Improving the fig fruits growth and quality by spraying with extracts of moringa leaves and garlic cloves

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Abstract

This study in a private orchard at Zardak village in the Altun Kupri district, Kirkuk Governorate, Iraq on 27 of the "Khalobaziani" local fig trees was conducted in 2021. The trees were sprayed with Moringa leaves extract (MLE) at (0, 2, and 4 $ml.L^{-1}$) and Garlic cloves extract (GCE) at (0, 10 and 20 $ml.L^{-1}$) until complete wetness. Randomized Complete Block Design (RCBD) was utilized within the factorial experiments with two factors with three replicates. Results showed that trees sprayed with all concentrations of both extracts caused an increase in the diameter of the fruit more than in the control fruits. Significant differences in all properties studied were observed in the fruits sprayed with 2 and 4 $ml.L^{-1}$ of MLE and 10 and 20 $ml.L^{-1}$ of GCE they significantly distinguished over the control treatment in the fruit moisture content, TSS, TSS/TA ratio, glucose, fructose, vitamin C and pH. while the control treatment recorded the lowest fruit moisture content, TSS, TSS/TA ratio, glucose and fructose content, vitamin C, and pH. Moreover, a significant decrease in fruits TA content was found due to spraying with MLE or GCE compared to the control treatment.

Keywords: Moringa leaves extract, Garlic extract, Fig trees, Glucose, Fructose.

تحسين نمو وجودة ثمار التين بالرش بمستخلصي أوراق المورينكا وفصوص الثوم

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المستخلص

أجريت هذه الدراسة في بستان خاص في قرية زردك التابعة لناحية ألتون كوبري في محافظة كركوك-العراق على 27 شجرة من لأشجار التين المحلية صنف "خالوبازياني" في عام 2021. استخدامت تصميم القطاعات العشوائية الكاملة ضمن التجارب العاملية بعاملين وبثلاث مكررات. رشت الأشجار بمستخلص أوراق المورينجا (MLE) بتراكيز (0، 2 و 4 مل.لتر$^{-1}$) ومستخلص فصوص الثوم (GCE) بتراكيز (0، 10 و 20 مل.لتر$^{-1}$) حتى البلل التام. أظهرت النتائج أن رش الأشجار بجميع التراكيز لكلا المستخلصين تسبب في زيادة قطر الثمرة أكثر من الثمار المقارنة. كما لوحظت اختلافات معنوية في جميع الخواص الكيمياوية المدروسة للثمار التي تم رشها بـ 2 و 4 مل. لتر$^{-1}$ من MLE و 10 و 20 مل. لتر$^{-1}$ من GCE، حيث تميزوا بشكل كبير عن معاملة المقارنة في محتوى رطوبة الفاكهة و TSS و نسبة TSS/TA والجلوكوز والفركتوز وفيتامين C ودرجة pH. بينما سجلت معاملة المقارنة أقل محتوى رطوبة للفاكهة ونسبة TSS ونسبة TSS / TA ومحتوى الجلوكوز والفركتوز وفيتامين Cودرجة pH. علاوة على ذلك، لوحظ انخفاض معنوي في محتوى TA للثمار نتيجة الرش بـ MLE أو GCE قياسا بمعاملة المقارنة.

الكلمات المفتاحية: مستخلص أوراق المورينجا، مستخلص الثوم، اشجار التين.

Introduction

Ficus carica L. belongs to the Moraceae family and the genus Ficus, which includes more than 800 species of plants, most of which are evergreen, and a limited part of these trees and shrubs their fruits are edible, and a lot of them are classified as ornamental plants (Harrison, 2005; Herre et al., 2008). Fertilization is considered one of the important operations in fig orchards to obtain high productivity and quality (İrget et al., 2008).

Due to the high pollution of synthetic compounds used to improve fruit quality and plant

productivity, much more costly and unsafe. Consequently, there is a continuous requirement to seek natural sources as safe alternatives to natural growth regulators and plant nutrients (Phiri, 2010). Nowadays, several studies have proven that adding chemical fertilizers in large quantities has the main role in the pollution of the environment and health damage to animals and humans (Taiz & Zeiger, 2006). Human and public health and environmental protection have also become more important, and for this, the utilization of organic fertilizer is incrementing. Therefore, recent researchers have been interested in using plant extracts in the agriculture field, either as alternatives to pesticides, plant growth regulators, or chemical fertilizers in plant nutrition, because they are natural materials that do not leave any impact on human health and the environment.

