.36 ±0.56bA	0.07 ±0.71aC	0.11 ±0.27bB	0.14 ±0.60bB	0.17 ±0.05cB	0.26 ±0.31bA
Gr -600	0.78 ±0.23bC	1.38 ±0.28cB	1.78 ±0.04cAB	2.02 ±0.09cA	2.20 ±0.44cA	0.09 ±0.61abC	0.18 ±0.39bB	0.22 ±0.01cB	0.26 ±0.39bAB	0.32 ±0.30bA	0.07 ±0.09aC	0.09 ±0.14bB	0.11 ±0.22cB	0.14 ±0.20cB	0.22 ±0.70bcA

[a] Means with the same lowercase letters in the same column are not significantly different, and means with the same uppercase letters in the same row are not significantly different.[b] For treatment abbreviations, see Table 2.

Rancimat test

The induction period (hrs) shown in Figure 1 is utilised as a measure of the antioxidant capacity of the antioxidants administered. In comparison to the SCA control sample (C1), GPE and TPE were found to be more effective at stabilising SCA against oxidative degradation. The pomaces extract-enriched SCA induction period was discovered to be considerably ($P \leq 0.05$) longer than that of the control sample. According to Nahak & Sahu (2010), phenolic compounds are one of the main antioxidant components of plant materials, and there is a strong correlation between their concentrations and their overall antioxidant capabilities.

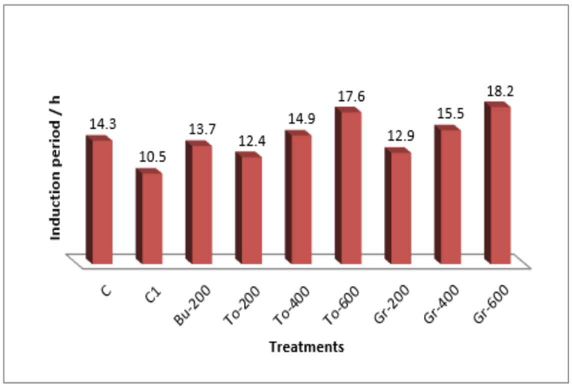

Figure 1. Oxidative stability index (Rancimat) of sour cream analogue

The anti-oxidative properties of SCA enhanced with BHA and GPE and TPE were found to be considerably ($P \leq 0.05$) higher than those of control SCA. The outcomes are consistent with those that were previously reported by El-Shourbagy and El-Zahar (2014); Atwaa and El-Araby , (2020).

Organoleptic properties

Table 5 shows the organoleptic properties of SCA supplemented with GPE and TPE as natural antioxidants. The achieved results noticeably revealed that the control sour cream (C) recorded the greatest organoleptic properties as competed to the other SCA treatments. The supplementation of SCA with pomace extracts slightly increased the scores of appearance, body characteristics and flavor as related to control SCA (C1) and with 200 ppm of BHA (Bu-200). The organoleptic properties of SCA treatments decreased with the progress in storage period up to the end of storage at refrigerator temperature. The outcomes are consistent with those that were previously reported by Atwaa and El-Araby , (2020).

Table 5. Sensory evaluation of sour cream analogues supplemented with tomato or grape pomaces extract.[a]

