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Effect of Addition of Cumin and Cinnamon on Sensory Properties and Antioxidant Potential of Greek Yogurt

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Abstract
This study aimed to find out how adding cumin and cinnamon to Greek yogurt affects its ability to break down proteins and how long it stays fresh. Both spices were added in powdered form at a concentration of 0.5%, and the yogurt samples were tested for taste, acidity, pH level, and total phenolic content (TPC). Since spices are known for their antioxidant qualities, we also looked at the TPC and antioxidant activity of cumin and cinnamon using DPPH and ABTS tests. The sensory test showed that the Greek yogurt with 0.5% cumin was the most liked by people. The fresh yogurt with cumin had the highest TPC and the strongest antioxidant activity compared to the others.

Keywords: Greek yogurt, Sensory score, cumin, cinnamon, antioxidant

Introduction

Yogurt is one of the most popular fermented dairy products and has been enjoyed for a long time because of its nutritious and health benefits. It's usually made with starter cultures such as *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*. These bacteria work together to change milk into a product that has a specific nutritional makeup. Some types of yogurt might also include additional probiotic cultures like *Bifidobacterium bifidum*, *Lactobacillus acidophilus*, or other approved lactic acid-producing bacteria. If these extra cultures are used, they should be clearly mentioned on the label (Rul, 2017). Yogurt is a good source of several important nutrients, including high-quality protein, calcium, phosphorus, potassium, zinc, magnesium, and various B-complex vitamins like B_1, B_2, B_3, B_9, and B_{12} (Tamime & Robinson, 1999) [41].

Greek yogurt, also called strained or concentrated yogurt, is regular yogurt with some of the liquid and water-soluble parts removed. This makes it thicker, creamier, and more tangy than regular yogurt. It can be considered to be between traditional fermented milk and high moisture, unripened soft cheeses like quarg (Nsabimana *et al*., 2005) [29].

Spices have been used for a long time in food to preserve it, make it taste better, and give it health benefits. Many spices contain compounds that have medicinal properties, such as preventing blood clots, reducing plaque in arteries, lowering blood fat, fighting inflammation, and stopping certain chemicals in the body (Singh *et al*., 2017) [38].

Cumin is made from the dried seeds of the *Cuminum cyminum* plant, which is part of the *Umbelliferae* family. It has a strong aroma and contains compounds like cuminaldehyde, carvone, limonene, linalool, eugenol, and pinene. These natural chemicals help fight microbes and act as antioxidants. Cumin has also been traditionally used to help boost appetite and relieve digestion issues like indigestion, diarrhea, and gas (Amin, 2012) [5].

Cinnamon powder comes from finely grinding the dried inner bark of the *Cinnamomum zeylanicum* plant. The main active compound in cinnamon is cinnamaldehyde, which is mainly responsible for its known antibacterial and antifungal effects (Thomas & Kuruvilla, 2012) [44]. Cinnamon also includes several strong antioxidants, such as vanillic, caffeic, gallic, protocatechuic, p-hydroxybenzoic, p-coumaric, and ferulic acids, along with p-hydroxybenzaldehyde. In addition, its essential oils have antimicrobial, antifungal, antioxidant, and anti-diabetic properties (Kim *et al*., 2006) [25].

With more people looking for foods that use fewer synthetic preservatives, spices like cinnamon are becoming more popular as natural functional additives. In this context, this study added cinnamon to Greek yogurt to explore its potential as a natural way to improve the quality and functionality of the product.

Materials and Methods

The milk used to make Greek yogurt was toned, containing 3% fat and 8.5% solids-not-fat. The starter culture used was DVS YO-MIXÂ® 300 LYO 50 DCU, which contains *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*.

All the chemicals used for testing were obtained from Himedia Chemicals and Sigma-Aldrich in India.

Preparation of Greek yogurt

Toned milk was first heated to 90°C for 10 minutes, then cooled to 43°C, and inoculated with a DVS starter culture (50 units per 100 L), which contained *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*. The milk was then incubated at 43°C until it reached a titratable acidity of 0.6% lactic acid. The fermented curd was transferred into cloth bags and drained until the thick consistency of Greek yogurt was achieved. Once the desired texture was reached, salt (3.0% w/w) and spice powders (0.5% w/w) were thoroughly mixed into the Greek yogurt. The final product was filled into 500 g polypropylene (PP) tubs and stored under refrigeration at 7 ± 2°C. The Greek yogurt made without any spices was used as the control sample.