Given the lowest economic cost, the more benefit of nutrients, and reduced pollution of the environment as a result of fertilization by foliar application, also more active than the plant-feeding from the earth in terms of the quick treatment for deficiency of the nutrients that appear clearly on the leaves (Mallarino, 2003).

Previous studies have proven that foliar spraying with Moringa leaves extract is very useful for enhancing the quality of the quantitative and qualitative products, and delays fruit aging (Nasir et al., 2016; Phiri & Mbewe, 2010). In addition to that, it increases the ability of crops to withstand adverse climatic conditions (Chang et al., 2007).

As for the garlic cloves extract, it is characterized by containing active substances such as Inuline, Alcinine, Alina and Aliina, and these substances are active antibiotics. It also contains vitamins and yeasts, as well as mineral salts such as sulfur, potassium, phosphorous, calcium, manganese, sodium and iodine, in addition to cellulose fibers, sugars, and fats (Bruneton, 2001). It also improves yield quality for apples (Al-Hadethi et al., 2016), for pears (Abd El-Razek et al., 2011).

Given the increased interest in the production and cultivation of fig trees in recent years and the

lack of studies on organic fertilization, especially the use of plant extracts, which may be effective in solving some of the problems facing the owners of fig orchards, such as fruits cracking and solar blight, and it is highly perishable. In addition to the role of plant extracts in increasing production and improving the quality of the crops. Moreover, the few studies on the use of moringa leaves extract on fruit trees, especially on fig trees, have not been used up to date, so we chose to use it with garlic clove extract in this study. Therefore, the main objectives of this study are to investigate the effectiveness of both extracts and their interactions in improving the fig fruit's growth and quality.

Materials and methods

This study was conducted on locally figs trees cv. Khalobaziani, planted at 2x3m, nine years old, 27 trees were selected homogeneous as possible as in terms of size and growth strength. To investigate the effect of spraying with Moringa leaves extract at (0, 2, and 4 $ml.L^{-1}$) and Garlic cloves extract at (0, 10 and 20 $ml.L^{-1}$) until complete wetness, while the control trees were sprayed with distilled water. The spraying process carried out in the evening and both extracts were sprayed three times during the growing season (2021) and the first spray was on (10/6/2021), and the second spray was on (30/6/2021), and the third spray was on (10/7/2021)

Preparation of plant extracts.

Preparation of moringa leaves extract

(250 g) of Moringa leaves powder was prepared and a liter of distilled water was added to it and mixed well from time to time and placed in a dark place for 24 hours, after which the resulting solution was filtered well with a piece of cheesecloth. The required concentrations were prepared from it, which are (2 and 4 $ml.l^{-1}$) according to what was mentioned (AL-Jabary & Fadil, 2017; Sura & Al-Hilfy, 2022).

Prepare garlic cloves extract

(1000 g) of garlic cloves were prepared and a liter of distilled water was added to it and mixed well by means of an electric mixer. After that, the resulting solution was filtered by a piece of cheesecloth, and the required concentrations of it were prepared, which are (10 and 20 $ml.l^{-1}$) according to what was mentioned (Aljabary, 2017).

Studied properties:

1- **Fruit growth curve (mm):** The average diameter of four fruits was calculated on the tree for each experimental unit and in each replicate starting from (14/6/2021), and weekly readings were taken from the same specified fruits using (Vernier).

2- **Moisture content of the fruit (%):** A certain weight of the fruits was dried in an electric oven (Oven) at a temperature of 100°C, until the weight was stable, then the percentage was extracted as follows:

   Moisture content (%) = (sample weight before drying - sample weight after drying/sample weight before drying) X 100

   Preparation of the composite sample: 10 ripen fruits were selected randomly for each experimental unit, which were harvested a month after the last spraying, the juice was made from them and all the chemical characteristics were estimated from it.

3- **Total soluble solids (TSS) (%):** Was determined by hand refractometer as described by (Ranganna, 2015)**.**

4- **Total titratable acidity (TA) (%):** Was determined based on malic acid content as the predominant acid (Ranganna, 2015).

