Journal of
Food Chemistry & Nanotechnology

https://doi.org/10.17756/jfcn.2024-182

Research Article

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Use of Mono-diglyceride Emulsifier and Carotin Vegetable Oil to Prevent Oil Separation from the Texture of New Pistachio Halva Product: A Short Article

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Received: June 22, 2024
Accepted: August 09, 2024
Published: August 14, 2024

Citation: Shakerardekani A, Kordi F, Morshedi A. 2024. Use of Mono-diglyceride Emulsifier and Carotin Vegetable Oil to Prevent Oil Separation from the Texture of New Pistachio Halva Product: A Short Article. *J Food Chem Nanotechnol* 10(3): 115-119.

Published by United Scientific Group

Abstract

Separation of oil is one of the most important problems of pistachio halva. In this study, carotino oil (0, 1.5, and 3%) and monodiglyceride (0, 1, and 2%) were used to reduce oil separation from pistachio halva texture. The control halva, and the halva containing 2% monodiglyceride showed the highest and lowest oil separation for 8 weeks storage, respectively. The highest and lowest sensory evaluation score were obtained by halva containing 1% monodiglyceride and control halva, respectively. The control halva and halva containing 2% monodiglyceride had the highest and lowest peroxide values during the 2 months of storage, respectively. There was no significant difference between the use of 1% or 2% monodiglyceride. The amount of monodiglyceride used affects the amount of pistachio paste needed. If 1% emulsifier is used, no need to use carotino oil. The oil separation can be prevented up to 60% in pistachio halva, contains 1% monodiglyceride. Reducing the separation of oil from the product improves its texture and appearance and reduces its oil oxidation.

Keywords

Pistachio halva, Oxidation, Shelf life, Emulsifier, Stabilizer

Introduction

Tree nuts can be a good part of a low-fat, high-fiber diet. They can reduce the risk of some cardiovascular diseases, cancers and congenital defects [1]. Nowadays, tree nuts are widely used as snacks. Raw pistachio contains 45 - 72% fat, depending on the variety and harvest time [2]. The predominant fatty acid of pistachio oil is oleic acid, which is 56 to 64%. Linoleic acid (23 - 31%) and palmitic acid (9 - 13%) constitute other fatty acids in pistachio oil [2]. Unsaturated fatty acids are more susceptible to oxidation than saturated fatty acids [3]. Also, the rate of oxidation of fatty acids increases with an increasing degree of unsaturation and decreases with the presence of fat-soluble antioxidants such as tocopherol [4]. Increases in free fatty acids, peroxide and anisidine values have been reported by other researchers during storage [5].

Oil stability analysis of some tree nuts showed that among the studied samples (pecan, pistachio, hazelnut, almond, Brazil nut, and walnut), pistachio oil had the lowest anisidine value after 12 days of storage at 60 °C [6]. In the Shakerardekani and Abootalebi [7] study, the oxidation stability of pistachio oil alone and in combination with carotino oil (obtained from red palm tree and rich in antioxidants and carotenoids) and the monoglyceride emulsifier was investigated. Based on the results, the addition of mono-glyceride and carotino oil, either individually or in combination with the pistachio oil, influences its stability. The

high amount of oleic acid in pistachio oil and the high content of palmitic acid in carotino oil and the emulsifier stabilizing properties have made the pistachio, carotino and emulsifier oils more stable than other oils.

Tree nuts and their products are susceptible to oxidation due to their high content of unsaturated fatty acids. The development of an undesirable taste or rancidity of the product is due to improper storage of the kernels or long-term storage [8, 9].

The production of secondary oxidation products is accompanied by a change in the smell and taste of the product, which will result in rancidity. Oxidation of fats adversely affects the flavor, odor, color, and nutritional value of the product during storage, which may affect the application of tree nuts to processed and fortified foods as well as dietary supplements [10].

Oxidation status evaluation is often combined with sensory evaluation. For example, in roasted peanuts, the formation of secondary oxidation products, including pentanal, hexanal and octanal causes a loss of peanut flavor [11].