Determination of physico-chemical properties of Greek yogurt

Greek yogurt fortified with 0.5% cumin and cinnamon powders was tested for various physicochemical and functional properties. The analyses included titratable acidity, fat, protein, and ash, following methods from FSSAI (2022). pH was measured using standard procedures. Carbohydrate content was calculated by difference, and salt content was determined according to IS: 2785-1979 (1992). Total phenolic content (TPC) was measured using the Folin–Ciocalteu method described by Singleton and Rossi (1965) [39]. Antioxidant activity was evaluated through two methods: ABTS radical scavenging activity following the method of Re *et al*. (1999), and DPPH radical scavenging activity based on McCune and Johns (2002), with modifications according to Tachakittirungrod *et al*. (2007).

To determine total phenolic content (TPC), gallic acid (10–100 µg) was used as the reference standard, and results were expressed as mg gallic acid equivalents (GAE) per gram of Greek yogurt, based on the calibration equation $y=0.0072x+0.0151$ ($R^2=0.9967$).

For DPPH and ABTS antioxidant assays, Trolox served as the standard (10–80 µM for DPPH and 50–250 µM for ABTS), and antioxidant activity was reported as mM Trolox equivalent antioxidant capacity (TEAC) per gram of Greek yogurt.

Sensory evaluation of Samples

The sensory quality of the Greek yogurt samples was assessed by a trained panel using a 9-point hedonic scale under standard evaluation conditions. Each panelist evaluated the sensory attributes namely flavour, colour and appearance, body and texture, and overall acceptability, using a 9-point hedonic scale, where a score of 1 represented “dislike extremely” and a score of 9 represented “like extremely.” In addition to the numerical ratings, the judges also offered descriptive remarks to support and explain their overall assessment of the samples.

Microbiological analysis

Eleven grams of Greek yogurt was aseptically weighed and placed into 99 ml of phosphate buffer for a 10^{-1} dilution, followed by making further dilutions in 9 ml of phosphate buffer. For *Lactobacillus bulgaricus* and *Streptococcus thermophiles* count De Man, Rogosa and Sharpe agar (MRS) and M17 agar medium, respectively. The petri plates were then incubated upside down at 37°C for 72 hours (APHA, 2004). While for enumerating coliform (FSSAI, 2024) and yeast and mold counts (FSSAI, 2024) violet red bile lactose agar (VRBL) and Chloramphenicol yeast Glucose Agar (CGYEA), respectively was used.

Statistical Analysis

The data was examined using a completely randomized setup (CRD).

Results and Discussion

Sensory Characteristics of Greek yogurt Added with Different Spices

Flavor plays a major role in how good a food item is and how much people enjoy it. The flavor scores for Greek yogurt with added spice powders are listed in Table 1. Among the samples tested, the yogurt with cumin (T_1) had the highest flavor rating, constantly scoring above 8.0 and showing a significant difference ($p < 0.05$) compared with both the regular yogurt (T_0) and the cinnamon added sample (T_2). The yogurt with cinnamon (T_2) had the lowest scores, possibly due to the strong woody and spicy taste caused by cinnamic aldehyde, the main flavoring element in cinnamon.

The color and look of dairy products are also important in how they are judged. Table 1 shows that the type of spice used affected these scores significantly. The plain yogurt (T_0) and cumin yogurt (T_1) had similar scores ($p>0.05$), but both were quite different from the cinnamon yogurt (T_2).

Looking at the texture comparisons in Table 1, there was no big difference between the yogurt with cumin (T_1) and the plain yogurt (T_0). However, there was a clear contrast when these two samples were compared with the cinnamon yogurt (T_2). This suggests that cinnamon had a stronger impact on the texture of the yogurt than cumin.

The overall acceptance of the yogurts matched the flavor results. The yogurt with cumin (T_1) was most preferred, followed by the plain yogurt (T_0), with a significant difference between them ($p<0.05$). The cinnamon yogurt (T_2) had the least acceptance, which was much lower than the cumin yogurt (T_1), but not significantly different from the plain yogurt (T_0). These observations agree with earlier research that shows adding cinnamon to yogurt is less preferred than plain yogurt (Yadav and Shukla, 2014; Güneş Bayır and Bilgin, 2019).