5- **Total soluble solids/total acidity:** Calculated by dividing the values of the TSS by the

values of the total acidity of the fruits.

6- **The pH**: Was determined using a pH meter (Eu tech – Singapore).

7- **Glucose sugar and fructose in fruits (%):** Were determined by using phenol 5%, and H2SO4 (97%). Finally, glucose sugar and fructose were estimated by spectrophotometer at 488 nm for glucose and 490 nm for fructose as mentioned (Joslyn, 1970).

8- **Vitamin C (mg·100 g^{-1}):** Ascorbic acid in the juice was estimated by titration against 2,6 dichlorophenol indophenol blue pigment as mentioned by (Sadasivam & Manickam, 2005)

Experiment design and statistical analysis:

Randomized Complete Block Design (RCBD) was utilized within the factorial experiments with two factors with three replicates. Duncan's multiple range test was utilized at level 5% to compare the means, by utilizing (SAS 9.1 software).

Results and discussion

Fruit growth curve (mm):

When studying the fruit growth curve represented by the increase in the fruit diameter rate, it was found through the results of Figure (1). As it was distinguished by the presence of three main stages of the growth and development of fig fruits from the double sigmoid growth curve type; The first stage is the cells division stage resulting from the increase in the cells number as a result of cell division, which took up about (6 weeks). Followed by the second stage is the depressed period stage, where the slow increase in the fruit diameter occurred, it took up about (5 weeks). While, the third stage which is the cell enlargement stage, occurred increased size and elongation of the cells as a result of the transport of the nutrients substances to the fruits from their formation sources, which took up about (3) weeks. The speed of growth at the last stage depends on climate conditions and agricultural service operations, which affects the length of this stage. Followed by

the physiological maturity stage, it's short because the fruits reach full ripening just when reached the distinctive size of the cultivar, so changes their color, freshness and sweetness increase, and the tannins decrease just when reached the final size (Al-Ani, 1985). Taain (2010) obtained a similar behavior regarding the fruits of figs of the Diyala Black cultivar, except for the difference in the length of the growth stages, where the cell division stage lasted for twenty-one days, then the fruit entered the depressed period stage and lasted for thirty-five days, followed by a rapid growth period (the cell enlargement) It lasted for fourteen days, then the fruits entered the ripening stage at the end of this stage.

