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Optimization process to study the effect of black pepper (*Piper nigrum*) and turmeric (*Curcuma longa*) powder on physico-chemical properties of burfi

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Abstract
The present study was carried out for the development of burfi with the addition of black pepper (*Piper nigrum*) and turmeric (*Curcuma longa*) powder. The process of development of the addition of black pepper (*Piper nigrum*) and turmeric (Curcuma longa) powder was successfully optimized by using response surface methodology (RSM). The study was conducted in the Department of Animal Husbandry and Dairy Science, College of Agriculture, VNMKV, Parbhani. The sensory characteristics of thirteen formulations with three levels of black pepper (0.6%, 0.8%, 1.0%) and turmeric powder (0.5%, 1.0%, 1.5%) were evaluated as per Central Composite Rotatable Design (CCRD) and the different component was optimized using Response Surface Methodology. Besides, optimized burfi comprising 1.01 percent turmeric and 0.90 percent black pepper powder on a khoa weight basis was optimized for sensory and physicochemical properties. Sensory evaluation of the product was carried out by the panel of experts for the parameters, color and appearance, body and texture, flavor, and overall acceptability by using 9 points hedonic scale. It was observed that due to the incorporation of black pepper and turmeric powder there is the increase in the nutritional content of burfi as well as shelf life as both ingredients are acting as natural preservatives. Hence considering the benefits of supplementation of black pepper and turmeric powder in the diet; concerning its nutritional, medicinal value, and technological properties. It is decided to study the effect of the addition of black pepper and turmeric powder on the physic-chemical properties of burfi.

Keywords: Burfi, black pepper, turmeric, sensory evaluation, physico-chemical properties and response surface methodology

Introduction
Burfi is one of the trendy and promoted *khoa-based* indigenous sweets. It is a product with a smooth texture white to light cream in color and has a very fine grains firm body. Addition of sugar in different quantities and other ingredients incorporated according to the consumer's insist. Different varieties of Burfi are sold in the market *viz*. *Rava* Burfi, plain, chocolate, nut (Kaju and pista), and coconut. Many variations are observed in sensory and chemical composition characteristics in market samples of Burfi. The huge variations in market samples were caused due to non-existence of officially permitted standards. Burfi is one of the most popular traditional dairy-based sweets in the Indian market. It is prepared by a heating special type of *khoa* called *dhap khoa* with sugar to a homogenous consistency (Chetna *et al*., 2009) [28]. Spices and herbs have been in use for a long time, both for culinary and medicinal purposes. Spices enhance the flavor, aroma, and color of food and beverages as well as protect from acute and chronic diseases (Jiang, 2019) [7]. People are now more conscious of health and health risks, so there is a need to develop sweet products fortified with health beneficiary herbs and spices. Turmeric, *Curcuma longa* L. (Zingiberaceae) is a common spice used traditionally for cancer-fighting. It is a golden spice resulting from the rhizome of the Curcuma longa plant. Turmeric exhibits anti-HIV, anti-bacterial, nematocidal, antiparasitic, antispasmodic, and anti-carcinogenic activities (Tanvir *et al*., 2017) [18]. A hot water extract of the dried rhizome has been taken orally to slow lactation and regulate fat metabolism (Bhowmik *et al*., 2009) [1]. Black pepper is one of the worldwide most used spices. It is obtained from unripe fruits, called peppercorns, of the plant species *Piper nigrum* L, of the *Piperaceae* family. Piperine is the main chemical constituent of this plant, which has diverse activities such as central nervous system depression, cytotoxic, anti-inflammatory, and hepatoprotective effects, as well as the ability to enhance bioavailability (Hammouti *et al*., 2019) [6].

Black pepper and turmeric powder added burfi is prepared like the indigenous burfi where *khoa*, black pepper, and turmeric (powder) are used in combination with an appropriate level of sugar. The present study was undertaken to optimize the preparation of black pepper and turmeric powder-based Indian dairy dessert (Burfi) using a statistical software tool namely Response Surface Methodology (RSM).

Materials and Methods

The experiment research work was carried out to prepare a burfi with the addition of black pepper (*Piper nigrum*) and turmeric powder (*Curcuma longa*) which was conducted in the laboratory of the Department of Animal Husbandry and Dairy Science, College of Agriculture, VNMKV, Parbhani, Maharashtra, India, during the year 2020-21. The materials used and the methodologies adapted are as under.