Chemical composition of Greek yogurt

The chemical composition of Greek yogurt samples is listed in Table 2. Based on Codex standards (2003), concentrated fermented milk can have a minimum protein content of 5.6% and less than 15% fat. This means the Greek yogurt made in this study met the Codex guidelines. The results are similar to those reported by Jyoti (2015), who found that Greek yogurt made with standardized milk (4.5% fat and 8.5% SNF) had an average composition of 23.52% total solids, 7.09% protein, 6.72% fat, 8.50% lactose, and 0.79% ash with a titratable acidity of 0.56% lactic acid and a pH of 4.64. Uduwerella *et al*. (2017) reported Greek yogurt with 22.81% total solids, 8.61% fat, 9.98% protein, 2.44% lactose, 0.79% ash and a titratable acidity of 0.47% lactic acid. Aly et al. (2020) found that labneh made from whole milk had 70% moisture, 14.5% protein, 13.5% fat, 6.1% lactose, and 1.21% ash with a titratable acidity of 1.4% lactic acid.

Effect of spices on acidity and pH combine of Greek yogurt

The acidity of the Greek yogurt samples with different spice powders are shown in Table 3. The differences in acidity and pH between T_0, T_1, and T_2 were not significant ($p>0.05$), indicating that adding spices did not change the acidity and pH of the fresh Greek yogurt samples.

Aly *et al*. (2020) found that adding sesame seed powder to labneh at levels of 0, 2.0, 4.0, and 6.0% resulted in lactic acid levels of 1.4, 1.38, 1.30, and 1.28%, respectively. Ahari and Massoud (2020) observed similar trends in probiotic yogurt, where control samples and those with 1.0, 2.0, or 3.0% Cuminum cyminum essential oil had acidity levels of 0.82, 0.79, 0.79, and 0.78% lactic acid. Saji (2021) found similar acidity in cream cheese: 0.75% for control, and 0.76, 0.76, 0.74, or 0.75% when fortified with 1.0% cumin, 1.0% coriander, 1.0% pepper, or 0.5% cinnamon. These patterns match the current study's findings where spice additions slightly lowered the acidity in fermented dairy products.

Effect of spices on pH of Greek yogurt

The pH of Greek yogurt samples with different spice powders is shown in Table 3. Azari-Anp`ar *et al*. (2017) reported that the pH of control and yogurt with aloe vera gel at 1.0, 3.0, and 5.0% were 4.35, 4.48, 4.47, and 4.60, respectively. de Carvalho *et al*. (2019) noted that the pH of control and yogurt fortified with 0.25 and 0.5% of stevia extract was 4.65, 4.65, and 4.66, respectively. The statistical analysis showed that the differences in pH of the fresh experimental samples were not significant ($p>0.05$). Ahari and Massoud (2020) reported similar results, noting pH values of 4.64 for control probiotic yogurt and 4.62, 4.61, and 4.63 for samples with 1.0%, 2.0%, and 3.0% essential oil, respectively.

Looking at the data for the acidity and pH of Greek yogurt, it appears that the addition of different spices did not have a substantial effect on the acidity and pH of the final product ($p>0.05$).

TPC of Spice

Spices naturally contain a variety of phenolic compounds, which not only enhance the flavor, aroma, and appearance of food but also benefit health due to their powerful antioxidant properties. These compounds help protect the body from harm caused by oxidative stress, which is connected to many health issues, both immediate and long-term.

Cumin contains a wide range of phenolic compounds, such as cuminaldehyde, carvone, limonene, linalool, eugenol, and pinene. Cinnamon, in contrast, is rich in various phenolic acids, including vanillic, caffeic, gallic, protocatechuic, p-hydroxybenzoic, p-coumaric, and ferulic acids, along with p-hydroxybenzaldehyde.

In the current study, cumin had a higher total phenolic content (9.21 ± 1.41 mg GAE/g) than cinnamon (3.70 ± 0.28 mg GAE/g). These findings align with previous research that also shows cumin to have a greater concentration of phenolic compounds, while cinnamon typically has lower levels.

