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Effect of Foliar Application of Cow Urine on Yield and Nutrient Uptake by Byadgi chilli (*Capsicum annuum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was carried out at farmer's field of Agadi village) in Dharwad district during *kharif* seson of 2018 to investigate the "Yield and nutrient uptake by Byadgi chilli (*Capsicum annuum* L.) as influenced by foliar spray of cow urine in a *Vertisol*". The experiment was conducted in randomized block design and replicated thrice. Experimental results revealed that, two foliar applications of 15 per cent cow urine each at 60 and 90 DAT recorded highest fruit yield (14.07 q ha^{-1}) which was statistically at par with two foliar application ten per cent cow urine (13.06 q ha^{-1}). Significantly lowest fruit yield was recorded in control with the corresponding value of 9.68 q ha^{-1}. Significantly highest total nutrient uptake was recorded with two foliar application of 15 per cent cow urine each at 60 and 90 days after transplanting.

Keywords: Cow urine; fruit yield; nutrients uptake.

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1. INTRODUCTION

"Byadgi chilli is a long duration (180 to 210 days) and indeterminate crop requires timely manuring particularly at grand growth (60-75 DAT) and fruit development (90-105 DAT) stages. Chilli plants should have adequate supply of nitrogen during fruit development for realizing higher yield. But, the conventional nitrogenous fertilizers applied to soil as basal dose during transplanting and top dressed after 45 DAT are subjected to leaching, volatilization and run off losses leaving very little nitrogen available during fruit development. This results in significant reduction in yield of chilli. In order to meet the timely and immediate requirement of nitrogen, foliar application of nitrogen through cow urine in addition to top dressing of urea is very essential. On an average about 13.0 liters of urine will be excreted by a cow in a day. This urine gets lost due to percolation, evaporation and runoff in cattle shed if the floor of cattle shed is of ordinary type and volume of urine excreted by cow will be more during rainy season. Hence urine excreted by farm animals can be used as source of nutrient after proper dilution with water" [1]. Stahl [2] reported that, "cow urine contains 1 per cent nitrogen, 1.9 per cent potassium and traces of phosphorus which can be used as source of liquid fertilizer". "Besides it contains oxalic acid, hipuric acid, crietinine, eltine, enzymes, steroids, propiline oxide, ethylene oxide, glycosides, glucose, citric acid, alkalide, acetate, endesonine, carbolic acid and growth promoting substances" [3]. "Foliar spray of cow urine at flowering and fruit development stages in chilli significantly enhance fruit yield. Very little information is available about the foliar spray of cow urine as a source of nutrients in influencing the yield" [4]. Hence the present study was planned to assess the effect of foliar application of cow urine on yield and nutrient uptake by Byadgi Chilli.

2. MATERIALS AND METHODS

A field experiment was conducted during *kharif* season of 2018 at farmer's field (Survey No. 88) of Agadi village (Tq., Hubballi) in Dharwad district. The soil of the experimental site is *Typic Chromustert*.

"Soil of the experimental site is clay in texture, neutral in pH (7.40), normal in soluble salts (0.26 dS m^{-1}), medium in organic carbon (6.90 g kg^{-1}), low in available nitrogen (188.65 kg ha^{-1}) and phosphorus (19.85 kg ha^{-1}), medium in potassium (290.50 kg ha^{-1}) and high in available sulphur (22.00 kg ha^{-1}). Cow urine was collected from a selected animal and analysed for its nutrient content and reaction (pH) and total soluble salt content. The concentration of diluted cow urine solution fixed for foliar spray is based on total soluble salt content of solution as indicated by EC values. It was observed that, 4, 6, 8, 10, 12, 14, 15 and 20 per cent solutions of cow urine after dissolving in bore well water recorded total soluble salt contents of 0.84, 0.95, 1.06, 1.14, 1.27, 1.46, 1.56 and 2.43 dS m^{-1} respectively. Based on the critical limit of total salt content in spray solution as given by CSSRI, Karnal as 2 dS m^{-1}, fifteen per cent solution of cow urine was taken as upper limit. Based on the peak requirement of nutrients to chilli crop, time and frequency of foliar sprays were fixed as 60 and 90 days after transplanting (DAT). The treatments details are furnished in Table-1" [1]. All the treatments received uniform dose of recommended fertilizers (100:50:50 N, P_2O_5, K_2O Kg ha^{-1}) along with 25 tonnes ha^{-1} of FYM. 45 days old chilli seedlings were transplanted at 75 cm X 75 cm spacing on Second fortnight of July, 2018. Completely matured red fruits were harvested in two stages, first on 10th Jnurary,2019 and second on 30th Janurary, 2019. These red fruits were sundried and yield was recorded by combining the fruits of two pickings and expressed in quintals per hectare. Plants and red chilli fruits were analysed for major and secondary nutrients as per standard procedures after wet ashing of samples with di-acid (HNO_3: $HClO_4$) mixture.

