MORE EFFICIENT RESIN PRODUCTION FROM *PINUS ROXBURGHII* (CHIR PINE)

by

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Summary. *The study was started with a view to increasing the resin output from chir pine (Pinus roxburghii) forests.* 500 *trees,* 27.5 *to* 40 *cm in diameter were selected at two different sites. In the first year i.e.,* 1974, *all the trees were worked under French system of tapping for the purpose of calibration of yield. At the end of the tapping season, progressive increase in yield was indicated with the increase in diameter. Some trees turned out to be natural high yielders.*

In 1975, *use of chemicals was introduced.* 10% *sodium chloride solution,* 40% *sulphuric acid solution and* 60% *sulphuric acid paste were used. Whereas for sulphuric acid paste and solutions, American bark chipping method was employed, for the purposes of control and sodium chloride solution, French blazes were used. It was found that* 40% *sulphuric acid solution provided maximum stimulation; the yield under this treatment was the highest. The trees were subjected to the same treatment during the year* 1976 *and* 1977 *and the results of first year were confirmed. As compared to the control the resin yield was almost doubled by the application of* 40% *sulphuric acid solution.*

In the year 1977, *not only the treatment was continued on the old* 500 *trees but also another set of* 225 *trees was selected as an adaptation of the American method to suit the existing management and silvicultural requirements of chir forests in Pakistan. Only one stimulant i.e.,* H_2SO_4, 40% *and* 50% *in solution form was used and compared with the French method (control). The major change was that the annual face width was not kept equal to diameter of the tree but only* 15 *cm. In the new experiment, also* 40% *sulphuric acid solution gave the best results, the average yield per tree being* 3.7 *kg as compared to the control,* 1.5 *kg.*

Introduction. Resin is an important produce from *Pinus roxburghii* (chir pine) in the northern and western parts of Pakistan. Out of nearly 1.1. million hectares under conifers in this country, this species is growing over an area of 0.37 million hectares approximately. With the present method of tapping known as the French method, chir forests of a particular age which are annually tapped for resin are yielding about 11.5 million kg resin per annum. This roughly comes to about 2.3 kg per tree. On account of rising tempo of development in the country, domestic demand for resin has increased manifold in the last few years. The present production is totally inadequate to meet the requirements of the industry. It is not even sufficient to keep the existing resin factories in full time operation.

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The anticipated annual requirement of resin for use within the country by 1980 is estimated to be 16 million kg in addition to turpentine. There are no immediate prospects of increasing the area under chir forests. Even if planting of chir is taken up on a large scale, it will be about 50 years before the trees would attain reasonable diameter fit enough for tapping. The only alternative, therefore, is to try other methods which could help increase yield of resin. Besides the need for an increase in quantity of resin, the foresters are also confronted with some other problems. One snag in the French method of tapping is that the butt log which is the most valuable part of the tree is very badly damaged and fetches far less price. Secondly, under the French method, the blaze has to be renewed evey 5 to 6 days and lot of expert labour is needed for freshening and collection. It is becoming a problem to find suitable labour as there is continuous shifting of population from hilly areas to the industrial sites in bigger cities where they get much better wages.

With a view to finding a solution to these problems, the project entitled "Stimulation of flow of resin in *Pinus roxburghii* with chemicals" was started with the following objectives:

— How far *Pinus roxburghii* would react to the treatment of different chemicals in so far as stimulation of flow of resin concerned?

— Which chemicals would be more suitable and what would be their optimum dose?

Experimental procedure. *Design of the* 1974 *study:* In 1974 two sites were selected for this study viz. Batrasi and Baz Khan in the district of Hazara, N.W.F.P. The study was laid out in split pot design. In all 500 trees were selected at both the sites. The 250 trees at each site were divided into 5 blocks of 50 trees each, subdivided into 5 major plots containing 10 trees. Each major plot was further split into two minor plots each having 5 trees. Application of fertilizer (1.13 kgs of urea + 1.13 kgs of superphosphate to each of 5 trees constituting a minor or subplot) necessitated this subdivision.

No chemicals were applied during 1974, and the crop was tapped under the French system as it was considered desirable to put the trees through a calibration period.

Use of stimulants was introduced for the first time in 1975. 40% H_2SO_4 solution turned out to be the best stimulant during that year. In 1976 and 1977, the same trees were again subjected to stimulation.