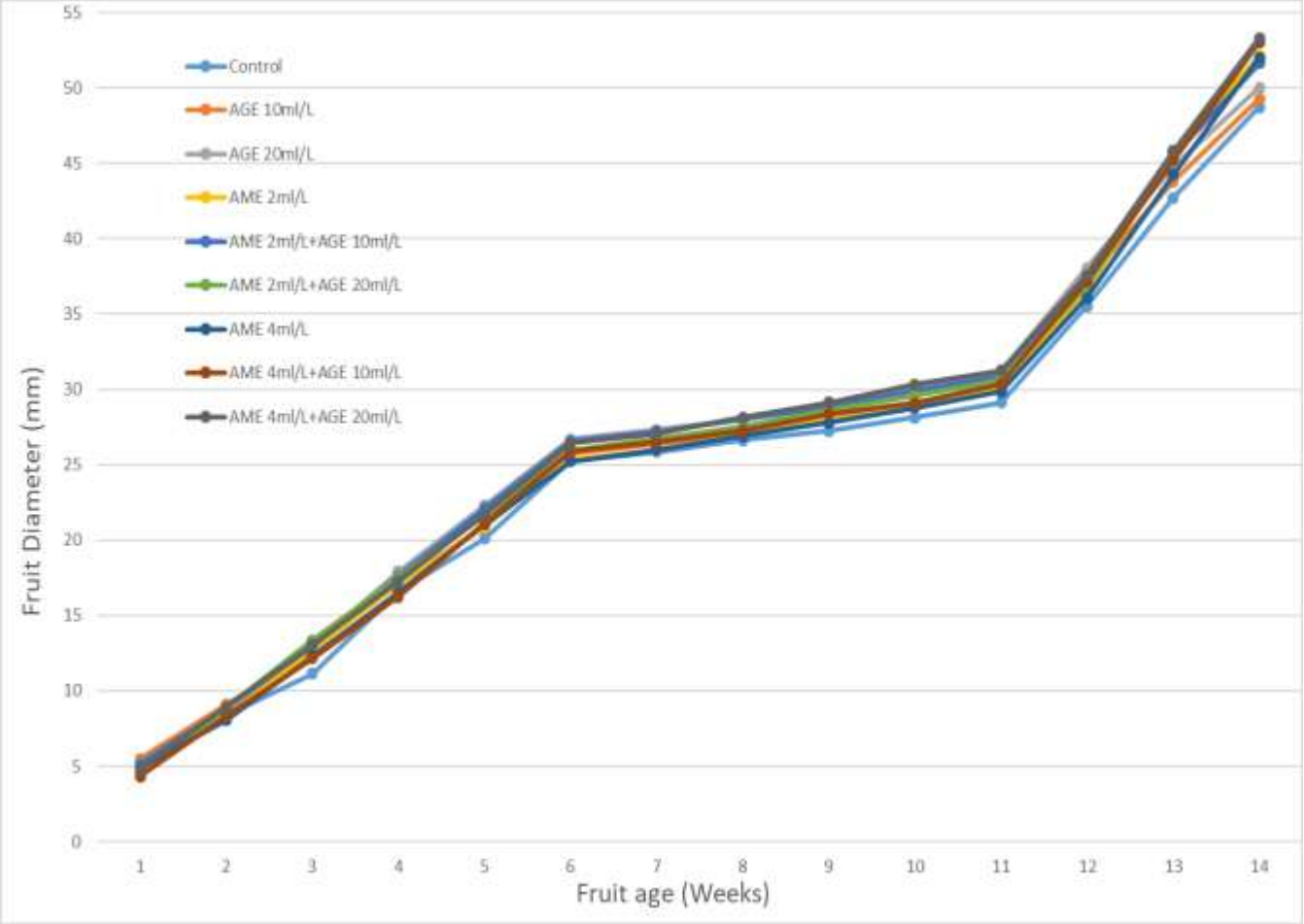

Figure 1: Shows the fruit growth curve represented by the increase in the fruit diameter (mm).

Figure (1) shows that spraying with all concentrations of both extracts caused an increase in the diameter of the fruit more than in the control fruits, especially from the 8th week to the last. The reason for this may be attributed to the use of spraying with moringa leaves extract containing plant growth regulators such as cytokinin hormone, which has physiological effects as it stimulates cell division and expansion, as well as the use of spraying with garlic clove extract rich in auxin hormone, which has a physiological effect on the plant. It stimulates cell division and enlargement and so fruit growth (Wasfi, 1995), which caused an increase in the diameter of fruits treated with both extracts.

Chemical properties:

Significant differences in all properties studied were observed (Table 1), especially in the fruits sprayed with 2 and 4 ml.L^{-1} of moringa leaves extract they significantly distinguished on the control treatment in the fruit moisture content (67.839 and 66.854 %), TSS (19.044 and 21.178 %), TSS/TA ratio (58.839 and 69.972 %), glucose (5.884 and 6.523 %), fructose (7.554 and 7.647 %), vitamin C (4.548 and 4.068 mg.100ml^{-1}) and pH (4.344 and 4.811) sequentially. While the control treatment recorded the lowest fruit moisture content, TSS, TSS/TA ratio, glucose and fructose content, vitamin C, and pH with values of 64.521 %, 17.989 %, 48.758, 5.517 %, 7.019 %, 4.210 mg.100ml^{-1} and 4.011 sequentially. Moreover, a significant decrease was found in fruits TA content due to spraying with moringa leaves extract compared to the control treatment.

Table 1. Effect of spraying with MLE and GCE concentrations on some chemical content in the fruit.