Table 1. Treatment details [1]

T_1	Control (Water spray at 60 & 90 DAT)
T_2	5 % cow urine spray at 60 DAT
T_3	10 % cow urine spray at 60 DAT
T_4	15 % cow urine spray at 60 DAT
T_5	5 % cow urine spray at 90 DAT
T_6	10 % cow urine spray at 90 DAT
T_7	15 % cow urine spray at 90 DAT
T_8	5 % cow urine spray at 60 & 90 DAT
T_9	10 % cow urine spray at 60 & 90 DAT
T10	15 % cow urine spray at 60 & 90 DAT
T11	1 % urea spray at 60 DAT
T12	50 ppm NAA spray at 60 DAT

Note: RPP (Recommended Package of Practices) for chilli is 100:50:50 N, P_2O_5, K_2O Kg ha^{-1} + FYM 25 tonnes ha^{-1} is common for all the treatments.

3. RESULTS AND DISCUSSION

3.1 Fruit Yield

"Foliar application of 15 % cow urine at 60 and 90 DAT (T_{10}) recorded highest fruit yield (14.07 q ha^{-1}) which was followed with 10% cow urine each at 60 and 90 DAT (13.06 q ha^{-1}) and 15 % cow urine spray each at 60 DAT (11.66 q ha^{-1}). This is due to fact that growth harmones present in cow urine stimulate meristematic tissue in chilli plants which lead to maximum number of flower buds and flowering. This might have formed a greater number of fruits in plants". Pujiharti *et al.* [5]. "It was noticed that, treatments (T_4, T_7 and T_{10}) that received 15 per cent foliar spray recorded numerically higher fruit yield than treatments that received five (T_2, T_5 and T_8) and ten (T_3, T_6 and T_9) per cent foliar spray. This was due to increased absorption of nitrogen by chilli leaves leading to increased chlorophyll content and photosynthesis. Further the photosynthates were translocated to developing fruits facilitated by the presence of potassium" [6] Significantly lowest fruit yield was recorded with water spray which was at par with foliar spray of NAA and 1% urea spray at 60 DAT. This is might have happened because of non-availability of N, P and K during flowering and fruit development stages in adequate amount which resulted in significant reduction in lowest yield.

3.2 Nutrient Uptake

3.2.1 Major nutrient uptake

3.2.1.1 Nitrogen

Significant difference existed between treatments with regard to nitrogen, phosphorus and potassium uptake by both plants and fruit samples.

Highest nitrogen uptake (43.82 and 47.02 kg ha^{-1} for plant and fruits, respectively) was observed in treatment (T_{10}) that received two sprays of 15 per cent cow urine at 60 + 90 DAT closely followed by treatment (T_9) that received two foliar sprays of 10 per cent cow urine (35.89 and 37.48 kg ha^{-1} for plant and fruits, respectively). This was mainly due to high fruit yield recorded in this treatment compared to other treatments. This is obvious because of higher amounts of nitrogen supplied through foliar spray of urine. This higher amount of nitrogen stimulated the growth of chilli plants leading to increased fruit yield and subsequent increased uptake. Control (T_1) recorded lowest nitrogen uptake (12.03 and 14.94 kg ha^{-1} for plant and fruit samples respectively) and differed significantly from all other treatments. Treatment (T_{10}) that received two sprays of 15 per cent cow urine at 60 + 90 DAT recorded highest total uptake (90.84 kg ha^{-1}) and differed significantly from rest of the treatments. Treatments with two sprays of cow urine recorded higher uptake than treatments with one spray. Foliar sprays given on 60 and 90 DAT have closely synchronized with peak flowering and fruit development stages and during these stages due to high physiological activities there might be greater demand for nitrogen by the plant. The nitrogen uptake values are in accordance with the values reported earlier by Jadhav [7] and Neelgar *et al.* [8] for Byadgi chilli. Control (T_1) recorded lowest total nitrogen uptake (26.97 kg ha^{-1}) and differed significantly from all other treatments. Lastly all treatments (T_2 to T_{10}) that received foliar spray of cow urine recorded higher total N uptake than treatments that received either water spray (T_1) or urea spray (T_{11}) or NAA spray (T_{12}). This was because of lower fruit yield along with leaching losses of nitrogen applied to the soil at the time of transplanting (45 DAT) through urea as top dressing. Further this treatment did not received N through foliar spray of urine.

