Research article

Incorporating Ginger Oil Extracts to Optimize the Chemical Composition, Sensory Evaluation, and Antimicrobial Efficacy of Soft White Cheese: A Novel Approach

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Abstract | Soft Casablanca cheese is very susceptible to spoilage; as the product deteriorates during storage crucial components that determine taste and flavor quality are lost. The current study deals with the one weakness of small scale producers in term of their oils by exploring how a ginger oil extract can improve toffee, taste, viscosity, and, last but not least, fight against mold growth in soft cheese. The goal is, however, to lengthen its shelf life and increase organoleptic values. In this experiment, ginger oil extract was being extracted and used at different ratios in soft cheese samples. This was shown by consumption test as well as Panel test where cheese samples which were added with ginger oil extract indicated much better visual properties, texture and taste compared to control/base cheese. Chemical tests were performed which confirmed a change in water content, pH as well, protein and carbohydrate percentage values that signified the difference of ginger oil extract on cheese properties. In addition, the noticed anti-fungal efficiency against the common fungus provides a promising solution as ginger oil extract has antimicrobial properties too with a very affordable cost. To be concise, the application of ginge oil extra has highly improved the texture, taste, and the reception of the product; moreover, it has also acted well in mold inhibition. The result shows that the purpose of the study is met and it can also be helped to makes the cheese preservation and quality improvement.

Keywords: Ginger, Cheese, Antifungal, Sensory Evaluation, Microbial Control

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INTRODUCTION

Cheese is undoubtedly the most difficult dairy product to preserve, as the process of deterioration happens literally before your eyes. Not to mention that it also changes its taste and smell as well as its whole evident quality too. Microbes are not to blame in combination with the others for the cheese properties to change making the cheese vary in texture and flavor. This determined, knowing which microorganisms are being responsible for soft cheese Casablanca spoilage is crucial to programming sharp antimicrobial technologies with the aim of enhancing the shelf life. This research aims at purposely pinpoint the root cause of soft cheese spoilage through thorough inspection of microbial modification in chemical composition and sensual characteristics of the soft Casablanca cheese. The structure of the study is focused on two main objectives: (1) assessing the effects of ginger oil extract on the deterioration of the soft cheese products tasting quality and (2) looking for the enhancing aspects of the same extract. Zingiber officinale (the botanical name for ginger) is a monocot (a type of flowering plant) with perennial status. This species is commonly grown in the climes (climates) of America, Africa, Asia, and Australia. Traditionally, this spice has been used for over two thousand years, and its application for diabetes healing, for pain relief, for fever reduction, for antiviral cure, for fighting cancer and for inflammation has been long recognized. Quite commonly suggested in the

traditional medicine as the antimicrobial and the antioxidant properties which this product has makes it suitable for treating conditions that affect the digestive tract and respiratory system. In 2017, the FDA classified Acquiring Ginger essential oil and ginger extracts as generally safe in human consumption (Bauza et al. , 2019). The ginger plant component has carbohydrates (50-75%) fats (2-7%), and essential oil (1.3-2.8%). As any other fruit, tomatoes have a mandat (45-50%), protein (7-20%), fat (3-8%), water (78-92%), ash (3-9%), along with the other permeable substances and sugar (Peter et al., 2006). Also, including of the terpenes and phenolic compounds in it is another one. Zingeren, β-bisabolene, α-farnesene, β-sesquiphellandrene, and α-curcumin constitute the individual terpene substances while there are gingerol, parasols and shogaol as the individual phenolic compounds (Khajehei et al. , 2015). Consequently, dry ginger includes flavonoid compounds that have been verified as supportive of health, as well as vitamin C and certain minerals such as calcium, magnesium and iron (Yamprasert et al., 2020). Ginger encompasses a great quantity of antioxidants in their chemical form such as polyphenols (Idris et al. , 2019). Therefore, a neutralization reaction has been discovered, aiming to turn the free radicals, which result from having elevated blood sugar levels (Alsherbiny et al. , 2019). Ginger, a medicinal herb, is used widely as a cure for different diseases like cancer, inflammatory bowel diseases and diabetes by means of the people across the globe (Anh et al., 2020). Moreover, it is a comprehensive reservoir of antioxidant and antimicrobial polyphenols and flavonoids that are getting discovered by Asamenew et al. (2019). Not surprisingly, gingerol, zingerone, paradol and shogaol - four major active constituents in ginger - are the compounds responsible for the aroma and taste of this popular spice (Rahmani, 2014; Haksar et al., 2006). What makes ginger to be pungent is the gingerol 9 (shigaol) and the gingerol 10 (dan shen) of which are of active compounds. It is commonly accepted that these bioactive molecules possess anti-inflammatory and antioxidant properties as well as being implicated in the combatting of cancer and proven so in laboratory environments. Different studies have started a discussion that ginger is a right spice in the control of cancer cells especially in the chest gland or the prostate. The drying of ginger transforms grindol into other elements. They are shogaols. Such ingredients are more cutting in the ground and powder form of ginger than in its fresh form. The study proved that Shogaol prevents cells from Alzheimer's disease precursor compound that causes the disease. Nevertheless, these findings are not yet enough for us to stress the success of this technique in humans (Rahmani et al. , 2014). In regard to the above, the purpose of the current research was to prepare a variety of extracts from ginger plants, assess the effectiveness of these extracts as antifungal agents, and investigate the possibility of extending the shelf life of cheese. The overall objective was to enhance the cheese's acceptability, nutritional value, and sensory and qualitative qualities.