Plan of application of stimulants. Following plan of treatment was used. It was started on March 31 and April 2 at Batrasi and Baz Khan respectively:

General view of the crop showing 4th year of tapping under the two systems viz French and American bark hack

French method of tapping-Control

Code	Treatment	Chipping intervals	Chipping method	No. of streaks per year	Average height of streak	
					Inch	Cms
A	10% NaCl solution	7 days	French blaze	32	0.25	0.64
B	60% H_2SO_4 paste	21 days	American bark hack	11	1.50	3.81
C	40% H_2SO_4 solution	14 days	,,	16	0.75	1.90
D	60% H_2SO_4 solution	14 days	,,	16	1.00	2.54
E	Control—Untreated	7 days	French blaze	32	0.25	0.64

The schedule adopted for the application of different chemicals and collection of resin is appended (I).

Analysis of data. *Old study.* Summary of resin yield under different treatments is given in tables (1) and (2). The data collected from each locality were analysed statistically using "analysis of variance" method. A resume for both the localities is given as under:

TABLE 1

SUMMARY OF AVERAGE RESIN YIELD PER SUB PLOT Kg Site : Batrasi

Blocks	Treatment A		B		C		D		E		Block sub-total		Block total	Block means
	F	X	F	X	F	X	F	X	F	X	F	X		
I	9.905	11.515	15.860	24.2'0	35.570	28.780	20.015	22.085	14.265	12.665	95.705	99.285	194.990	19.499
II	5.830	9.915	17.460	15.815	26.945	29.020	24.235	25.025	14.725	10.450	89.195	90.225	179.420	17.942
II	8.260	9.010	18.820	17.785	29.355	28.240	23.995	17.070	11.710	10.835	92.140	84.940	175.080	17.708
IV	9.330	9.220	19.300	17.395	23.430	24.295	18.875	24.650	9.960	11.390	80.795	86.950	167.845	16.784
V	11.090	10.160	15.045	15.060	27.665	30.090	18.980	18.445	6.495	11.090	79.275	84.845	164.120	16.412
F x T totals	44.415	49.820	86.485	90.295	142.965	140.425	106.190	107.275	57.155	56.430	437.210	444.245	881.455	
F x T means	8.880	9.964	17.297	18.059	28.593	28.085	21.239	21.455	11.431	11.286				
F x T sums	18.847		35.356		56.678		42.693		22.717					

TABLE 2

SUMMARY OF AVERAGE RESIN YIELD PER TREE (kg)

Blocks	Treatment A		B		C		D		E		Block sub-total		Block total	Block means
	F	X	F	X	F	X	F	X	F	X	F	X		
I	1.981	2.303	3.172	4.848	7.114	5.756	4.021	4.417	2.853	2.533	19.141	19.857	38.998	
II	1.166	1.983	3.492	3.163	5.389	5.804	4.847	5.005	2.945	2.090	17.839	18.045	35.884	
III	1.652	1.802	3.764	3.557	5.871	5.648	4.799	3.414	2.342	2.167	18.428	16.588	35.016	
IV	1.866	1.844	3.860	3.479	4.686	4.859	3.775	4.930	1.992	2.278	16.179	17.390	33.569	
V	2.218	2.032	3.009	3.012	5.533	6.018	3.756	3.689	1.299	2.218	15.815	16.969	32.784	
F x T totals	8.883	9.964	17.297	18.059	28.593	28.085	21.198	21.455	11.431	11.286	87.402	88.849	176.251	
Treatment means	18.847		35.356		56.678		42.653		22.717		176.251			
F x T means sum	1.776	1.993	3.459	3.612	5.517	5.617	4.239	4.291	2.286	2.257				
Treatment sum	3.769		7.071		11.134		8.530		4.543					
Treatment means	1.884		3.535		5.567		4.265		2.271					