Overall, the higher phenolic content in cumin explains its strong antioxidant activity. This allows cumin to neutralize harmful substances like hydroxyl, peroxyl, and DPPH radicals, which can reduce lipid peroxidation and improve its functional properties.

TPC of Greek Yogurt

In the Greek yogurt samples, cumin and cinnamon were added at a concentration of 0.5% (w/w). The total phenolic content (TPC) of each sample was measured using the Singleton and Rossi (1965) [39] method. The Greek yogurt sample with cumin (T_1) had a TPC of 1.56 ± 0.16 mg GAE/g yogurt. The high TPC in T_1 is due to the high TPC value of the cumin powder, as shown in Table 4, compared to cinnamon. The control sample, which had no spices, also showed a TPC value because the Folin–Ciocalteu reagent used in the test not only reacts with phenols but also with other reducing substances naturally present in yogurt, such as carbohydrates, amino acids, peptides, nucleotides, thiols, certain vitamins, and even some fatty acids.

The TPC reading can be influenced by several factors, such as the pH and temperature of the sample, the structure and size of the phenolic compounds, and how they interact with proteins in the yogurt (Josipovic *et al*., 2015). Overall, the TPC values of the yogurt samples matched well with the phenolic levels of the spices added, and the yogurt with cumin had the highest phenolic content.

Antioxidant potential of spice powders

Antioxidant compounds protect the human body by removing free radicals, such as reactive oxygen species, and extend the shelf life of food by slowing down the process of lipid peroxidation through hydrogen or electron transfer. Antioxidant properties can result from multiple mechanisms, and protein hydrolysates can exhibit antioxidant activity through different reaction pathways (Chen *et al*., 2003). Since no single antioxidant test can fully capture a sample's true antioxidant power, multiple assays are needed to provide a complete picture of the tested compound's antioxidant capacity. This justifies the current study's evaluation of the antioxidant potential of spice powders and Greek yogurt using two different methods: DPPH radical scavenging activity and ABTS radical scavenging activity.

DPPH Radical Scavenging Activity of Spices

DPPH is a stable free radical commonly used to determine how effectively plant extracts can neutralize free radicals. It has an unpaired electron, making it useful for measuring proton radical scavenging. The DPPH radical absorbs strongly at 517 nm, and its deep purple color becomes lighter when it reacts with substances that donate protons.

In this study, the DPPH radical scavenging activity of cumin and cinnamon was 2.97 mM TEAC per gram of spice (82.34 ± 0.81% inhibition) and 1.18 mM TEAC per gram of spice (34.20 ± 0.10% inhibition), respectively. This indicates that cumin has a stronger DPPH radical scavenging activity than cinnamon. Gupta (2013) reported that the percent inhibition of DPPH radical by methanolic extracts (100 µl) of cumin and cinnamon were 67.67 and 9.61%, respectively, while Dalwadi (2016) [11] recorded a value of 30.71% for cinnamon. Similarly, Al-Shawi *et al*. (2017) observed that a 100 mg ethanolic extract of cumin showed strong antioxidant activity, producing 80–85% inhibition of the DPPH radical. In contrast, Rathour *et al*. (2017) reported that a 100 µl extract of cinnamon had a much lower DPPH radical scavenging effect, with an inhibition value of 32.48%. Table 4 displays the DPPH radical scavenging activity levels of various spices, indicating their ability to neutralize DPPH free radicals as a measure of antioxidant strength. In most studies, antioxidant activity is commonly expressed as percentage inhibition, and this measurement has shown good correlation with other analytical results.