MATERIAL AND METHODS

Aqueous extraction

Fresh ginger roots were obtained from local markets in Najaf city in Iraq, that root was cleaned, washed, dried, peeled, sliced, and further dried at 22+°C for three days then ground by grinder, and stored in containers.

Preparation of Oil Extract

Ginger oil was extracted using the distillation method as described in the British Pharmacopoeia of 1958 since 50 g of dried ginger was placed in a Clevenger with 400 ml of water and ether. The upper layer of separation was collected, and ether was evaporated using a rotary vacuum evaporator. The extracted oil was stored in bottles at 4°C for subsequent analysis.

Manufacturing of Cheese

The Soft white cheese was produced from raw cow's milk, and pasteurized at 65°C for 30 minutes following that the temperature was reduced to 35°C, and microbial rennet was added for coagulation then cutting and draining the curd, salt was added, and the ginger extract was incorporated with stirring and left to cool before cutting.

Experimental Design

The experimental design has four groups: the 1st is a Control (C), where no extract was added; 2nd is TgO group, with 1% ginger oil extract; the 3d TgW group, with 0.6% Aqueous ginger extract; and 4th is TgE group, with 0.3% alcohol-based ginger extract. Each group had three replicates, resulting in a total of 12 experimental units.

Chemical Analysis of Cheese

The moisture percentage was calculated using the formula: Moisture = (Initial weight - Final weight) / Initial weight × 100%.

pH of Cheese

For pH Testing, One gram of cheese sample was mixed with 9 ml of distilled water, and the pH value was measured using a pH meter (Hool et al., 2004).

Acidity % of Cheese

Acidity was determined by mixing of 1 gram of cheese with 9 ml distilled water and was titrated with 0.1 N NaOH until the colour were changed, and calculated using the formula:

Total Acidity = NaoH * 0.1 / Sample weight * 100%.

Ash Content in Cheese

The Ash determined by weighing 5 grams of cheese and burning in a muffle furnace at 550°C until complete ashing, and calculating ash percentage using the formula:
Ash content %= (Initial weight - Final weight) / Original weight × 100%.

The DPPH Test

The DPPH antioxidant was performed by mixing chess with the ginger extract and measuring the absorbance using an ELISA reader at 514 nm using the formula: Radical scavenging % = (A) control – (A) sample / (A) control × 100.

The Protein

Protein content was determined by mixing 10 ml of cheese with sulfuric acid and titrating with 0.1 N NaOH. Nitrogen was calculated using the equation: Protein percentage = Nitrogen percentage × 5.38.

The Carbohydrate

Carbohydrate percentage was calculated using the formula: Carbohydrates = 100 – (Moisture + Ash + Protein + Acidity + Fat) %.

Antifungal Activity on Ginger Extracts

The extracts were diluted, and antifungal activity was tested using Potato Dextrose Agar for fungi.