Examination of lipid oxidation rate can be done by instrumental or sensory evaluation. The sensory evaluation method is widely used to detect lipid oxidation, but it takes a long time, and it is difficult to select evaluators, especially as their ability to evaluate products over time may change. There have been numerous instrumental methods for assessing the oxidation of fats in tree nuts and their oils, including the measurement of peroxide, anisidine, volatile compounds, and the use of multiple spectroscopic methods [12, 13].

Pistachio halva is a new solid product with a uniform appearance that is prepared by mixing pistachio paste and sugar syrup [14]. This product is similar to sesame halva, with the difference that sesame is not used in its formula. Emulsifiers are used to prevent oil separating from the texture of food products. Mono and diglycerides in sweeteners improve the gum properties, reduce the stickiness, and also increase the product shelf life and reduce the spreadability in the final product [15].

Pistachio halva is a new product which is prepared from pistachio paste as the main ingredient. One of its problems is product oil separation. The separation of oil from the product makes its appearance inappropriate, the texture from which the oil is separated becomes harder and lowers the product's desirability. Also, due to the reduction of oil in the product, its taste score is also lower. The separated oil is also exposed to air oxygen and its oxidation rate increases. In addition, there is a possibility of the separated oil leaking during the transportation of the product. Therefore, in this research, mono-diglyceride emulsifier and carotino oil were used to reduce the separation of oil from pistachio halva texture, and the oil separation, peroxide value, and sensory characteristics of the resulting product were measured after 8 weeks of storage.

Materials and Methods

Formula used in the preparation of pistachio halva

Ingredients used in pistachio halva production were 30.1% sugar, 12.9% glucose, 44.2% pistachio paste, 10% water, 1.2% egg white, 0.5% soapwort extract (Brix 4 - 5), 1% confectionary oil, and 0.1% citric acid [14] (Figure 1). Carotino oil (0, 1.5, and 3%) and monodiglyceride (0, 1, and 2%) were used in the mixing stage of pistachio paste. The amount of oil separation was measured over a period of 2 months at a weekly interval. The method of measurement was that the halva sample with the separated oil was weighed, and then the oil separated on the surface of the halva collected with the soft texture. The halva sample was then weighed again. The percentage of oil extracted from the pistachio halva texture was calculated by dividing the initial weight by weight multiplied by 100 after removing the oil separated from the texture divided by the initial weight.

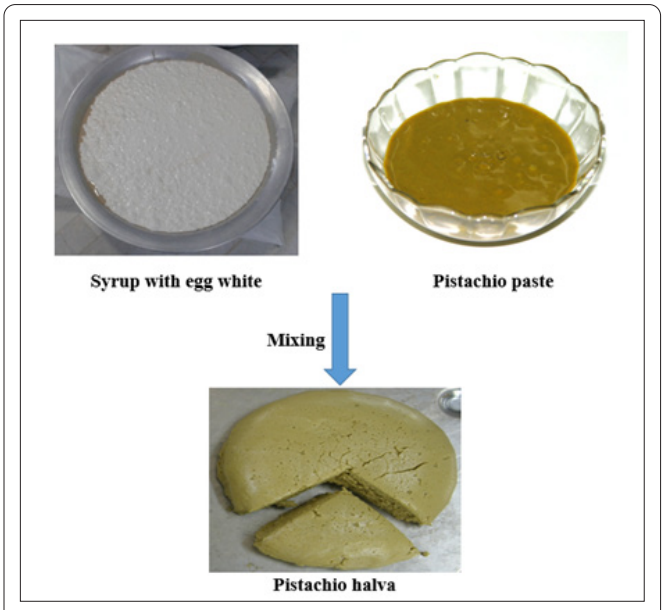

Figure 1: Production steps of pistachio halva.

Preparation of pistachio oil and other treatments

To prepare pistachio oil samples, 400 g of hexane was added to each 40 g of pistachio halva and homogenized in a homogenizer for 3 min. The resulting mixture was filtered with Whatman No. 4 filter paper and filtered in Buchner funnel. The residue was extracted twice. The oil and hexane mixture were then passed through a layer of aqueous sodium sulfate on a Buchner funnel. The residual solvent was extracted using a rotary evaporator at 40 °C and transferred to a 50 ml glass vessel and stored in a freezer until use [6].