TABLE 3

SUMMARY OF AVERAGE RESIN YIELD PER SUB-PLOT (kg) Site : Baz Khan

Blocks	Treatment										Block sub-total		Block total	Block means
	A		B		C		D		E					
	F	X	F	X	F	X	F	X	F	X	F	X		
I	10.035	8.935	17.095	16.820	29.625	31.700	20.665	23.920	10.725	10.695	88.145	92.070	180.215	18.021
II	10.290	9.305	19.355	20.340	37.680	29.300	22.885	18.425	9.460	8.605	99.650	85.975	185.625	18.562
III	9.825	9.840	16.500	18.240	30.180	29.245	22.130	22.695	9.515	9.475	88.150	89.495	177.645	17.764
IV	11.050	11.080	20.070	18.873	32.815	29.040	23.465	23.960	11.825	12.010	99.225	94.963	194.188	19.418
V	10.790	11.635	12.545	19.795	28.230	28.675	28.780	24.615	10.670	10.030	91.015	94.750	185.765	18.576
F x T total	51.990	50.795	85.565	94.068	158.510	147.960	117.925	113.615	52.195	50.815			923.438	
F x T means	10.358	10.159	17.113	18.813	31.702	29.592	23.985	22.723	10.439	10.63				
F x T sums	20.517		35.926		61.294		46.708		20.602					

TABLE 4

SUMMARY OF AVERAGE RESIN YIELD PER TREE (kg)

Blocks	Treatment										Block sub-total		Block total	Block means
	A		B		C		D		E					
	F	X	F	X	F	X	F	X	F	X	F	X		
I	2.007	1.787	3.419	3.364	5.925	6.340	4.133	4.784	2.145	2.139	17.629	18.414	36.043	3.604
II	2.058	1.861	3.871	4.068	7.532	5.860	4.577	3.685	1.892	1.721	19.930	17.195	37.125	3.712
III	1.965	1.968	3.300	3.648	6.036	5.849	4.426	4.539	1.903	1.895	17.630	17.899	35.529	3.552
IV	2.210	2.216	4.014	3.775	6.563	5.808	4.693	4.792	2.365	2.402	19.845	18.993	38.838	3.883
V	2.158	2.327	2.509	3.959	5.646	5.735	5.756	4.923	2.134	2.006	18.203	18.950	37.153	3.715
F x T total	10.398	10.159	17.113	18.814	31.702	29.592	23.585	22.723	10.439	10.163	93.237	91.451	184.688	
F x T means	2.079	2.031	3.422	3.762	6.340	5.918	4.717	4.544	2.087	2.033				
F x T sums	4.110		7.184		12.258		9.261		4.120					
Treatment means	2.055		3.592		6.129		9.630		2.060					

Summary of data given in tables 1 and 2 were subject to 'F test.

Table 5

Analysis of variance (Split plot design)

Source of variation (S.V.)	Degree of freedom (df)	Sum squares (SS)	Mean squares (MS)
Blocks	4	58.038	14.509
Treatments	4	2351.757	587.939
Major plot error (I)	16	117.152	7.322
Fertilizer	1	0.990	0.990
F x T (interaction)	4	4.149	0.050
Subplot error (II)	20	138.575	6.929
Total:	49	2670.711	

'F Test for:

$$\text{Treatment} = \frac{\text{Treatment MS}}{\text{Major plot error MS}} = \frac{2351.757}{7.322} = 80.297^{**}$$

$$\text{Fertilizer} = \frac{\text{Fertilizer MS}}{\text{Subplot error MS}} = \frac{0.990}{6.929} = 0.142\ \text{NS}$$

$$\text{F x T} = \frac{\text{F x T MS}}{\text{Subplot error MS}} = \frac{0.050}{6.2929} = 0.152\ \text{NS}$$

** = Highly significant
N.S. = Non-significant

'F' test showed that the treatment effects were highly significant. To further analyse the data to see which treatment(s) differed significantly from other(s) 't' test was applied which yielded the following statistics:

Treatment	Mean of Major plots	Blocks		Treatment	Means of subplots
A	9.423	I	19.499	Fertilized (F)	17.488
B	17.678	II	17.942		
C	28.339	III	17.508	Unfertilized (X)	17.770
D	21.346	IV	16.784		
E	11.358	V	16.412		

't' test for major plot means with 16 df.