Materials

Good quality buffalo milk was obtained from the Dairy Unit of the Department of Animal Husbandry and Dairy Science, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, was standardized to 6% fat and filtered to remove dirt and other extraneous matter, before use. Good quality sugar, black pepper, and turmeric powder was procured from Parbhani local market. *Khoa* was prepared by heating milk in an iron pan (*karahi* having 31 cm diameter and 8.5 cm depth) as per the method described by Dharampal (1998) [29] with slight modification.

Methods

Preparation of black pepper and turmeric added burfi

Burfi was prepared by following the traditional method of preparation as suggested by Dharampal (1998) [29] with slight modification. The received milk was preheated at 35-40 ºC before filtration. The standardized buffalo milk was taken in an iron *karahi* and heated on a gentle fire. The stirring-cum-scrapping process was continued till a pasty consistency was reached. After *the khoa* formation stage, as per the treatment, parts of black pepper, turmeric powder, and sugar 30% by weight of *khoa* were added. Stirring it continuously with wooden khunti on low flame until solid mass stage. Spread this solid mass into the tray and keep it for cooling. After setting, cut it into square blocks and store them at room temperature in cardboard boxes for further study.

Procedure of Methodology

Preparation of shrikhand

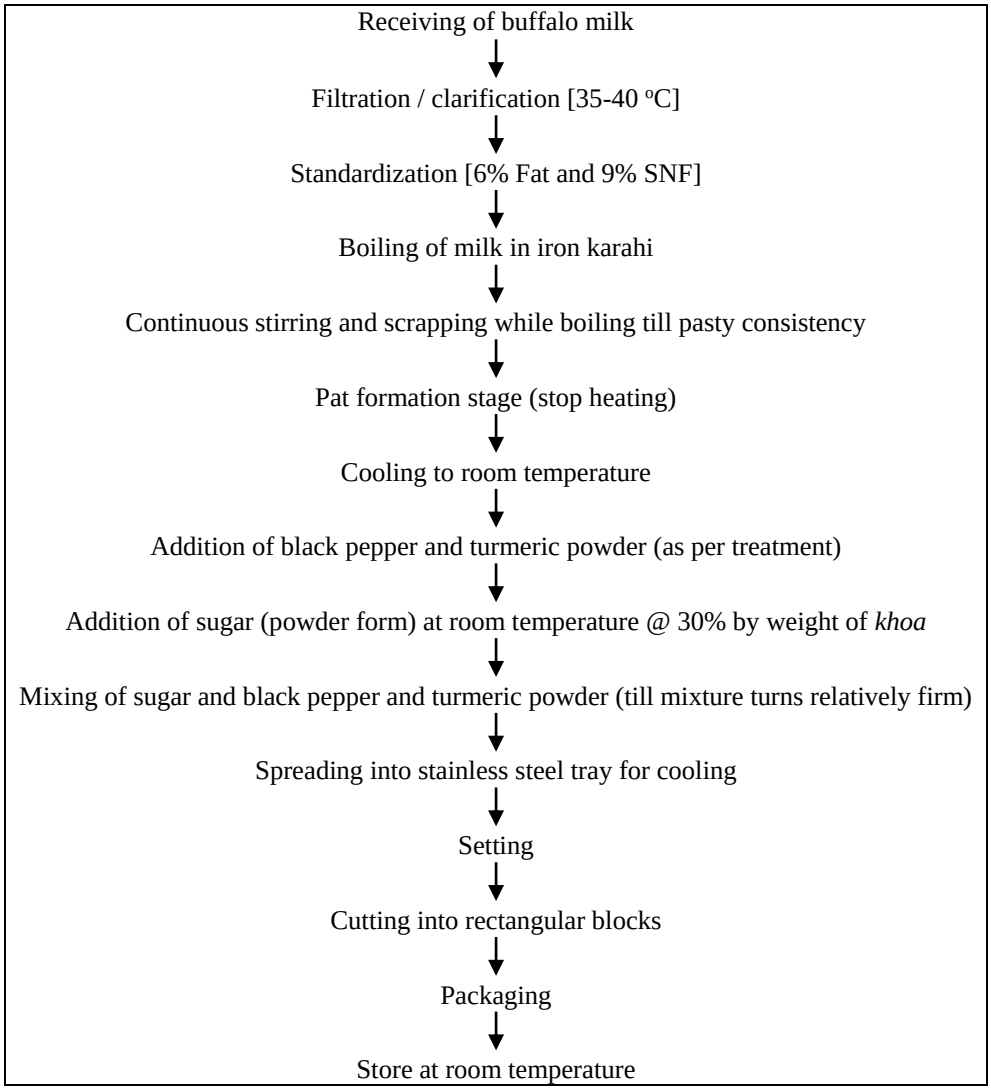

Fig 1: Flow-chart for preparation of Burfi with addition of black pepper powder and turmeric powder (Procedure according to (Dharampal 1998) [29], with slight modification

Sensory evaluation

The samples of black pepper and turmeric powder added burfi prepared from thirteen formulations were evaluated by the panel of ten judges from the Department of Animal Husbandry and Dairy Science and College of Food Technology, VNMKV, Parbhani concerning the flavor, colour, and appearance, body and texture and overall acceptability attributes by using 9-point hedonic scale described by (Gupta 1976) [5]. Water and taste breakers (Potato chips) were also presented to each panel list for rinsing of their mouths between samples evaluation.

Chemical Analysis

The burfi added black pepper and turmeric powder were chemically analyzed for moisture as per the procedure described by ISI: 2785 (1964) [12], fat by ISI: 1224 (part II) (1977) [10], protein as per the procedure described in ISI: (1981) [11], ash by ISI: 1547 (1985) [8], total solids estimated as per the procedure described in ISI: (1981) [11], carbohydrate was determined by subtraction method and dietary fiber were estimated as per the method described in AOAC method (1975) [1].