3.2.1.2 Phosphorus

Highest uptake (7.78 and 7.87 kg ha^{-1} for plant and fruits, respectively) was observed in treatment (T_{10}) that received two sprays of 15 per cent cow urine at 60 + 90 DAT and differed significantly over all other treatments. This is obvious because of the presence of phosphorus (0.002 %) in cow urine. The absorbed phosphorus along with nitrogen enhances cell division, cell development leading to increased fruit yield. Treatment (T_{10}) that received two sprays of 15 per cent cow urine recorded highest total uptake (15.65 kg ha^{-1}) and differed significantly from rest of the treatments. Treatments with two sprays of cow urine (T_8, T_9 & T_{10}) recorded higher uptake of phosphorus than treatments with one spray. Treatments receiving 15 per cent cow urine recorded numerically higher P uptake than treatments receiving 5 and 10 per cent cow urine spray. Control (T_1) recorded lowest phosphorus uptake (5.33 kg ha^{-1}) and differed significantly from all other treatments except T_{12}. All the treatments that received cow urine spray recorded higher phosphorus uptake (7.65 to 15.65 kg ha^{-1}) than treatments which were devoid of cow urine spray except treatment T_2 that recorded 7.01 kg ha^{-1} of

phosphorus uptake. This was attributed to higher supply of phosphorus through foliar spray resulting in high fruit yield. Control recorded lowest uptake of phosphorus because, applied phosphorus at the time of transplanting might have been subjected to fixation, since the soil is slightly calcareous. The present values of phosphorus uptake closely with values reported earlier by Prabhavathi *et al.* [9] for Byadgi chilli.

3.2.1.3 Potassium

Treatment (T_{10}) that received two sprays of 15 per cent cow urine on 60 + 90 DAT recorded highest total uptake (158.94 kg ha^{-1}) and differed significantly from all other treatments except T_9 (157.43 kg ha^{-1}). This is obvious because of high K content in cow urine (0.93 %). Further, treatment with two sprays recorded higher uptake of potassium than treatments with one spray either at 60 or 90 DAT. Foliar sprays given at 60 and 90 DAT have closely synchronized with colour development in chilli fruits leading to increased potassium uptake. Treatments receiving 15 per cent cow urine recorded numerically higher potassium uptake than treatments receiving 5 and 10 per cent cow urine spray. Treatment with 50 ppm NAA spray recorded 79.91 kg ha^{-1} of total potassium uptake which differed significantly from treatment with one per cent urea spray (106.5 kg ha^{-1}) and control (T_1) recorded lowest potassium uptake (51.50 kg ha^{-1}). Potassium supplied through foliar spray of urine on 60 and 90 DAT directly enters the chilli fruits and participates in balancing acid: sugar ratio in fruits. Further it facilitates rapid transformation of chloroplasts (green colour) to chromoplasts. Because of these reasons, there was greater uptake of potassium at 105 and 140 DAT. Since the foliar spray of cow urine closely coincides with red colour development, there was increased uptake. Results of increased potassium uptake by chillies closely confirm the earlier findings reported by Prabhavathi *et al.* [9], Ananthi *et al.* [10].