Mean of	versus	Mean of	't' Value
A	,,	B	8.255**
A	,,	C	18.916**
A	,,	D	11.920**
A	,,	E	1.935 NS,
B	,,	C	10.661**
B	,,	D	3.668**
B	,,	E	6.320**
C	,,	D	6.993**
C	,,	E	16.981**
D	,,	E	9.988**

** = Highly significant
NS = Non-significant

Tabulated value of 't'
t (.05, 16) = 2.120
t (.01, 16) = 2.921

B. Baz Khan

Data given in tables 3 and 4 were subjected to 't' test as was done for Batrasi data. The analysis table 6 based on split plot design is given below:

Table 6

Analysis of variance (Split plot design)

Source of variation (S.V.)	Degree of freedom (df)	Sum of squares, (SS)	Means of squares (MS)
Block	4	0.6478	0.1620
Treatments	4	121.7236	30.4309
Major plot error (I)	16	3.5281	0.2205
Fertilier	1	0.0638	0.0638
F x T (interaction)	4	0.7584	0.1896
Subplot error (II)	20	3.1787	0.1589
Total	49	129.9004	

'F' test for:

$$\text{Treatment} = \frac{\text{Treatment MS}}{\text{Major plot error MS}} = \frac{30.4309}{0.2205} = 138.00^{**}$$

$$\text{Fertilizer} = \frac{\text{Fertilizer MS}}{\text{Subplot error MS}} = \frac{0.0638}{0.1589} = 0.402\ NS$$

$$\text{F x T} = \frac{\text{F x T MS}}{\text{Subplot error MS}} = \frac{0.1896}{0.1589} = 1.193\ NS$$

** = Highly significant
NS = Non-signaficant

'F' test showed that the treatment effects were highly significant. To further analyse the data to see which treatment(s) differed significantly from other(s) 't' test was applied which yielded the following statisics:

Treatment	Mean of Major plots	Blocks		Treatment	Means of subplots
A	2.055	I	3.604	Fertilized (F)	3.730
B	3.592	II	3.712		
C	6.129	III	3.552	Unfertilized (X)	3.658
D	4.630	IV	3.883		
E	2.060	V	3.715		

TABLE 7

Comparison of 1975, 1976 *and* 1977 *average yields from single tree*

Treatment	Yield per tree (kg)											
	Fertilized						Not fertilized					
	1975		1976		1977		1975		1976		1977	
	Yield	Deviation %	Yield	Devtation %	Yield	Deviation %	Yield	Deviation %	Yield	Deviation %	Yield	Deviation %
					Locality : Batrasi							
A	1.955	—23	1.927	—12	1.776	—22	1.720	—21	2.104	—6	1.993	—12
B	3.140	+24	3.159	+44	3.459	+51	3.067	+41	3.576	+60	3.612	+60
C	4.841	+91	5.690	+160	5.517	+141	4.260	+96	5.507	+146	5.617	+149
D	3.963	+56	4.032	+84	4.239	+85	3.685	+69	4.191	+87	4.291	+90
E	2.533	—	2.190	—	2.286	—	2.180	—	2.240	—	2.257	—
					Locality : Baz Khan							
A	2.145	—9	2.122	—6	2.075	—	1.892	—10	1.845	—13	2.031	—
B	4.180	+78	3.196	+42	3.422	+64	3.786	+81	3.668	+75	3.762	+85
C	5.023	+114	6.247	+177	6.340	+204	4.343	+107	5.739	+172	5.918	+191
D	4.806	+104	4.537	+101	4.717	+126	4.043	+93	4.375	+107	4.544	+123
E	2.353	—	2.254	—	2.087	—	2.096	—	2.111	—	2.033	—

't' test for major plot means with 16 df.

Mean of	versus	Mean of	't' Value
A	,,	B	5.175 **
A	,,	C	13.717 **
A	,,	D	8.670 **
A	,,	E	0.017 NS
B	,,	C	8.542 **
B	,,	D	3.495 **
B	,,	E	5.158 **
C	,,	D	5.047 **
C	,,	E	13.700 **
D	,,	E	8.653 **

**—— Highly significant
NS = Non-significant

Tabulated value of 't'
t (.05, 16) = 2.120
t (.01, 16) = 2.921

Results and discussions. *Comparison of resin yield for* 3 *consecutive years.* Resin yields for the three consecutive years of tapping under 5 treatments are given below in table 7.

It is indicated that:

At Batrasi, there is gradual increase in the yield under all acid treatments, the highest positive deviation being in trees treated with 40% H_2SO_4 solution.