Optimization of levels of black pepper and turmeric powder

The RSM was developed to overcome those disadvantages by reduction of the number of experimental trials needed to evaluate multiple parameters and their interactions, thus less time-consuming compared to other approaches. RSM has been widely applied in optimization processes in food industries (Pisecky, 1985; Arnous *et al*. 2001; Giusti & Wrolstad, 2001; Klaypradit & Huang, 2008) [30, 31, 32, 33]. The design of experiments (DOE) is a mathematical and statistical technique for designing experiments and evaluating the effects of factors. It also finds the optimum conditions of factors for desirable responses (Quek *et al*. 2007) [34]. The levels of black pepper powder and turmeric powder in *khoa* (w/w) based on sensory attributes were evaluated and optimized by response surface methodology (RSM) by the method described by (Myers and Montgomery, 2002) [13]. The levels of turmeric powder and black pepper powder factors were two and the experimental design was set up with experimental points having 5 replicates at the center. The center points of the experimental design were defined as 1.0 percent turmeric powder and 0.8 percent black pepper powder as shown in Table 1.

Table 1: Optimization of Levels of turmeric powder and black pepper powder using RSM

Sr. No	Variables	-1	0	+1
1.	Turmeric powder (A)	0.5	1.0	1.5
2.	Black pepper powder (B)	0.6	0.8	1.0

Data Analysis

The experiments were performed and responses were fitted in the design. After each individual experiment, responses were analyzed to assess the effect of independent variables on them. The first order or second order polynomial equation (Eq.1) examines the statistical significance of the model and the following form was fitted to the responses:

Numerical optimization technique of the Design Expert software (9.0.6.2) was used for simultaneous optimization of the multiple responses. The desired goals for each factor and responses were chosen. Responses obtained after each trials were analyzed to visualize the interactive effect of various parameters on sensory properties of fiber enriched shrikhand.

$$Y = b0 + b1X1 + b2X2 + b3X3 + b4X4 + b5X5$$

Where,
Y = response (dependent variable),
xi = level of inulin (coded independent variable),
x_2= level of psyllium (coded independent variable),
x_3= level of PHGG (coded independent variable)
bo, b1, b2, b3, b4 and b5 = response model coefficient.