Sensory Evaluation of Cheese

Fifteen panellists, including professors and fourth-year students in the Department of Food Science at the University of Kufa, evaluated white cheese for flavor, consistency, and color using a prepared questionnaire (Lima, 2019), with each attribute rated on a scale of 1 to 10.

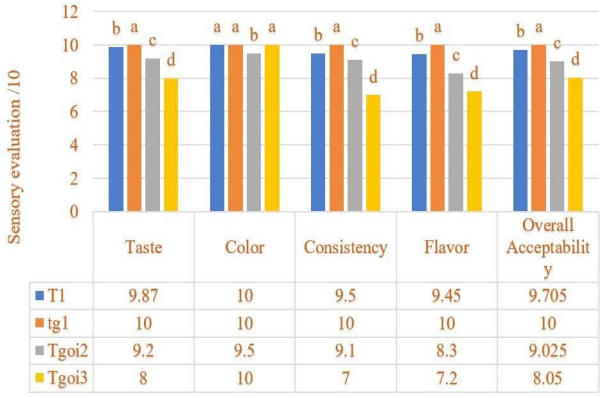
Statistics Analysis

The data were compared using the Least Significant Difference (L.S.D) at a significance level of 0.05.

RESULTS

Sensory assessment of Cheese

Figure 1 illustrates the sensory evaluation results of soft white cheese and cheese with ginger oil extract. the result analysis showed significant differences between various treatments and storage periods for soft white cheese, in which, cheese with ginger oil extract, the Tg1, was better specifically than the control sample. in terms of color, there were no significant differences observed among treatments except for Tg3, which was less preferred compared to other treatments and the control. While in terms of consistency, samples with ginger oil extract, Tg1 and Tg2, showed superiority over the control sample more over the result agreement the benefit of Ginger Leaf Extracts and Oils in last studies (Lima, 2019).



	Taste	Color	Consistency	Flavor	Overall Acceptability
T1	9.87	10	9.5	9.45	9.705
tg1	10	10	10	10	10
Tgoi2	9.2	9.5	9.1	8.3	9.025
Tgoi3	8	10	7	7.2	8.05

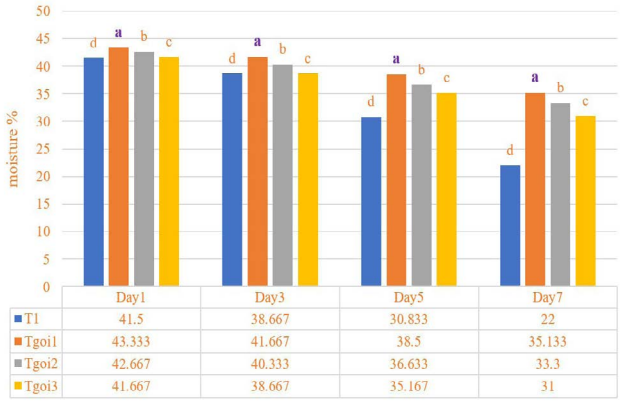
Figure 1: Sensory Evaluation of Soft White Cheese with Ginger Oil Extract

Moisture Content of Soft White Cheese with Ginger Oil Extracts during Storage

It has been found that the structure, and, importantly, chemical composition of samples of soft white cheese and cheese samples enriched with ginger oil extracts is illustrated in Figure 2. Then, samples with 1, 3, 5, and 7-day rent periods were prepared. To be specific, it was revealed that the level of water that was in the soft white cheese experiment was zero. Gyrus, 36, 0.38, 4.00, and 0. 44-days for this study, the storage period was divided into 4 equal intervals. The moisture levels displayed in the cheese samples were 0, for the unadulterated samples. With speed approaching 38, 42, 44, and 0. 48 total, yet the moisture content of the control cheese samples that were added with alcohol collected from each plant was 0 i=42, pi=0. 46, e=0. 52, and zero=0. The percentage of dry weight of the fruit DM was 12.25%, which was the water extract content was 0. Among them are 40, 0. , 0. , and 0. 46. Absolutely, the water content of all the test samples of white soft cheese, where ginger oil was added to some or the control, showed a decrease in the amount of water in the samples. The depletion at the end of the seventh day, and the most substantial decrease, is for all of the samples. This implies that the decrease may be associated with the progress of storage time. Additionally, as the storage period advances, there is a tendency for syneresis or a decrease in pH, leading to moisture loss in the cheese. (Kandylis, 2021)