Treatments[b]	Appearance (10)					Body & texture (30)					Flavor (60)					Total (100)				
	Storage period (week)					Storage period (week)					Storage period (week)					Storage period (week)				
	Fresh	1	2	3	4	Fresh	1	2	3	4	Fresh	1	2	3	4	Fresh	1	2	3	4
C	9 ± 0.39^{aA}	9 ± 0.44^{aA}	9 ± 0.23^{aA}	9 ± 0.04^{aA}	8 ± 0.16^{aB}	29 ± 0.12^{aA}	28 ± 0.26^{aB}	27 ± 0.12^{aC}	26 ± 0.22^{bD}	26 ± 0.01^{aD}	59 ± 0.62^{aA}	58 ± 0.17^{aB}	58 ± 0.39^{aB}	57 ± 0.11^{aC}	55 ± 0.02^{aD}	97 ± 0.12^{aA}	95 ± 0.11^{aB}	94 ± 0.02^{aC}	92 ± 0.13^{aD}	89 ± 0.22^{aE}
C1	8 ± 0.27^{bA}	8 ± 0.13^{bA}	8 ± 0.09^{bA}	8 ± 0.39^{bA}	7 ± 0.28^{bB}	27 ± 0.49^{cA}	27± 0.37bA	26 ± 0.09^{bB}	25 ± 0.39^{cC}	25 ± 0.39^{bC}	56 ± 0.06^{cA}	55 ± 0.12^{cB}	54 ± 0.26^{cC}	52 ± 0.28^{cD}	50 ± 0.41^{cE}	91 ± 0.02^{bA}	90 ± 0.02^{bB}	88 ± 0.21^{bC}	85 ± 0.48^{bD}	82 ± 0.29^{cE}
B -200	8 ± 0.40^{abA}	8 ± 0.40^{bA}	8 ± 0.17^{bA}	8 ± 0.11^{bA}	7 ± 0.47^{bB}	26 ± 0.33^{dA}	26 ± 0.40^{cA}	25 ± 0.28^{cB}	25 ± 0.11^{cB}	24 ± 0.41^{cC}	56 ± 0.22^{cA}	55 ± 0.61^{cB}	55 ± 0.40^{bB}	53 ± 0.02^{bC}	51 ± 0.20^{cD}	90 ± 0.22^{bA}	89 ± 0.30^{bB}	88 ± 0.09^{bC}	86 ± 0.23^{bD}	82 ± 0.01^{cE}
To -200	8 ± 0.30^{abA}	8 ± 0.64^{bA}	8 ± 0.29^{bA}	8 ± 0.59^{bA}	7 ± 0.20^{bB}	29 ± 0.65^{aA}	28 ± 0.63^{aB}	27 ± 0.17^{aC}	27 ± 0.44^{aC}	26 ± 0.18^{aD}	55 ± 0.50^{dA}	55 ± 0.32^{cA}	54 ± 0.05^{cB}	53 ± 0.04^{bC}	52 ± 0.44^{bD}	90 ± 0.01^{bA}	89 ± 0.43^{bB}	87 ± 0.02^{bC}	86 ± 0.36^{bD}	83 ± 0.10^{bcE}
To -400	8 ± 0.22^{bA}	8 ± 0.20^{bA}	8 ± 0.61^{abA}	7 ± 0.04^{cB}	7 ± 0.03^{bB}	27 ± 0.01^{cA}	26 ± 0.38^{cB}	25 ± 0.41^{cC}	25 ± 0.21^{cC}	24 ± 0.38^{cD}	55 ± 0.29^{dA}	54 ± 0.03^{dB}	54 ± 0.39^{cB}	52 ± 0.11^{cC}	52 ± 0.01^{bC}	90 ± 0.64^{bA}	88 ± 0.05^{bB}	87 ± 0.18^{bC}	84 ± 0.01^{bD}	83 ± 0.02^{bcE}
To -600	7 ± 0.18^{cA}	7 ± 0.01^{cA}	7 ± 0.08^{cA}	6 ± 0.18^{dB}	6 ± 0.41^{cB}	27 ± 0.21^{cA}	27 ± 0.09^{bA}	26 ± 0.05^{bB}	26 ± 0.32^{bB}	25 ± 0.15^{bC}	56 ± 0.59^{cA}	55 ± 0.62^{cB}	55 ± 0.11^{bB}	54 ± 0.08^{bC}	53 ± 0.06^{bD}	90 ± 0.02^{bA}	89 ± 0.20^{bB}	88 ± 0.03^{bC}	86 ± 0.12^{bD}	84 ± 0.01^{bE}
Gr -200	8 ± 0.22^{bA}	8 ± 0.21^{bA}	8 ± 0.05^{bA}	7 ± 0.48^{cB}	7 ± 0.04^{bB}	27 ± 0.06^{cA}	27 ± 0.10^{bA}	26 ± 0.01^{bB}	25 ± 0.05^{cC}	25 ± 0.38^{bC}	55 ± 0.12^{d}	54 ± 0.03^{d}	52 ± 0.01^{d}	52 ± 0.03^{c}	50 ± 0.02^{c}	90 ± 0.21^{bA}	89 ± 0.21^{bB}	86 ± 0.21^{bC}	84 ± 0.29^{bD}	82 ± 0.03^{cE}
Gr -400	8 ± 0.59^{abA}	8 ± 0.48^{bA}	7 ± 0.30^{cB}	7 ± 0.08^{cB}	7 ± 0.09^{bB}	28 ± 0.40^{bA}	28 ± 0.07^{aA}	27 ± 0.27^{aB}	26 ± 0.50^{bC}	25 ± 0.02^{bD}	56 ± 0.04^{cA}	55 ± 0.20^{cB}	54 ± 0.24^{cC}	52 ± 0.20^{cD}	51 ± 0.03^{cE}	92 ± 0.32^{bA}	91 ± 0.38^{bB}	89 ± 0.23^{bC}	86 ± 0.31^{bD}	85 ± 0.29^{bE}
Gr -600	7 ± 0.16^{cA}	7 ± 0.50^{cA}	7 ± 0.09^{cA}	6 ± 0.11^{dB}	6 ± 0.22^{cB}	28 ± 0.18^{bA}	28 ± 0.22^{aA}	27 ± 0.06^{aB}	27 ± 0.37^{aB}	26 ± 0.57^{aC}	57 ± 0.40^{bA}	56 ± 0.01^{bB}	55± 0.02bC	54 ± 0.10^{bD}	53 ± 0.01^{bE}	92 ± 0.04^{bA}	91 ± 0.03^{bB}	89 ± 0.47^{bC}	87 ± 0.03^{bD}	85 ± 0.08^{bE}