Table 2: Sensory scores of black pepper and turmeric powder added burfi with different combinations of black pepper and turmeric powder

Standard Order	Turmeric powder %	Black paper powder %	Flavour	Colour and Appearance	Body and Texture	Overall acceptability
1	0.50	0.60	6.00	6.9	6.9	6.6
2	1.50	0.60	6.6	7.0	7.0	6.8
3	0.50	1.00	8.6	7.0	7.3	7.6
4	1.50	1.00	8.5	7.4	7.4	7.7
5	0.29	0.80	7.8	6.5	7.0	7.1
6	1.71	0.80	6.9	7.0	7.2	7.0
7	1.00	0.52	6.2	7.9	7.3	7.1
8	1.00	1.08	8.9	8.0	8.0	8.3
9	1.00	0.80	8.7	7.6	8.7	8.4
10	1.00	0.80	7.8	8.5	8.4	8.2
11	1.00	0.80	8.0	8.4	8.1	8.1
12	1.00	0.80	8.0	8.1	8.0	8.0
13	1.00	0.80	7.9	8.3	8.1	8.1

Table 3: Coefficient of full second order polynomial model for coded sensory responses to different levels of ingredients in Burfi prepared by addition of turmeric and black pepper powder

Factor	Flavour	Colour and Appearance	Body and Texture	Overall acceptability
Intercept	8.40	8.44	8.64	25.48
A-Turmeric powder	-0.097*	0.15	0.060	0.040 *
B-Black pepper	1.04	0.098	0.28	1.34
A2	-0.53 *	-0.92 *	-0.84	-2.26
B2	-0.43 *	-0.30*	-0.49	-1.18
AB	-0.18*	0.075	0.0001*	0.050*
R2	0.94	0.95	0.95	0.98
Adequate Precision	14.18	15.025	13.066	18.57
PRESS	3.53	1.50	1.70	4.69
Model 'F' value	25.20	31.56	33.28	76.95
AB	-0.18	0.075	0.0001*	0.050*

*Significant at 5% level ** Significant at 1% level

Table 4: Verification of predicted sensory quality of optimized black pepper and turmeric powder added burfi prepared with optimum combination of black pepper and turmeric

Parameter	Predicted score*	Actual score*	* Calculated t value
Flavour	8.7	8.9	2.46
Body and Texture	8.7	8.8	2.45
Colour and appearance	7.6	8.0	2.26
Overall acceptability	8.4	8.6	3.88

♦Average of triplicate experiments
Table't' 0.05 is 7.54

It is evident from table 4 that the actual sensory score of Burfi prepared by the addition of black pepper and turmeric powder was slightly higher than predicted, though statistically, the difference was non-significant. The optimized combination comprising 1.01 % turmeric powder and 0.90 percent black pepper powder resulted in Burfi prepared by the addition of black pepper and turmeric powder rated 8.9 score which was for flavor, 8.8 for body and texture, 8.6 for colour and appearance and 26.3 for overall acceptability. Thus it had highly desirable sensory quality.

Results and Discussion

Effect of Process Variables on chemical attributes of attributes of burfi shrikhand

The sensory parameters chosen to evaluate the quality of black pepper and turmeric powder added burfi were flavor, body and texture, colour and appearance, and overall acceptability. The sensory scores of thirteen formulations of black pepper and turmeric powder added burfi with different proportions of black pepper (0.52 - 1.08%) and turmeric (0.29 -1.71%) depicted in Table 2, revealed that black pepper and turmeric powder added burfi with 1% turmeric and 0.80% black pepper powder obtained the highest scores in respect of flavor (8.7), body and texture (8.7), colour and appearance (7.6) and overall acceptability (8.4). Physico-chemical composition of Burfi prepared by addition of black pepper and turmeric powder

For optimization of Burfi prepared by addition of black pepper and turmeric powder using two ingredients each of with three levels was carried out using Design Expert software (8.0.7.1 version) Response Surface Methodology Technique. This software suggests 13 formulations comprising different level of black pepper and Turmeric powder. The products were prepared as per the formulations and total 13 experiments were conducted and the product was subjected for sensory evaluation. Based on results obtained to sensory evaluation of Burfi prepared by addition of black pepper and Turmeric powder with different levels of black pepper and Turmeric powder suitable level of these ingredients were selected for further investigation. The optimized formulation contributes 1.01 per cent turmeric and 0.90 per cent black pepper powder. The best product selected on the basis of sensory evaluation was subjected to the chemical composition.