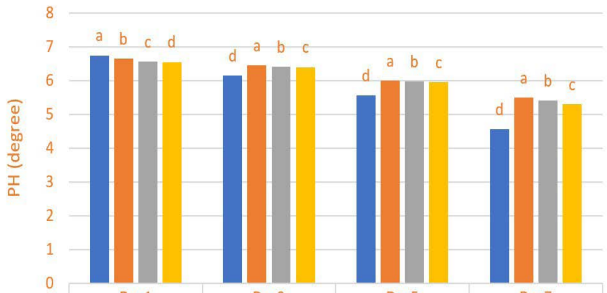
The figure shows the chemical composition of soft white cheese and cheese with ginger oil extracts (4), in addition to its storage 1, 3, 5, and 7 days reliably. The readings recorded show that the pH values for the control samples of white curd cheese were (6.25, 6.43, 6.53, and 6.63) for the corresponding storage periods under study. On the contrary, the quantities taken by rinds were (2). 40, 6. 43, 6. 48, 6), for alcohol and extract, it was r08m1t, 6. The initial pH

levels of the soil were recorded at 7.19, 7.25, 7.31, 7.33 and 7.35 whereas the values of pH for the water extract were measured at 6.38, 6.40, 6.42 and 6.44 pH. The trends for pH values determine a decrease in them over the storage duration which, in turn, causes a rise in bacterial counts throughout this period. An increase in the concentration of these microorganisms creates organic acids of higher acidity than they were before, thus lowering the pH value (Yin et al. , 2021).



	Day1	Day3	Day5	Day7
T1	41.5	38.667	30.833	22
Tgoi1	43.333	41.667	38.5	35.133
Tgoi2	42.667	40.333	36.633	33.3
Tgoi3	41.667	38.667	35.167	31

Figure 2: Moisture Content of Soft White Cheese with Ginger Oil Extracts during Storage

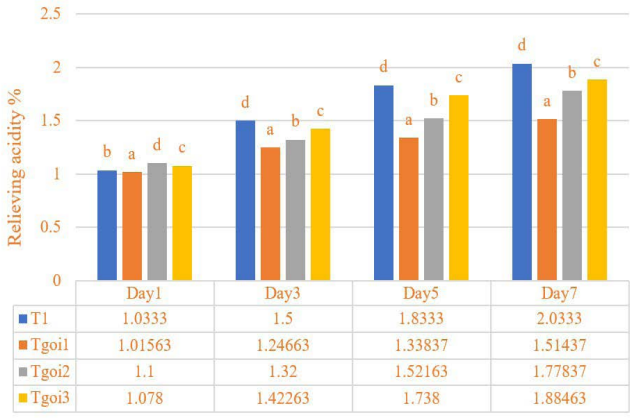


	Day1	Day3	Day5	Day7
T1	6.74	6.14	5.5633	4.5633
Tgoi1	6.65	6.45	5.9945	5.5
Tgoi2	6.5567	6.4	5.97	5.4
Tgoi3	6.5467	6.3954	5.947	5.3

Figure 3: pH Estimation for Soft White Cheese with Ginger Oil Extracts during Storage

Acid Hydrolysis Assessment for Cheese Samples

The chemical composition of cheese samples (soft white-cheese -specimena dulci alba; cheese with ginger oil addition -g girlsib oiilled) is given in Figure 4-4, during storage periods of storage of 1, 3, 5, and 7 days. It follows from the results that the acid hydrolysis of the control sample of soft white cheese was through (0. 3, 0. 2, 0. 1) represents the concerned time periods. While off this, samples of cheese both with and without ginger oil extract were hydrolyzed to yield acids and bases. The concentration of extract in the wells was arranged in ascending order, as follow: (0. 4, 0. 3, 0. 2), and for those wells to which alcohol extract oil extract had been added it was (0). Mycotoxins levels which were established as (0. 25, 0. 2, 0. 15, 0. 1) and water (0. 3, 0. 2, 0. 15, 0. 1) of soft cheese sample decreased for all the seven days of storage periods. Thus, an increase in the levels of lactic acid bacteria (Chan, 2012).