[a] Means with the same lowercase letters in the same column are not significantly different, and means with the same uppercase letters in the same row are not significantly different.[b] For treatment abbreviations, see Table 2.

CONCLUSION

Sour cream analogues with an acceptable flavor and oxidative stability characteristics could be produced from a blend comprising 25% fat, 7.5% solids not-fat, and 2% mono-di-glyceride fatty acid E471 (lacta). The addition of tomato or grape pomace extracts at levels of 400 or 600 ppm to the sour cream analogue improved the oxidative stability of the obtained product. Further studies are recommended to investigate the implementation of these extracts in other dairy products and studying their nutritional characteristics.

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القشدة الحامضية المقلدة المدعمة بمستخلص تفل الطماطم وتفل العنب: التركيب الكيميائي ، الثبات التأكسدي ، والخصائص الحسية

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الملخص

أجريت هذه الدراسة لتقييم تأثير إضافة مستخلصات تفل الطماطم والعنب بمستويات (200، 400، 600 جزء في المليون) على التركيب الكيميائي، والخصائص الحسية، والثبات التأكسدي للقشدة الحامضية المقلدة المخزنة عند درجة حرارة 5-8 درجة مئوية لمدة 4 أسابيع .أظهرت مستخلصات تفل العنب وتفل الطماطم ارتفاعاً في المحتوى الكلي للفينولات (2278.0 و284.0 ملجم/100جم) ، ومحتوى الفلافونيدات الكلي (58.60 و6.20 ملجم/100جم) ونشاط الكسح الجذري (92.24 و87.32%) على التوالي .و إن إضافة المستخلصات الي القشدة الحامضية بتركيزات مختلفة لم يؤثر بشكل كبير على محتوى الدهن والمواد الصلبة الكلية، ولكنه أدى إلى زيادة إجمالي الأحماض الدهنية المتطايرة، وانخفاض طفيف في قيم الحموضة .أظهرت المعاملات التي تحتوي على مستخلص تفل العنب بمعدل 400 و 600 جزء في المليون قيم أقل لرقم البيروكسيد ورقم الحامض ووحمض الثيوباربيوتيرك وقيم اعلي لمعدل الثبات التأكسدي (الرنسيمات) خلال فترة التخزين عند 5 درجات مئوية مقارنة بالمعاملات الأخرى .وأظهرت الدراسة أن مستخلصات تفل العنب و تفل الطماطم بتركيزات 400 أو 600 جزء في المليون يمكن استخدامها كمضادات أكسدة طبيعية للقشدة الحامضية المقلدة .يوصى بإجراء مزيد من الدراسات للتحقيق في تطبيق هذه المستخلصات في منتجات الألبان الأخرى.