Table 5: Chemical composition of optimized Burfi prepared by addition of black pepper and Turmeric powder

Sr. No.	Characteristics	Composition (%)
1	Moisture	16.82
2	Fat	17.14
3	Protein	14.67
4	Ash	2.34
5	Crude fiber	0.23
6	pH	6.85
7	Acidity	0.45
8	Total solid	83.18
9	SNF	66.04
10	Carbohydrates	49.03

The average chemical composition of Burfi prepared by the addition of black pepper and Turmeric powder was prepared in the laboratory with 1.01 per cent turmeric and 0.90 per cent black pepper powder is given in table 4.6. It was observed that the average moisture of the final product was 16.82 percent, 14.67 per cent protein,17.14 per cent fat, 2.34 per cent ash, 0.23 per cent crude fiber, 83.18 per cent total solids, 6.85 pH, 0.45 acidity, 49.03 per cent carbohydrates, 66.04 per cent SNF.

1. Acidity

Acidity in Burfi prepared with addition of black pepper and turmeric powder showed variation due to incorporation of different levels of black pepper and Turmeric powder. It ranged from 0.32 to 0.50. It was found that addition of black pepper and turmeric powder increases acidity. Experiment no. 5 i.e. Burfi prepared from 0.29 per cent level of turmeric and 0.80 per cent black pepper gives 0.47 acidity. Here, the increase in level of both the ingredient showed increases the level of acidity with Experiment no. 6 i.e. highest treated Burfi having 1.71 turmeric level and 0.80 per cent black pepper level obtained acidity 0.46. The optimized Burfi prepared with 1.01 per cent turmeric and 0.90 per cent level of black pepper gives 0.45 acidity as given in table 5.

2. pH

pH in Burfi prepared with addition of black pepper and Turmeric powder showed variation due to incorporation of different levels of black pepper and Turmeric powder. It ranged from 7.40 to 6.66. It was found that addition of black pepper and turmeric powder deceases pH level. Experiment no. 5 i.e. Burfi prepared from 0.29 per cent level of turmeric and 0.80 per cent black pepper gives 6.66 pH acidity with Experiment no. 6 i.e. highest treated Burfi having 1.71 turmeric level and 0.80 per cent black pepper level obtained acidity 6.89. The optimized Burfi prepared with 1.01 per cent turmeric and 0.90 per cent level of black pepper gives 6.85 pH as given in table 5.

3. Moisture

Moisture content in Burfi prepared with addition of black pepper and Turmeric powder showed variation due to incorporation of different levels of black pepper and Turmeric powder. It ranged from 15.06 to 17.96. It is found that addition of black pepper and turmeric powder decreases moisture per cent. Burfi prepared from 0.29 per cent level of turmeric and 0.80 per cent black pepper i.e. Experiment no. 5 gives 15.20 per cent moisture content. Highest treated Burfi i.e. Experiment no. 6 having 1.71 turmeric levels and 0.80 per cent black pepper level obtained 16.94 per cent moisture. The optimized Burfi prepared with 1.01 per cent turmeric and 0.90 per cent level of black pepper gives 16.82 percent moisture content as given in table 5.

4. Protein

It was observed that the increased in turmeric and black pepper per cent in Burfi result in decrease in protein per cent. Protein content ranged from 12.50 to 14.67 per cent. Burfi treated with least content 0.29 per cent turmeric and 0.80 per cent black pepper i.e. Experiment no. 5 powder gives 14.29 per cent protein content while highest treated turmeric Experiment no. 6 i.e.1.71 per cent and black pepper with 0.80 per cent gives 12.50 per cent protein content. The optimized Burfi prepared with 1.01 per cent turmeric and 0.90 per cent level of black pepper showed 14.67 per cent protein content as given in table 5.

5. Total solids

It was observed that the increased in turmeric and black pepper per cent in Burfi result in decrease in total solid per

cent. Total solid content ranged from 84.94 to 82.04 per cent. Burfi treated with least content 0.29 per cent turmeric and 0.80 per cent black pepper powder i.e. Experiment no. 5 gives 84.80 per cent total solids content while Experiment no. 6 i.e. highest treated turmeric 1.71 per cent and black pepper with 0.80 per cent gives 83.06 per cent total solid content. The optimized Burfi prepared with 1.01 per cent turmeric and 0.90 per cent level of black pepper showed 83.18 per cent total solid content as given in table 5.