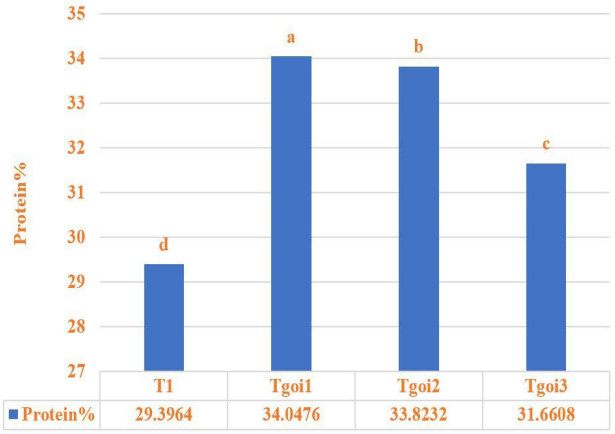


	Day1	Day3	Day5	Day7
T1	1.0333	1.5	1.8333	2.0333
Tgoi1	1.01563	1.24663	1.33837	1.51437
Tgoi2	1.1	1.32	1.52163	1.77837
Tgoi3	1.078	1.42263	1.738	1.88463

Figure 4: Determination of Acid-Base Balance in Cheese Samples

Protein Content Assessment in Cheese Samples

Through Figure (5), depicting the chemical composition of soft white cheese samples and samples added with ginger oil extracts over storage periods of 1, 3, 5, and 7 days, protein content results are illustrated. The protein percentage in the control sample of soft white cheese, T1, was 29.3964, whereas the protein percentage in the sample added with ginger oil extract at the first concentration, Tgoil1, was 34.0476, showing the highest protein content among the treatments. The protein percentages for the second (Tgoil2) and third (Tgoil3) concentrations of ginger oil extract were 33.8232 and 31.6608, respectively. Notably, the sample with the first concentration of ginger oil extract exhibited the highest protein content (El-Aziz, 2022).



	T1	Tgoi1	Tgoi2	Tgoi3
Protein%	29.3964	34.0476	33.8232	31.6608

Figure 5: Protein Content Assessment in Cheese Samples

Inhibitory Effectiveness on Fungi by Ginger Oil, Alcohol, and Water Extracts

Figure (6) illustrates the inhibitory effectiveness on fungi by ginger oil, alcohol, and water extracts. The positive effect on Aspergillus flavus was most pronounced in Tg3 (90mm), while Penicillium italicum was most effectively inhibited by Tg3 (30mm). Tg1 showed the highest inhibitory effect on both fungi (45mm for Aspergillus flavus and 14mm for Penicillium italicum).

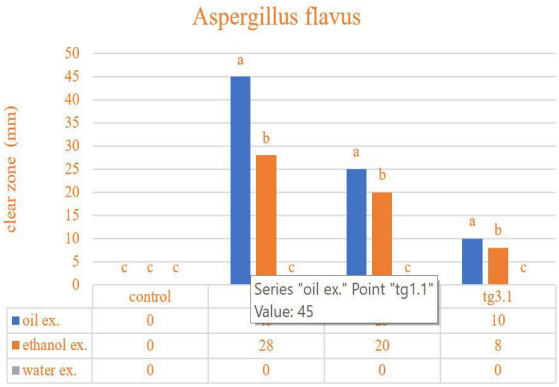


Figure 6: Inhibitory Effectiveness on Fungi by Ginger Oil, Alcohol, and Water Extracts

Carbohydrate Content Assessment in Cheese Samples

The carbohydrate content results for the control sample and the sample added with ginger oil extract . The carbohydrate percentage for the control cheese was 13.7703, while for the sample added with ginger oil extract at the first concentration (Tgoil1), it was 2.5094, for the second concentration (Tgoil2) it was 4.2531, and for the third concentration (Tgoil3) it was 7.5722 (Kavas et al., 2016).

DISCUSSION

The sensory evaluation results show significant mixed results for soft white cheese which vary with the applied treatments and storage time. On top of this, the cheese fermented with the ginger oil extract, Tg1, competes in the edges of the control sample for both antifungal and antioxidant activities. This result confirms those other studies expressing the potential of ginger leaf extracts and oils being beneficial as in the study of (Shaukat, M et al., 2023) also have the same result. In addition, it should be emphasized that although Tg1 was the preferred one, the other color options except for the control, in general, demonstrated a bit less liking.