Determination of peroxide value

The peroxide value was measured according to the Wrolstad et al. [16] method. The oil sample (1 - 2 g) was weighed in a 250 ml Erlenmeyer flask, and 30 ml of glacial acetic acid and chloroform (3 - 2 volumes) were added. Then 0.5 ml of saturated potassium iodide was added. The flask was placed in a dark place for 1 min and then 30 ml of ionized water was added. The mixture was titrated with a standard solution of 0.01 normal sodium thiosulfate to give a yellow color. Then 0.5 ml of 1% starch reagent solution was added, and titration continued until blue. Untitled titration was performed before

titration containing the sample. The peroxide value was calculated by the following formula:

$$PV(meq/kg) = \frac{(V_{sample} - V_{blank}) \times N_{Na_2S_2O_3} \times 1000}{W}$$

Where: V is the volume of sodium thiosulphate consumed per milliliter; N is the normality of sodium thiosulphate; and W is the weight of sample consumed in grams.

Sensory evaluation

Sensory evaluation evaluators were recruited from the staff and students at Pistachio Research Institute, Rafsanjan, Iran. They were familiar with the pistachio product and were consumers of pistachios and its products. Written informed consent was obtained from all participants before the experiment was conducted. All participants signed and returned the consent form to the research team to ensure the consent of the participant before participating in the sensory evaluation. This study was conducted according to the guidelines presented in the declaration of Helsinki. All sensory evaluations were performed under the same protocol, which was approved by the Pistachio Research Institute Ethics Committee (Approval No: NO. 84002).

Sensory evaluation (taste, color, texture, and total acceptance) was performed by 32 evaluators (17 men and 15 woman) on the prepared halva. The method used was the Hedonic test, which gives the following scores: 1: Dislike extremely; 2: Dislike very much; 3: Dislike moderately; 4: Dislike slightly; 5: Neither like nor dislike; 6: Like slightly; 7: Like moderately; 8: Like very much; and 9: Like extremely.

Statistical analysis

All experiments were performed using a completely randomized design with three replications. Analysis of variance (ANOVA) was performed using Minitab software version 20.1. Mean comparisons between treatments were performed using the Tukey test.

Results and Discussion

Oil separation

Table 1 shows the percentage of oil extracted from pistachio halva texture for 8 weeks (2 months) of storage. According to the results, control halva, which did not contain carotino oil and monoglyceride, showed the highest oil separation for 8 weeks. Thereafter, more oil was separated from half 1.5 C0M, 3 C0M, and 0 C0M, which only had different amounts of carotino oil. These results show that carotino oil has a positive role to some extent in the stabilization of pistachio halva oil, which has been confirmed in other studies on similar products [17, 18].

It was not oil separated from the texture of the halva containing 2% monodiglyceride during 8 weeks of oil storage. Also, a little oil was extracted from the texture of halva containing 1% monodiglyceride, but there was no significant difference between the application of 1 or 2% monodiglyceride at the statistical level of 5%. This indicates that monodiglyceride emulsifier has been very effective in preventing oil separation. This emulsifier forms a strong network of fat, protein, and starch in the halva, preventing the oil from separating from the texture depending on the severity of the formation [19, 20].

Sensory evaluation

Based on the results (Table 2), the taste score of the halves varied from 7.6 to 8.5 (very much in the range I like). Only halva containing 2% monodiglyceride and halva containing1% monodiglyceride showed statistically significant differences at 5% level. Neither of these halves used carotino oil.

The reason for this difference is that the higher the use of monodiglyceride, the faster the product is prepared, and the less pistachio paste needs [21, 22]. Most pistachio halva consumed 3.3 - 5.3% less pistachio paste (5 - 8 kg of pistachio paste in the 150 kg halva batch). When pistachio paste is reduced, it is natural to substitute it with a mixture of white sugar syrup and egg whites. The result is that with less pistachio paste, the taste of pistachio paste will also decrease in pistachio halva.