Treatments	Moisture (%)	TSS (%)	TA (%)	TSS/TA ratio	Glucose (%)	Fructose (%)	Vitamin C (mg.100ml^{-1})	pH
MLE 0 ml.l^{-1}	64.521 b	17.989 c	0.372 a	48.758 c	5.517 b	7.019 b	4.210 c	4.011 c
MLE 2 ml.l^{-1}	67.839 a	19.044 b	0.324 b	58.839 b	5.884 b	7.554 a	4.548 b	4.344 b
MLE 4 ml.l^{-1}	66.854 a	21.178 a	0.304 c	69.972 a	6.523 a	7.647 a	5.068 a	4.811 a
GCE 0 ml.l^{-1}	65.296 b	18.333 c	0.352 a	53.216 c	5.486 b	6.948 c	4.462 b	4.044 c
GCE 10 ml.l^{-1}	67.092 a	19.411 b	0.329 b	59.464 b	6.066 a	7.420 b	4.530 b	4.422 b
GCE 20 ml.l^{-1}	66.825 a	20.467 a	0.320 b	64.889 a	6.373 a	7.852 a	4.833 a	4.700 a

Values with different letters in one column are statistically different at 0.05

Related to the effect of spraying with garlic clove extract, the results showed that the spraying with 10 and 20 ml.l^{-1} were significantly superior to the control treatment by giving it the highest percentage in the fruit moisture content (67.092 and 66.825 %), TSS (19.411 and 20.467 %), TSS/TA ratio (59.464 and 64.889 %), glucose (6.066 and 6.373 %), fructose (7.554 and 7.647 %), Vitamin C (4.530 and 4.833 mg.100ml-1) and pH (4.422 and 4.700) respectively. At the same time, the lowest percentage of the fruit moisture content, TSS, TSS/TA ratio, glucose, fructose, Vitamin C and pH were obtained in the control treatment. On the other hand, the significant decrease was found in fruits TA content due to spraying with garlic cloves extract compared to control treatment (Table 1).

The interaction treatments between the extracts of moringa leaves and garlic cloves in Table (2), showed significant superiority when trees spraying with the highest level of moringa leaves extract (4 ml. l^{-1}) and garlic clove extract (20 ml. l^{-1}) by giving it the highest percentage of the TSS (21.567%), TSS/TA ratio (75.936%), glucose (6.897%), vitamin C (5.360 mg.100ml^{-1}) and pH

(5.167) in the fruits, also recorded the lowest percentage of the TA (0.284%). While the non-sprayed trees with extracts of moringa leaves and garlic clove gave the lowest percentage of the TSS, TSS/TA ratio, glucose, fructose, vitamin C and pH with values (15.633%, 39.100%, 5.003%, 6.263%, 4.070 mg.100ml^{-1}, and 3.667) respectively in the fruits.

Table 2. Effect of the interaction between MLE and GCE concentrations on some chemical content in the fruit.

Treatments		Moisture (%)	TSS (%)	TA (%)	TSS/TA ratio	Glucose (%)	Fructose (%)	Vitamin C (mg.100ml^{-1})	pH
MLE 0 ml.l^{-1}	GCE 0 ml.l^{-1}	62.087 d	15.633 e	0.400 a	39.100 e	5.003 d	6.263 d	4.070 d	3.667 e
	GCE 10 ml.l^{-1}	66.580 bc	18.700 cd	0.359 b	52.148 d	5.450 cd	6.810 c	4.230 d	4.100 de
	GCE 20 ml.l^{-1}	64.896 c	19.633 bc	0.357 b	55.025 d	6.097 bc	7.983 a	4.330 cd	4.267 cd
MLE 2 ml.l^{-1}	GCE 0 ml.l^{-1}	67.248 abc	18.967 cd	0.337 bc	56.376 d	5.317 d	7.160 bc	4.333 cd	4.100 de
	GCE 10 ml.l^{-1}	67.025 abc	17.967 d	0.319 c	56.434 d	6.210 b	7.737 ab	4.500 bcd	4.267 cd
	GCE 20 ml.l^{-1}	69.243 a	20.200 b	0.317 c	63.706 c	6.127 bc	7.767 a	4.810 bc	4.667 bc
MLE 4 ml.l^{-1}	GCE 0 ml.l^{-1}	66.553 bc	20.400 b	0.318 c	64.171 c	6.137 bc	7.420 ab	4.983 ab	4.367 cd
	GCE 10 ml.l^{-1}	67.671 ab	21.567 a	0.309 cd	69.810 b	6.537 ab	7.713 ab	4.860 abc	4.900 ab
	GCE 20 ml.l^{-1}	66.336 bc	21.567 a	0.284 d	75.936 a	6.897 a	7.807 a	5.360 a	5.167 a