Additionally, the samples that contained ginger oil extract, namely Tg1, Tg2, incorporate the effect of superiority as compared with the control sample. Not only did the presence of the ginger oil extract affect the appearance of the cheese like in the study of (Mao,Q et al., 2019) "Bioactive Compounds and Bioactivities of Ginger (Zingiber officinale Roscoe)." , but this also implied its possible contribution in bringing the best sensory attributes of the cheese to surface.

The results of this study uncover many aspects concerning features of the chemical composition of the cheese after the addition of a ginger oil extract such as the quantity and quality of the cheese, its taste, color and shelf life. Our data comparison with the findings of other authors, working on ginger and its bioactive substances, promote an integrative comprehension of the observed processes more fully.

This study have revealed a uniform trend of loss in water content in soft white cheese samples by an immersion of time in the duration of storage, taking into great consideration that evaporation of water was initiated when the storage time increased. In agreement with the previous mentioned studies on the moisture-regulating properties of ginger, this result portrays the finding of the study reported by Singh et al., 2017. Furthermore, the pH values of the cheese were seen to decrease at storage time which was a measure of the acidification and the accompanying growth of the bacteria which in line with the research article (Kamaruddin et al., 2023) that relate the changes in pH levels and the microbial activity to the presence of ginger. The acid hydrolysis test demonstrated that acyl peptide bonds in cheese samples containing the ginger oil extract were hydrolyzed more extensively, indicating the possibility that the ginger constituents affected the enzymatic reactions within the cheese matrix. This conclusion is in accordance with the findings of the previous studies which are indicating the bioactivities of the ginger components in elevating the physiological activities through enzymes (Mao, et al., 2019).

This, in turn, brings to conclusion that cheese samples to which ginger oil extract was added have statistically higher protein concentration levels and its significance in using ginger oil extract as one of the sources of protein in the production of cheese is obvious. This features the meaningful biological role of ginger in the treatment of multiple illnesses which is with potential incorporation in its therapeutic processes (Garza-Cadena et al. , 2023). Ginger oil can put a stop to Aspergillus flavus and Penicillium italicum fungi development via its activity(ies). As therefore, representing a discovery from the earlier findings, this can then be used as a natural preservative for cheese manufacturing and this conclusion will support the earlier findings on extensively improved shelf-life period for the cheese samples with ginger oil extract (Dalsasso et al. , 2022).Hence, the shifting of carbohydrates in the cheese formulations which were supplemented with the ginger oil extract confirms to the potential transformation of the cheese composition,

which suggests opportunities to analyze further, the interactions between the ginger compounds and the components of cheese matrix (Beristain-Bauza et al., 2019).

The conclusion is that ginger oil extract in blend with soft white cheese can have several advantages as discussed above. The outcomes of our investigation constitute a valuable part of the continuing research in food systems functionality that points to the widespread potential uses of ginger as a functional ingredient in cheese manufacturing. Next studies will investigate the cellular level basis of the noted changes, which could improve production process of a high-grade cheese.

CONCLUSION

To sum up, the study highlights the possibility of ginger oils serving as effective antimicrobials having sensory and functional impacts on a soft-white cheese making process. Through the experimental evaluation of sensory samples, it was clearly seen that the chemical compounds from ginger oil extracts solution enriched the color and texture of the cheese products, this could be a promising applicant for sensory improvement of cheese products. Moreover, a chemical analysis of the cheese was conducted which showed the dynamic changes in its composition with the appreciable impact in the percentages of moisture, pH levels, protein, and carbohydrates to suggest the ginger oil extract were a very good transformation of the cheese quality. That ginger oil extracts prevented common fungal growth means the antimicrobial antifungal properties of ginger oil are evident, therefore it is applicable to be used to control fungi growth in cheese products production. Consequently, these results prove finally that ginger oil liquids can be used in different ways for improving cheese freshness and potency, as well as with good performance in fighting pathogenic bacteria. Engaging these innovations in food science and technology ensures for a new horizon in the making of superior and safe cheese from the raw materials.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

NOVELTY STATEMENT

The results of the study can be helped to makes the cheese preservation and quality improvement using ginger oil liquids.

AUTHORS CONTRIBUTION

All authors contributed equally.

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