3.2.2 Secondary nutrient uptake

3.2.2.1 Sulphur

Treatment (T_{10}) that received two sprays of 15 per cent cow urine recorded highest uptake (26.89 kg ha^{-1}) and differed significantly from rest of the treatments. Treatments (T_8 to T_{10}) with two sprays of cow urine recorded significantly higher uptake (17.49 and 26.89 kg ha^{-1}) than treatments with one spray. Treatments receiving 15 per cent cow urine spray recorded numerically higher S uptake than treatments receiving 5 and 10 per cent cow urine spray. Foliar spray of cow urine has increased sulphur uptake because of synergistic relationship between nitrogen and sulphur as they are constituents of proteins. Absorbed N by plant canopy stimulated sulphur uptake by plant roots. Control (T_1) recorded lowest sulphur uptake (4.78 kg ha^{-1}) and differed significantly from all other treatments. Prabhavathi *et al.* [9] reported that, foliar spray of potassium sulphate to chilli crop increased sulphur uptake because of sulphate sulphur present in sulphate of potash because of its direct absorption by leaves and fruits.

Table 2. Effect of foliar spray of cow urine on yield parameters and dry fruit yield of chilli (Cv. Dyavnur) [1]

Treatments	No. of fruits/plant/ picking	100 fruit weight (g)	Fruit yield (q ha^{-1})
T_1 - Control (Water spray at 60 & 90 DAT)	16.85	148.80	9.68
T_2 - 5 % cow urine spray at 60 DAT	17.50	151.97	10.01
T_3 - 10 % cow urine spray at 60 DAT	18.82	154.27	10.55
T_4 - 15 % cow urine spray at 60 DAT	21.95	163.10	11.66
T_5 - 5 % cow urine spray at 90 DAT	19.20	155.17	10.80
T_6 - 10 % cow urine spray at 90 DAT	20.75	161.70	11.30
T_7 - 15 % cow urine spray at 90 DAT	21.15	163.17	11.65
T_8 - 5 % cow urine spray at 60 & 90 DAT	20.30	160.53	11.25
T_9 - 10 % cow urine spray at 60 & 90 DAT	23.13	167.67	13.06
T_{10} - 15 % cow urine spray at 60 & 90 DAT	25.78	168.73	14.07
T_{11} - 1 % urea spray at 60 DAT	15.85	151.80	10.30
T_{12} - 50 ppm NAA spray at 60 DAT	14.78	148.5	9.90
S.Em. ±	**1.27**	**5.45**	**0.74**
C.D. (0.05)	**3.72**	**16.56**	**2.17**
C.V. (%)	**11.15**	**10.52**	**11.44**

Table 3. Effect of foliar spray of cow urine on the uptake of N, P and K nutrients (kg ha^{-1}) by chilli (Cv. Dyavnur) at harvest