ABTS Radical Scavenging Activity of Spices

The decolorization of the ABTS radical cation ($ABTS^{\bullet+}$) was used to assess the antioxidant activity of yogurt samples. The ABTS assay is one of the most widely used methods for the screening of antioxidant activity as it measures the scavenging activity of several natural products and is applicable to both hydrophilic and lipophilic antioxidant systems (Re *et al*., 1999) [32]. The ABTS radical scavenging activity of cumin and cinnamon was 45.79 mM TEAC/g spice (94.60 ± 0.25% Inhibition) and 27.30 mM TEAC/g spice (57.35 ± 0.29% Inhibition), respectively. Among the two spices, cumin showed higher ABTS radical scavenging activity as compared to cinnamon. The antioxidant strength of different cinnamon bark extracts varied widely, ranging from 0.47 to 18.16 mM Trolox equivalents (TE) per gram of dry weight. Specifically, ABTS assay values ranged between 4.98 and 18.16 mM TEAC per gram dry weight, while DPPH values were lower, from 0.47 to 1.92 mM TEAC per gram. Higher TEAC values indicate more potent antioxidant activity (Georgieva and Mihaylova, 2014) [16]. Dalwadi (2016) [11] found that the methanolic cinnamon extract reduced ABTS radicals by 22.69%. On the other hand, Demir and Korukluoglu (2020) [13] noted that methanolic and ethanolic cumin extracts had ABTS radical scavenging activities of 55.3 and 25.2 mM Trolox per kg of dry weight, respectively. Table 4 shows the ABTS radical scavenging activity of various spices. In this study, the ABTS radical scavenging activity for cumin and cinnamon was higher than the values reported in previous studies, which could be because of differences in environmental conditions affecting the species. The antioxidant potential of cumin was higher compared to cinnamon as measured by DDPH and ABTS radical scavenging activity, which may be correlated to its higher total phenolic content (9.21±1.41 mg GAE/g spice).

Antioxidant potential of Greek yogurt

The effect of addition of spice powders on antioxidant potential of Greek yogurt are presented in Table 5.

T_1 and T_2 yogurts showed better ability to neutralize DPPH and ABTS radicals compared to T_0. This is mainly because T_1 and T_2 contain more phenolic compounds from cumin and cinnamon, along with peptides and other byproducts formed when yogurt bacteria break down proteins, all of which help in removing free radicals. The control sample, T_0, had the least DPPH and ABTS scavenging activity. The antioxidant power of T_0 came from substances like polypeptides, peptides, and amino acids made during fermentation, especially through the action of lactic acid bacteria. When natural antioxidants in yogurt increase, both total phenolic content and DPPH scavenging activity also rise gradually, as shown in studies by Alenisan *et al*. (2017) and Jung *et al*. (2016). Sah *et al*. (2014) [2, 22, 34] found that yogurt naturally has antioxidants such as certain peptides, free amino acids, and exopolysaccharides made by Lactobacillus. They also noted that adding ingredients high in phenolic compounds, like cinnamon or pomegranate, enhances the antioxidant strength of yogurt, as reported by Shori and Baba (2011) [36] and Trigueros et al. (2014) [45].

Ayyash *et al*. (2018) [7] found that the ABTS radical scavenging activity in yogurt is linked to the formation of protein-derived peptides and the presence of certain amino acid residues in these peptide chains. Jeong *et al*. (2018) [20] reported that the ABTS scavenging activity of plain yogurt and yogurt enriched with 1.0, 2.0, and 3.0% green tea powder (GTP) was 47.0, 100.0, 101.0, and 104.0% inhibition, respectively. Their research demonstrated that GTP supplementation boosted yogurt's antioxidant qualities by elevating phenolic levels and promoting lactic acid bacteria growth. Liu and Lv (2019) [26] also found that the antioxidant activity as measured by ABTS radical (measured in terms of IC_{50} value) of blueberry flowers yogurt (BFY) was higher (p<0.05) than those of the control, due to the presence of phenolic compounds in blueberry flower pulp that could enhance the antioxidant activity of yogurt. Qiu *et al*. (2021) [30] discovered that yogurt made with Rosa rugosa cv. Plena extract (RPE) had better antioxidant activity than regular yogurt, as shown by the DPPH radical scavenging test. The results showed that the antioxidant activity of regular yogurt and yogurt with 0.1%, 0.3%, and 0.5% RPE was 6.94%, 26.81%, 33.85%, and 39.28% inhibition, respectively. This shows that RPE is a good source of active compounds that can boost the antioxidant power of yogurt, which may help improve overall health. Shori (2022) [37] also found that adding extracts from nutmeg, black pepper, and white pepper can increase yogurt's antioxidant ability. These extracts have strong antioxidant properties and stay active even when stored in the fridge at 4°C. These findings match what has been reported in previous studies.