At Baz Khan, it is almost the same pattern except that under treatment B and D yield is more as compared to last year.

NEW EXPERIMENT 1977

Background information. Resin tapping in Pakistan is a slow process because of the long rotation on which chir forests are worked. Tapping is normally started when the tree attains a diameter of 40 cm. Depending upon site quality, this takes 60 to 70 years. Rotation being 100-120 years in different areas of the country, tree has thus to stay in the forest for another 40-50 years after the introduction of resin tapping. The American system which involves making of face width equal to the diameter of the tree would take only a few years to go round the whole tree, in the process, removing the bark upto the height of 80 cm or so from the ground level. After that it would not be possible to tap the tree further due to practical difficulties. The American system have had its success in U.S.A. because in routine the tapping is started about 4 to 5 years before final felling and the adverse effects of completely going round the tree during the course of tapping which might lead to girdling do not show up.

There is already a move in Pakistan that the rotation of chir pine should be reduced from 100-120 years to 60 years or so, because it has been established that the rate of growth of the tree after 60-70 years starts going down. If that decision comes through the American system can be applied in full in Pakistan putting the trees to stimulation 4 to 6 years before final felling. That would almost commensurate with the existing practice of starting tapping at the age of 55 to 60 years.

Mr. Ralph W. Clements, the Consulting Scientist on the project after studying this problem in depth has come out with a modification of the previous study plan to suit the local conditions in Pakistan till the rotation is reduced.

Objectives: To determine how resin yield by bark chipping and selected acid treatment would compare with untreated chipping (French blazes) with face width ranging from 10 to 14 percent of the circumference of the tree.

Experimental procedure. *Design of the study.* In all 225 trees of diameter from 30-40 cm were selected for 3 treatments replicated five times in a randomised block design, unit of treatment being 15 trees:

Replications:

I	II	III	IV	V
B	C	A	A	B
A	B	C	B	C
C	A	B	C	A

Treatments:

A : 40% H_2SO_4 solution
B : 50% H_2SO_4 solution
C : Untreated (Control)

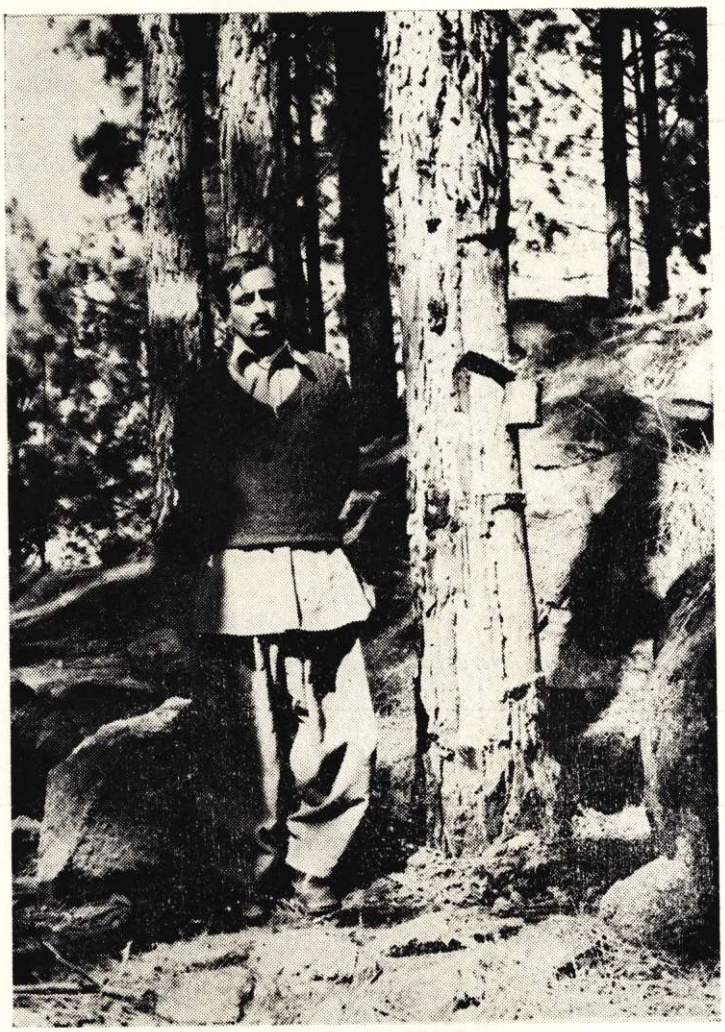
Setting up of the crop. Crop was set according to the American and French methods as done in the earlier years of the project. Size of the gutters and aprons was, however, reduced according to the face width i.e., 15 cm.