Treatments	Nitrogen			Phosphorus			Potassium		
	Plant	Fruit	Total	Plant	Fruit	Total	Plant	Fruit	Total
T_1 - Control (Water spray at 60 & 90 DAT)	12.03 (1.16)	14.94 (1.54)	26.97	1.42 (0.14)	3.91 (0.40)	5.33	25.00 (2.41)	26.5 (2.55)	51.50
T_2 - 5 % cow urine spray at 60 DAT	21.63 (1.34)	25.62 (2.56)	47.25	2.87 (0.18)	4.14 (0.41)	7.01	43.11 (2.67)	46.25 (2.86)	89.36
T_3 - 10 % cow urine spray at 60 DAT	24.68 (1.39)	28.06 (2.66)	52.74	3.26 (0.18)	4.39 (0.41)	7.65	52.04 (2.93)	56.67 (3.19)	108.71
T_4 - 15 % cow urine spray at 60 DAT	30.82 (1.53)	32.99 (2.83)	63.81	5.49 (0.28)	5.59 (0.48)	11.08	64.46 (3.20)	68.95 (3.42)	125.29
T_5 - 5 % cow urine spray at 90 DAT	25.08 (1.40)	28.94 (2.68)	54.02	4.01 (0.23)	4.55 (0.42)	8.56	53.76 (3.00)	59.87 (3.34)	113.63
T_6 - 10 % cow urine spray at 90 DAT	28.02 (1.52)	31.73 (2.80)	59.75	4.66 (0.25)	4.79 (0.42)	9.45	57.70 (3.13)	62.56 (3.39)	120.26
T_7 - 15 % cow urine spray at 90 DAT	29.65 (1.52)	33.15 (2.84)	62.80	4.97 (0.25)	5.14 (0.44)	10.11	61.06 (3.13)	64.23 (3.29)	133.41
T_8 - 5 % cow urine spray at 60 & 90 DAT	28.04 (1.51)	30.48 (2.71)	58.52	4.19 (0.22)	4.74 (0.42)	8.93	59.99 (3.23)	63.25 (3.40)	123.24
T_9 - 10 % cow urine spray at 60 & 90 DAT	35.89 (1.59)	37.48 (2.87)	73.37	6.34 (0.28)	6.69 (0.51)	13.03	76.76 (3.40)	80.67 (3.57)	157.43
T_{10} - 15 % cow urine spray at 60 & 90 DAT	43.82 (1.61)	47.02 (3.34)	90.84	7.78 (0.29)	7.87 (0.56)	15.65	78.25 (2.87)	80.69 (2.95)	158.94
T_{11} - 1 % urea spray at 60 DAT	24.64 (1.38)	26.98 (2.62)	51.62	3.19 (0.18)	4.29 (0.41)	7.48	51.25 (2.87)	55.25 (3.09)	106.50
T_{12} - 50 ppm NAA spray at 60 DAT	19.55 (1.29)	23.76 (2.40)	43.31	2.63 (0.174)	4.04 (0.40)	6.67	38.35 (2.53)	41.56 (2.74)	79.91
S.Em. ±	1.61	1.63	2.67	0.27	0.21	0.56	2.39	1.16	3.75
C.D. (0.05)	4.88	4.88	7.82	0.82	0.71	1.65	7.23	3.52	11.01
C.V. (%)	5.66	6.45	6.04	4.64	5.95	5.52	8.12	7.01	5.70

Figures in parenthesis indicate nutrient concentration in per cent
DAT - Days after transplanting

Table 4. Effect of foliar spray of cow urine on the uptake of secondary nutrients (kg ha^{-1}) by chilli (Cv. Dyavnur)

Treatments	Sulphur			Calcium			Magnesium		
	Plant	Fruit	Total	Plant	Fruit	Total	Plant	Fruit	Total
T_1 - Control (Water spray at 60 & 90 DAT)	2.07 (0.20)	2.71 (0.20)	4.78	8.29 (0.8)	10.64 (1.1)	18.93	2.22 (0.20)	2.74 (0.23)	4.96
T_2 - 5 % cow urine spray at 60 DAT	3.55 (0.22)	6.30 (0.63)	9.85	17.76 (1.1)	13.01 (1.3)	30.77	2.80 (0.25)	4.03 (0.28)	6.83
T_3 - 10 % cow urine spray at 60 DAT	4.08 (0.23)	9.57 (0.92)	13.65	15.09 (0.85)	10.02 (0.95)	25.11	2.63 (0.22)	3.90 (0.25)	6.53
T_4 - 15 % cow urine spray at 60 DAT	7.04 (0.35)	10.81 (0.93)	17.85	15.0 (0.75)	10.37 (0.89)	25.37	2.70 (0.19)	3.62 (0.22)	6.32
T_5 - 5 % cow urine spray at 90 DAT	4.83 (0.27)	10.44 (0.97)	15.27	13.44 (0.75)	9.18 (0.85)	22.62	2.16 (0.19)	3.74 (0.22)	5.90
T_6 - 10 % cow urine spray at 90 DAT	5.52 (0.30)	10.58 (0.94)	16.10	21.20 1.15)	14.91 (1.32)	36.11	3.73 (0.31)	5.53 (0.32)	9.26
T_7 - 15 % cow urine spray at 90 DAT	6.43 (0.33)	11.68 (1.00)	18.11	15.60 (0.8)	11.06 (0.95)	26.66	2.91 (0.20)	3.90 (0.25)	6.80
T_8 - 5 % cow urine spray at 60 & 90 DAT	5.57 (0.30)	11.92 (1.06)	17.49	16.71 (0.9)	12.93 (1.15)	29.64	3.26 (0.20)	4.64 (0.29)	7.90
T_9 - 10 % cow urine spray at 60 & 90 DAT	8.80 (0.39)	14.35 (1.09)	23.15	20.31 (0.90)	20.88 (1.60)	41.19	3.56 (0.23)	6.54 (0.32)	10.1
T_{10} - 15 % cow urine spray at 60 & 90 DAT	10.88 (0.40)	16.01 (1.13)	26.89	29.94 (1.1)	23.20 (1.65)	53.14	5.40 (0.34)	8.64 (0.36)	14.04
T_{11} - 1 % urea spray at 60 DAT	3.93 (0.22)	9.17 (0.89)	13.10	16.07 (0.9)	10.81 (1.05)	26.88	2.67 (0.23)	4.10 (0.26)	6.77
T_{12} - 50 ppm NAA spray at 60 DAT	3.18 (0.21)	6.47 (0.65)	9.65	17.42 (1.15)	11.84 (1.20)	29.26	2.77 (0.25)	3.79 (0.28)	6.56
S.Em. ±	**0.32**	**0.18**	**0.81**	**1.55**	**1.19**	**1.63**	**0.24**	**0.22**	**0.49**
C.D. (0.05)	**0.95**	**0.55**	**2.37**	**4.87**	**3.95**	**5.01**	**0.75**	**0.71**	**1.43**
C.V. (%)	**6.23**	**5.12**	**7.27**	**5.56**	**3.59**	**3.32**	**4.10**	**4.95**	**3.95**