In terms of texture, the lowest score belonged to control halva and monodiglyceride-free halva. Control halva gained 5.9 points 2 months after production, which is equal to a little bit like it. Much more oil is separated from the texture of these halves. Separation of the oil, in addition to its disgusting appearance, causes the non-oily texture (the underlying texture of the halva) to become extremely rigid and lose its desirability and quality [23]. The highest texture score (7.5) (between average I like and very much I like) belonged to halva contain-

Table 1: Oil separation (%) from the pistachio halva texture.

Carotino oil (%)	Monodiglyceride (%)	Storage time (week)							
		1	2	3	4	5	6	7	8
0	0	0.6 ± 0.1^{a}	2.3 ± 0.1^{a}	4.0 ± 0.2^{a}	4.8 ± 0.2^{a}	6.6 ± 0.2^{a}	7.4 ± 0.4^{a}	8.2 ± 0.2^{a}	10.3 ± 0.8^{a}
0	1	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.1 ± 0.0^{b}	0.3 ± 0.0^{b}	0.4 ± 0.0^{b}	0.6 ± 0.1^{b}	0.8 ± 0.1^{c}
0	2	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}
1.5	0	0.5 ± 0.1^{a}	2.3 ± 0.1^{a}	4.1 ± 0.2^{a}	4.8 ± 0.3^{a}	6.6 ± 0.3^{a}	7.4 ± 0.4^{a}	8.3 ± 0.3^{a}	9.2 ± 0.5^{b}
1.5	1	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.1 ± 0.0^{b}	0.2 ± 0.0^{b}	0.4 ± 0.0^{b}	0.5 ± 0.1^{b}	0.6 ± 0.1^{b}	0.7 ± 0.1^{c}
1.5	2	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}
3	0	0.5 ± 0.1^{a}	2.2 ± 0.1^{a}	4.0 ± 0.2^{a}	4.8 ± 0.3^{a}	6.5 ± 0.5^{a}	7.3 ± 0.3^{a}	8.1 ± 0.3^{a}	9.0 ± 0.5^{b}
3	1	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.1 ± 0.0^{b}	0.2 ± 0.0^{b}	0.3 ± 0.0^{b}	0.4 ± 0.0^{b}	0.5 ± 0.1^{b}	0.6 ± 0.1^{c}
3	2	0.0 ± 0.0^{b*}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}

Note: * and different letters in each column indicate significant statistical difference at 5% level.

Table 2: Sensory evaluation of different pistachio halva treatments after 2 months of storage.

Carotino oil (%)	Monodiglyceride (%)	Flavor	Texture	Color	Overall acceptability
0	0	8.0 ± 0.2^{ab}	5.9 ± 0.4^{b}	7.3 ± 0.4^{a}	6.8 ± 0.3^{b}
0	1	8.5 ± 0.2^{a}	7.5 ± 0.5^{a}	8.1 ± 0.4^{a}	7.9 ± 0.4^{a}
0	2	7.6 ± 0.3^{b}	6.5 ± 0.5^{ab}	8.0 ± 0.5^{a}	6.9 ± 0.3^{ab}
1.5	0	8.0 ± 0.2^{ab}	6.0 ± 0.2^{b}	8.1 ± 0.4^{a}	6.9 ± 0.3^{ab}
1.5	1	8.4 ± 0.3^{ab}	7.4 ± 0.4^{a}	8.0 ± 0.5^{a}	7.7 ± 0.3^{ab}
1.5	2	7.7 ± 0.3^{ab}	6.4 ± 0.4^{ab}	8.0 ± 0.5^{b}	7.1 ± 0.5^{ab}
3	0	8.1 ± 0.4^{ab}	6.0 ± 0.5^{b}	7.7 ± 0.4^{a}	6.9 ± 0.3^{ab}
3	1	8.2 ± 0.4^{ab}	7.4 ± 0.4^{a}	7.8 ± 0.3^{a}	7.6 ± 0.5^{ab}
3	2	7.7 ± 0.3^{ab*}	6.5 ± 0.2^{ab}	7.9 ± 0.4^{a}	7.1 ± 0.4^{ab}

Note: * and different letters in each column indicate significant statistical difference at 5% level.

ing 1% monodiglyceride, which is not significantly different from other halva containing 2% monodiglyceride. If it comes to cost, it is natural to prefer a 1% emulsifier.