Table 1: Effect of spice powders on sensory characteristics of Greek yogurt

Greek yogurt samples	Sensory Scores			
	Flavour	Colour and appearance	Body and texture	Overall acceptability
T_0	8.03±0.21^b	8.63±0.25^a	8.44±0.18^a	8.02±0.13^b
T_1	8.43±0.24^a	8.41±0.09^a	8.23±0.04^{ab}	8.40±0.08^a
T_2	7.91±0.20^b	7.69±0.23^b	8.13±0.14^b	7.87±0.17^b

T_0=Control (Greek yogurt without spice); T_1 = Greek yogurt with 0.5% cumin;
T_2=Greek yogurt with 0.5% cinnamon
Results are expressed as mean±SD of three replications.
Mean in column with different superscripts (a, b) differed significantly (p<0.05).

Table 2: Proximate composition and chemical characteristics of Greek yogurt

Proximate composition (%)			
Constituents	**Mean ± SD**		
	T_0	**T_1**	**T_2**
Moisture	79.32 ± 0.86	79.28 ± 0.38	79.27 ± 0.52
Fat	8.10 ± 0.14	8.00 ± 0.03	8.06 ± 0.06
Protein	9.35 ± 0.17	9.54 ± 0.12	9.55 ± 0.19
Total carbohydrate	2.37 ± 0.81	2.25 ± 0.01	2.19 ± 0.02
Ash	0.86 ± 0.02	0.93 ± 0.02	0.92 ± 0.02
Chemical characteristics			
Salt	0.30 ± 0.02	0.30± 0.01	0.30 ± 0.01
pH	4.08 ± 0.01	4.08 ± 0.01	4.08 ± 0.01
Acidity (% lactic acid)	1.13 ± 0.01	1.13 ± 0.01	1.13 ± 0.01

T_0=Control (Greek yogurt without spice); T_1 = Greek yogurt with 0.5% cumin;
T_2=Greek yogurt with 0.5% cinnamon
Results are expressed as mean±SD of three replications.

Table 3: Effect of addition of spice on acidity and pH of Greek yogurt

Types of spice	Acidity(% lactic acid)	pH
T_0	1.14±0.03^a	4.08±0.02^a
T_1	1.14±0.04^a	4.08±0.04^a
T_2	1.13±0.08^a	4.07±0.04^a

T_0=Control (Greek yogurt without spice); T_1 = Greek yogurt with 0.5% cumin;
T_2=Greek yogurt with 0.5% cinnamon
Results are expressed as mean±SD of three replications.
Mean in column with different superscripts (a, b) differ significantly (p<0.05).

Table 4: Effect of addition of spice on TPC of Greek yogurt

Types of spice	TPC (mg GAE/g)
T_0	0.86±0.12^a
T_1	1.56±0.16^b
T_2	1.02±0.15^c

T_0=Control (Greek yogurt without spice); T_1 = Greek yogurt with 0.5% cumin;
T_2=Greek yogurt with 0.5% cinnamon
Results are expressed as mean±SD of three replications.
Mean in column with different superscripts (a, b) differ significantly (p<0.05).

Table 5: Effect of addition of spice on antioxidant potential of Greek yogurt

Types of spice	DPPH radical scavenging activity (mM TEAC/g Greek yogurt)	ABTS (mM TEAC/g Greek yogurt)
T_0	0.25±0.24^a	0.15±0.16^a
T_1	1.00±0.21^b	0.24±0.23^b
T_2	0.67±0.18^c	0.18±0.20^c

T_0=Control (Greek yogurt without spice); T_1 = Greek yogurt with 0.5% cumin;
T_2=Greek yogurt with 0.5% cinnamon
Results are expressed as mean±SD of three replications.
Mean in column with different superscripts (a, b) differ significantly (p<0.05).

Conclusions

This study highlights the possibility of addition of spices as an additive in Greek yogurt. Amongst cumin and cinnamon, cumin possesses higher TPC and antioxidant activity, namely DPPH radical scavenging activity and ABTS radical scavenging activity. Cumin has ability to enhance the TPC and antioxidant potential of Greek yogurt compared to cinnamon. The cumin-fortified Greek yogurt earned the highest marks in sensory evaluations. In addition to its antioxidant properties, cumin shows great promise for delivering health benefits. It effectively neutralizes free radicals, potentially aiding in the prevention of various oxidative stress-related conditions. The findings suggested that cumin is an excellent natural antioxidant in Greek yogurt and is a promising alternative to enhance the shelf life of Greek yogurt without addition of synthetic preservatives.

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