Figures in parenthesis indicate nutrient concentration in per cent
DAT - Days after transplanting

3.2.2.2 Calcium

Treatment (T_{10}) that received two sprays of 15 per cent cow urine recorded highest uptake (53.14 kg ha^{-1}) and differed significantly from rest of the treatments. Treatments receiving 15 per cent cow urine spray recorded numerically higher Ca uptake than treatments receiving 5 and 10 per cent spray. This was mainly due to high fruit yield recorded in this treatment compared to other treatments and also due to higher production of fruit yield with high concentration of Ca and N given through foliar spray of cow urine because of rapid cell elongation, cell division and a greater number of leaves which resulted in more vegetative and reproductive growth. Increased uptake of calcium was due to calcium supplied through urine spray (50 mg L^{-1}) and its absorption by leaves, stems and to limited extent by fruits. Results of calcium uptake obtained in the present investigation are in accordance with the values reported earlier by Jadhav [7].

3.2.2.3 Magnesium

Highest magnesium uptake (5.40 and 8.64 kg ha^{-1} for plant and fruits, respectively) was observed in treatment (T_{10}) that received 15 per cent cow urine spray on 60 + 90 DAT and differed significantly from all other treatments. Control (T_1) recorded lowest magnesium uptake (2.22 and 2.74 kg ha^{-1} for plant and fruit samples respectively). Further treatment (T_{12}) with 50 ppm NAA spray recorded 2.77 and 3.79 kg ha^{-1} of magnesium uptake for plants and fruits that was on par with treatment (T_{11}) that received urea spray (2.67 and 4.10 kg ha^{-1} for plants and fruits, respectively). Treatment (T_{10}) that received two sprays of 15 per cent cow urine recorded highest total uptake (14.04 kg ha^{-1}) and differed significantly from rest of the treatments. This might be due to high dry matter production and Magnesium content of 22.22 mg L^{-1} present in cow urine which might be contributed to greater chlorophyll formation which in turn led to more vegetative growth that increased the dry matter production.

4. CONCLUSION

Two foliar applications of 15 per cent cow urine one each at 60 and 90 DAT recorded highest fruit yield (14.07 q ha^{-1}) closely followed by two foliar sprays at ten per cent (13.06 q ha^{-1}), further followed by one spray of cow urine at 15 per cent on 60 DAT (11.66 q ha^{-1}). Significantly highest total nutrient uptake was recorded with two foliar application of 15 per cent cow urine each at 60 and 90 days after transplanting. Irrespective of the concentration and frequency of foliar spray of cow urine, nutrient uptake of Byadgi chilli has increased because of cow urine foliar spray over control.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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