There was no significant difference in color between the different halves. This indicates that the addition of different amounts of monodiglyceride and carotino oil did not have a negative effect on the color of halva. The color score varied from 7.3 - 8.1, which is in the average of I like and, I like very much.

Overall acceptance can be a criterion for all traits studied, including taste, texture, and color. The overall acceptability score range was 6.8 - 7.9, which, on average, I like very much. Overall acceptance was highest for halva with 1% monodiglyceride (7.9) and least for control halva (6.8). This indicates that the separation of oil was an important factor for evaluators and affected the overall acceptability of the product. Since the amount of monodiglyceride has an effect on the amount of pistachio paste, if we use a 1% emulsifier, we do not need to use carotino oil and this halva is the best halva which is also cost-effective. In this case, it is not possible to prevent the oil from being separated 100%, but to a large extent. But if we want to avoid 100% oil separation, and can use a 2% emulsifier, it is better to use some amount of carotino oil or reduce the amount of pistachio paste used from about 3 - 5% to about 2% or less.

Peroxide value

Table 3 shows the peroxide value of halva with different amounts of carotino oil and monodiglyceride during 2 months of storage. According to the results, control halva had the highest peroxide value during 2 months of storage. This is because the oil separated from the pistachio halva texture is exposed to air and oxygen and its peroxide value increases. On the other hand, halves containing 2% monodiglyceride showed the lowest peroxide value. This indicates that when formed by a strong lattice, when the pistachio oil is locked in its texture (i.e., not a two-phase halva) and not exposed to air, the peroxide value will be reduced.

According to Iranian National Standard, the maximum permitted peroxide value in pistachio is 5 meq/kg [24]. This maximum is observed in samples without emulsifiers after 4 weeks and in samples with emulsifiers after 5 weeks. The control of halva peroxide reaches 8 after 8 weeks. Zero-time results in halva (fresh halva) show that the peroxide value is in the range of 1.7 to 2 meq/kg, which is high for newly produced halva. This is probably due to the high peroxide content of the pistachio paste, which is due to the initial conditions of the pistachio consumed or the process of pistachio or halva production. Therefore, it is necessary to carefully control the peroxide value of raw materials. Indirect heat should also be used as much as possible in the halva production process. If this problem is not resolved, the permitted antioxidants in the food industry may be used to the extent permissible in industrial plants.

Conclusion

Separation of oil from the product is one of the most important problems of halva that increases during storage, and negatively affects the color, texture and price of halva and decreases its shelf life. In this study, it was tried to use carotino

Table 3: Halva peroxide value with different amounts of carotino oil and monodiglyceride for 2 months storage.