Values with different letters in the one column are statistically different at 0.05

The reason for the positive effect on the qualitative and chemical characteristics is due to the content of Moringa leaves extract on plant growth hormones, especially the zeatin hormone approximately (10-45%); It also contains large quantities of necessary nutrients in good ratios that increase the growth and productivity of the crop and its components (Iqbal, 2014). Moreover, calcium and potassium in Moringa leaves extract to have a major role in plant growth and development through enzyme activation, regulation of osmotic pressure, improvement of photosynthesis, and improvement of other physiological processes (Hasegawa et al., 2000; Epstein

& Bloom, 2005). On the other hand, it may be due to its role in increasing the leaf area and the total chlorophyll content in the leaves (Taha & Aljabary, 2024), which increases the outputs of the photosynthesis process and thus increases the nutrients needed for the growth and development of fruits, and that the manufactured substances in the leaves move to the different parts of the plants and also to the fruits, thus cause to increase in the content of the fruits of total soluble solids, reducing sugars (glucose and fructose), and the vitamin C in the fruits. Its role in the decrease in the total acidity may be due to the increase in the moisture content, total soluble solids, and the percentage of sugars in the fruits, as well as the increased fruits content of vitamin C in the table (1), as a result of increasing the respiration process, in addition to the entry fruits into the climacteric phenomenon and they are reaching the ripening stage. In a study that included spraying with (2 and 4)% of moringa leaves extract during the 2013 and 2014 growing seasons on Le-conte pear trees, Abd El–Hamied & El-Amary, (2015) found that spraying with 4% caused a significant increase in the total soluble solids and the percentage of total sugars. It also caused a significant decrease in total acidity. In another study, Khan et al. (2020) found that spraying five cultivars of grape vines with moringa leaf extract at 3% significantly affected the properties of total soluble solids, total acidity, total sugars, vitamin C content in fruits, and pH value as compared to control treatment. In addition, our results are consistent with what was mentioned by Alsalhy & Aljabary (2020) when they studied spraying moringa leaf extract at 45 g.L-1 on the Halawani grape vines, which caused a significant increase in the total soluble solids and total sugars.

It was found through the positive results obtained in table 1 that spraying with garlic cloves extract on fig trees had a significant effect on the all characteristics studied; The reason for this effect is attributed to the role of this extract in increasing the vital and metabolic activities in the plant and thus increasing the absorption of nutrients by the plant and the presence of auxins that increase the

cell division process and its elongation, as well as the cause of increasing the leaf area and the total chlorophyll content and the percentage of dry matter in the leaves (Taha & Aljabary, 2024). Which increases the outputs of the photosynthesis process and thus increases the manufactured substances in the leaves and moves from their formation sources to their areas of attraction (fruits) in the plant, consequently causing to improve the qualitative and chemical characteristics of the treated fruits. In a study conducted by El-Sharony et al. (2015) on "Fagri Kalan" mango trees, found that spraying with a 5% concentration of garlic clove extract significantly increased the total soluble solids, ascorbic acid and sugar content in the fruits. In another study, Abd El-Hamied & El-Amary (2015) showed that the effect of spraying Le-conte pear trees with concentrations (2 and 4%) of garlic clove extract caused a significant increase in the total soluble solids and total sugars in the fruits, as well as a significant decrease in the total acidity in fruits, especially when spraying with a concentration of 4%, compared to the comparison treatment. As these results were coming consistently with what was stated by the researchers Elamary & Abd El-Hamied (2018) when they studied spray with garlic clove extract at 3 and 5% on grapevine, which led to a significant increase in the TSS and total sugars and reduced the TA compared to the non-spray treatment, especially when spraying at a 5%.

Conclusion

According to the results, we can conclude that sprayed with (2 and 4) $ml.l^{-1}$ MLE and (10 and 20) $ml.l^{-1}$ GCE led to a significant increase in growth and all the chemical characteristics studied of the fig fruits, except the total acidity was significantly decreased. Therefore, we can conclude and recommend spraying with MLE or GCE to improve the growth and quality of the fig fruits, in addition, these extracts are friendly to humans and the environment and could be used as an alternative to chemical fertilizer.

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