Plan of application of stimulants. Following plan of treatment was used:

Code	Treatments	Chipping of streks				Annual face	
		Method	Interval	Total	Height	Width	Height
			Days	No	Cm	Cm	Cm
A	40% H_2SO_4 Sol.	Bark	14	16	1.90	15	30
B	50% H_2SO_4 Sol.	Bark	14	16	2.54	15	40
C	Untreated	French	7	32	0.65	11	21

Note: Streak and face heights are estimates which served as guidelines for application procedures.

First year of the new experiment where annual face width has been reduced to 15 cm instead of keeping it equal to the diameter of the tree



The tree under 4th year of tapping showing 1st year's French and subsequent years American bark hack method.

Collection of data and its analysis. Data collected for one tapping season i.e., the year 1977 was put to analysis:

TABLE 8

Summary of total resin yield per plot (kg)

Site : Batrasi

Block	A	B	C	Block totals	Block means
I	51.090	46.410	23.216	120.716	40.572
II	58.975	48.580	24.540	132.095	44.031
III	55.230	46.530	22.900	124.660	41.553
IV	54.415	46.750	21.275	122.440	40.813
V	58.984	44.950	21.980	125.914	41.971
Treatment totals	278.694	233.220	113.911	625.825	
Treatment means	55.939	46.644	22.782		

TABLE 9

Summary of average resin yield per tree (kg)

Block	A	B	C	Block totals	Block means
I	3.473	3.094	1.548	8.115	2.671
II	3.932	3.239	1.636	8.807	2.932
III	3.682	3.102	1.527	8.311	2.770
IV	3.621	3.117	1.418	8.156	2.719
V	3.932	2.997	1.465	8.394	2.765
Treatment totals	18.640	15.549	7.594	41.783	
Treatment means	3.728	3.109	1.519		

TABLE 10

ANOVA

Source of variation (S.V.)	Degree of freedom (df)	Sum squares (SS)	Mean squares (MS)	'F' Value
Blocks	4	25.353	6.338	1.575 NS
Treatments	2	2897.064	1448.532	360.152 **
Error	8	32.178	4.022	
Total:	14	2954.595		

Standard error of difference of means $= S(\bar{x}_1 - \bar{x}) = 1.268$

t (.05, 8 df) = 2.306

t (.01, 8 df) = 3.355

L S D (.05) = 2.306 × 1.268 = 2.924

L S D (.01) = 3.355 × 1.268 = 4.254

Difference between the means are:

A — B = 9.295 **

A — C = 33.157 **

B — C = 23.862 **

All the means are highly significant.

A and B both are better than C but within the two, A is better than B. The yield from treatment A being more than double as compared to the control.

Following is the comparison between the anticipated and actual resin yield:

Treatment	Anticipated yield per tree (kg)	Actual yield per tree (kg)	Difference
40% H_2SO_4 solution	2.56	3.73	+1.17
50% H_2SO_4 solution	2.66	3.11	+0.45
Untreated	2.14	1.52	—0.62

Both the acid treatments have given more yield than anticipated but it is lower in the case of control. It may be stated that according to Punjab Forest Leaflet No. 13, yield of resin from chir trees in the first year is generally lower than the subsequent years. As indicated it would be possible to increase annual yield by one hundred percent by using 40% H_2SO_4 solution in conjunction with American bark hack method.

High yielders. Some new high yielders have been added to the list at both the sites. All the trees were under the 40% H_2SO_4 solution treatment. However, 5 trees in Baz Khan and 5 trees in Batrasi have continued to be high yielders for all the four years. 14 high yielders have been marked in the new experiment, the basis being more than 4 kg yield of resin per tree.

Other relevant data. Rain and temperature data have been collected from Shinkiari meteorological station, a place located about 8 kilometer from both the sites as the crow flies.

Total face heights by treatments have been measured. Yield per tree-by numbers has also been given in appendix II.

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