6. Ash

It was observed that the increased in turmeric and black pepper per cent in Burfi result in decrease in ash per cent. Ash content ranged from 1.22 to 3.78 per cent. Experiment no. 5 i.e Burfi treated with least content 0.29 per cent turmeric and 0.80 per cent black pepper powder gives 1.96 per cent ash while Experiment no. 6 i.e highest treated turmeric i.e.1.71 per cent and black pepper with 0.80 per cent gives 2.62 per cent ash. The optimized Burfi prepared with 1.01 per cent turmeric and 0.90 per cent level of black pepper showed 2.34 per cent ash content as given in table 5.

7. Carbohydrate

It was observed that the increased in turmeric and black pepper per cent in Burfi result in increase in carbohydrate per cent. Carbohydrate content ranged from 43.65 to 54.29 per cent. Experiment no. 5 i.e. Burfi treated with least content 0.29 per cent turmeric and 0.80 per cent black pepper powder gives 51.43 per cent carbohydrate while Experiment no. 56 i.e. highest treated turmeric i.e.1.71 per cent and black pepper with 0.80 per cent gives 52.28 per cent carbohydrate. The optimized Burfi prepared with 1.01 per cent turmeric and 0.90 per cent level of black pepper showed 49.03 per cent carbohydrate content as given in table 5.

8. SNF

SNF in Burfi prepared with addition of black pepper and Turmeric powder showed variation due to incorporation of different levels of black pepper and Turmeric powder. It ranged from 62.1 to 69.46. Experiment no. 5 i.e. Burfi prepared from 0.29 per cent level of turmeric and 0.80 per cent black pepper gives 67.68 SNF per cent. Experiment no. 6 i.e. Burfi having 1.71 turmeric level and 0.80 per cent black pepper level obtained 67.40 SNF per cent. The optimized Burfi prepared with 1.01 per cent turmeric and 0.90 per cent level of black pepper gives 66.04 SNF as given in table 5.

9. Crude Fiber

Crude fiber content in Burfi prepared with addition of black pepper and Turmeric powder showed variation due to incorporation of different levels of black pepper and Turmeric powder. It ranged from 0.12 to 0.62. It is found that addition of black pepper and turmeric powder increases crude fiber level. Experiment no. 5 i.e. Burfi prepared from 0.29 per cent level of turmeric and 0.80 per cent black pepper gives 0.37 per cent crude fiber. Experiment no. 6 i.e. highest treated Burfi having 1.71 turmeric level and 0.80 per cent black pepper level obtained 0.25 per cent crude fiber. The optimized Burfi prepared with 1.01 per cent turmeric and 0.90 per cent level of black pepper gives 0.23 percent crude fiber as given in table 5.

10. Fat

Fat content in Burfi prepared with addition of black pepper and Turmeric powder showed variation due to incorporation of different levels of black pepper and Turmeric powder. It ranged from 15.32 to 19.94. It is found that addition of black pepper and turmeric powder decreases the fat level. Experiment no. 5 i.e. Burfi prepared from 0.29 per cent level of turmeric and 0.80 per cent black pepper gives 19.94 per cent fat while the Experiment no. 6 i.e. highest treated Burfi having 1.71 turmeric level and 0.80 per cent black pepper level obtained 15.32 per cent crude fat. The optimized Burfi prepared with 1.01 per cent turmeric and 0.90 per cent level of black pepper gives 17.14 per cent fat as given in table 5.

Conclusion

In conclusion, the trials were conducted according to the experiments and CCRD were used to study the physico-chemical properties of black pepper and turmeric powder added burfi. The RSM was used to optimize the processing conditions using flavour, colour and appearance, body & texture and overall acceptability score as responses. The models for flavour, colour and appearance, body & texture and overall acceptability score were statistically significant. By superimposing the graphs, an optimum development process i.e. containing 1.01 per cent turmeric and 0.90 per cent black pepper powder was recommended with predicted responses close to experimental values. The physico-chemical properties of black pepper and turmeric powder added burfi attributes that were in the range of required for specific standard on consumer acceptability with promising health benefits.

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