Carotino oil (%)	Monodiglyceride (%)	Storage time (week)								
		0	1	2	3	4	5	6	7	8
0	0	1.7 ± 0.2^{a}	3.5 ± 0.2^{ab}	4.0 ± 0.2^{ab}	4.6 ± 0.4^{a}	5.2 ± 0.2^{a}	6.1 ± 0.2^{a}	6.7 ± 0.2^{a}	7.3 ± 0.4^{a}	8.0 ± 0.3^{a}
0	1	1.7 ± 0.1^{a}	3.0 ± 0.2^{b}	3.5 ± 0.3^{bcd}	4.0 ± 0.2^{ab}	4.9 ± 0.2^{ab}	5.4 ± 0.2^{bc}	6.1 ± 0.3^{ab}	6.8 ± 0.3^{ab}	7.3 ± 0.3^{ab}
0	2	1.8± 0.1^{a}	2.4 ± 0.2^{c}	3.0 ± 0.1^{cd}	3.6 ± 0.3^{b}	4.4 ± 0.2^{b}	5.2 ± 0.2^{c}	5.9 ± 0.2^{b}	6.3 ± 0.3^{b}	6.9 ± 0.4^{b}
1.5	0	1.7 ± 0.1^{a}	3.6 ± 0.2^{a}	4.1 ± 0.3^{ab}	4.6 ± 0.3^{a}	5.2 ± 0.2^{a}	6.0 ± 0.3^{ab}	6.5 ± 0.2^{ab}	7.1 ± 0.3^{ab}	7.5 ± 0.4^{ab}
1.5	1	1.9 ± 0.1^{a}	3.0 ± 0.1^{b}	3.6 ± 0.3^{abc}	4.1 ± 0.2^{ab}	4.9 ± 0.2^{ab}	5.4 ± 0.2^{bc}	6.1 ± 0.2^{ab}	6.9± 0.4^{ab}	7.4 ± 0.4^{ab}
1.5	2	2.0 ± 0.2^{a}	2.4 ± 0.2^{c}	2.9 ± 0.2^{d}	3.5 ± 0.2^{b}	4.3 ± 0.3^{b}	5.1 ± 0.2^{c}	6.0 ± 0.1^{b}	6.7 ± 0.2^{ab}	7.3 ± 0.3^{ab}
3	0	1.7 ± 0.0^{a}	3.6 ± 0.1^{a}	4.2 ± 0.2^{a}	4.6 ± 0.1^{a}	5.3 ± 0.3^{a}	6.0 ± 0.2^{ab}	6.5 ± 0.4^{ab}	7.2 ± 0.2^{a}	7.8 ± 0.4^{ab}
3	1	1.8 ± 0.1^{a}	3.0 ± 0.2^{b}	3.5 ±0.3^{bcd}	4.1 ± 0.2^{ab}	4.8 ± 0.2^{ab}	5.4 ± 0.2^{bc}	6.1 ± 0.2^{ab}	6.8 ± 0.2^{ab}	7.3 ± 0.3^{ab}
3	2	2.0 ± 0.1^{a*}	2.4 ± 0.2^{c}	3.0 ± 0.2^{cd}	3.7 ± 0.2^{b}	4.5 ± 0.2^{b}	5.1 ± 0.2^{c}	5.9 ± 0.2^{b}	6.5 ± 0.2^{ab}	7.1 ± 0.4^{ab}

Note: * and different letters in each column indicate significant statistical difference at 5% level.

oil and monodiglyceride emulsifier to reduce oil separation from pistachio halva texture. Based on the results, the control (without carotino oil and monodiglyceride), showed the highest oil separation for 8 weeks. However, the halva containing 2% monodiglyceride did not show oil separation during 8 weeks of storage. Also, a little oil was separated from the texture of halva containing 1% monodiglyceride, but there was no significant difference between the application of 1 or 2% monodiglyceride at a statistical level of 5%. This indicates that monodiglyceride emulsifier has been very effective in preventing oil separation. In terms of sensory evaluation, the highest score was obtained in halva with 1% monodiglyceride and the lowest score was observed in control halva. This indicates that the separation of oil was an important factor for evaluators and affected the overall acceptability of the product. Based on the results, control halva (without palm oil and monodiglyceride) had the highest peroxide value during 2 months of storage. On the other hand, halves containing 2% monodiglyceride showed the lowest peroxide value. However, there was no significant difference between the use of 1% or 2% monodiglyceride. This indicates that when the halva oil is locked into the texture (i.e., no two-phase halving) and is not exposed to air, the peroxide value will decrease even more when the solid network is formed. The results also showed that the addition of carotino oil and monodiglyceride did not affect the microbial load of halva. Overall, since the amount of monodiglyceride also affects the amount of used pistachio paste, if use 1% emulsifier, we don't need to use carotino oil and halva containing 1% monodiglyceride, is the best halva. It is also cost- effective. In this case, up to 60% of the oil separation can be prevented. Preventing the separation of oil from pistachio halwa keeps the final product softer, improves the taste and appearance of the product, and minimizes the possibility of the separated oil leaking during transportation.

Acknowledgements

The authors thank the Pistachio Research Center for supporting this research.

Conflict of Interest

None.

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